HPGCL

HARYANA POWER GENERATION CORPORATION LIMITED

1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR, HARYANA

EPC PACKAGE TENDER SPECIFICATION

VOLUME - III

MECHANICAL

Job No	D - 4041	Name / Sign	Date	
Prepared By		BHS/EVA	26.12.2022	
Checked By		BHS/EVA	26.12.2022	
Approved By		BHS	04.01.2023	
Document No.		4100	REV. No.	0

SELF-RELIANCE IN ENGINEERING
DESEIN

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CHAPTER - 1

STEAM GENERATOR AND AUXILIARIES

SECTION I

1.0 Scope of supply & services for Steam Generator (SG) Package shall include all equipment required for one (1) once through, single/double pass (tower type/two pass type), single reheat, radiant furnace, dry bottom, balanced draft, outdoor or semi-outdoor type, pulverised coal fired steam generating unit having supercritical steam parameters with all necessary auxiliaries, integral piping, elevators, etc. Items though not specifically mentioned but needed to complete the equipment and systems to meet the intent of specification, shall be deemed to be included in scope of work.

Biomass Co-Firing

MoP vide its policy dated 17.11.2017 on biomass utilization fpr power generation had advised all fluidized bed and pulverized coal units (coal based thermal power plants) except those having ball and tube mill, of power generation utilities, public or private, located in India, to endeavour to use 5-10% blend of biomass pellets made, primarily, of agro residue along with coal after assessing the technical feasibility, viz. Safety aspect etc.

In order to further promote the use of biomass pellets in coal based thermal power plants, MoP modified the above policy vide letter no. 11/86/2017-Th.II dated 08.10.2021 wherein it was stated that coal fired thermal plants in India have to mandatorily co-fire the biomass with coal in their power plant. The "Revised Policy" would be in force for a period of 25 years or till the useful life of the power plant, whichever is earlier. The steam generator should should be able to accommodate future stringent biomass co-firing norms. Stream Generator should be designed for minimum 10% co-firing with Biomass Torrefied Pellets. Performance Guarantees will be on the basis of design coal.

The Bidder shall prepare and submit the scheme and layout of Steam Generator and auxiliaries and Detailed Design Basis Report of Steam Generator and auxiliaries based on equipment / system requirements given in this specification. The Bidder shall include all necessary equipment / accessories required for a modern and efficient Steam Generator and its auxiliaries whether specifically mentioned in this specification or not. The entire DBR, technical performance parameters /data sheets scheme and Layout arrangement for Steam Generator and auxiliaries shall be submitted to the Owner for approval during detailed engineering and any other arrangement / equipment as desired and approved by the Owner shall be provided by the Bidder as a part of this scope.

The scope of supply and services for steam generating unit shall include all items indicated but will not be limited to the following:

1.1 **Furnace/Evaporator**

a) Water tube furnace complete with separator(s), water wall, headers, steam generating tubes, risers, furnace bottom hoppers, drains, observation ports, inspection doors/manholes, sample connections, Metal Temperature Measurement thermocouples etc.

b) Two (2) retractable type temperature probes with duplex type elements at the furnace outlet, complete with all accessories like guiding supports, cooling arrangement, motor with position indicator etc.

1.2 **Separator(s) & Drain collection vessel**

Minimum two (2) steam separators along with a drain collection vessel at the evaporator outlet. The separator(s) and drain collection vessel shall be of welded construction/ seamless tube with all its internals (if applicable), safety valves, mountings, fittings and accessories including the nozzle for connections and service manholes for checking and maintenance, necessary tapping points along with root valves for level measurement, drains, valves, piping and associated fittings.

1.3 **Super heater(s)**

Superheater(s) including safety valves, main steam stop valves at superheater outlet with integral bypass valves, drains, start up vents, air release valves, nitrogen connections, sampling connections, MTM thermocouples etc.

1.4 **Reheater(s)**

Reheater(s) including safety valves, drains, start up vents, air release valves, sampling connection, reheater inlet and outlet isolators, MTM thermocouples, hydraulic test arrangement of reheater tubes etc.

1.5 **Economizer**

In line, bare tube economizer, including vents, re-circulation system, drains and sampling connections, inlet NRV, motorized valve with integral by pass, Boiler preservation line through Economizer. etc.

1.6 **Start-up Recirculation & Drain system**

The scope shall include but will not be limited to following

1. 1x100% start-up drain recirculation pump complete with connecting pipe work between separator/drain collection vessel and the pump and between pump and the feed water supply pipeline along with necessary separator/drain collection vessel level control and isolation valves.

2. Double isolation (one motorised and one manual) valve at the suction and Motorised isolation, electrohydraulic operated control valve and a non return valve on the discharge of the pump.

   Alternatively, electrohydrualic operated control valve and a motor operated stop cum check valve is also acceptable.

3. A mixing box on the pump suction, a non return valve and motorized isolation valve upstream of the mixing box on the recirculation line from separator. Piping between the mixing box and the feed water supply line with a NRV on this line. Other proven standards systems with startup drain circulation pumps are also acceptable provided bidder has proven experience on satisfactory performance of such system(s) in supercritical units of similar capacity which are designed

for variable pressure operation. In case bidder offers startup circulation system without mixing box, bidder shall furnish necessary data/information in support in his bid proposal.

4. An alternate drain connection to enable start up of steam generator even when the start up drain recirculation pump is not in service shall also be provided. The system shall comprise of an atmospheric flash tank and drain receiving vessel located in the Steam Generator area and shall be complete with all necessary valves, piping, level control system etc. The start-up drain from the separator(s)/ Drain collection vessel to atmospheric flash tank shall be led through twin piping leg, each leg being provided with a motorised isolation valve and an Electro- hydraulic operated control valve. 2 x 100% pumps to transfer condensate from the receiving vessel to the main condenser either directly or through flash tank shall also be provided along with all necessary valves and discharge piping.

5. Vent pipe from atmospheric flash tank terminated above boiler roof level.

6. Circulating water pump motor shall be provided with cooler along with necessary valve and connecting cooling water pipelines.

7. All necessary instruments, like conductivity type level switches and level transmitters, pressure gauges etc., with necessary root valves to function in conjunction with the above

1.7 Superheater and Reheater Desuperheating Spray Systems

Desuperheating spray type attemperators with headers shall be provided for the spray for Superheaters and Reheaters. The superheater spray water shall be tapped off from a suitable location downstream side of HP heaters. However, for Reheater desuperheating, the spray water shall be tapped off from the intermediate stage of Boiler Feed Pumps. The super-heater spray water shall be tapped off from downstream side of HP heaters only.

1.7.1 Each leg of each stage of desuperheating spray system for superheater shall be provided with the following:

a) Two (2) pneumatically operated spray control valves, each rated for the full duty.

b) Two (2) pneumatically/motor operated isolating valves upstream of the spray control valves

c) Two (2) manual operated isolating valves downstream of spray control valves.

d) Drain lines with individual isolating valves.

e) Quick acting pneumatically/motor operated block valve (with solenoid) at upstream of each superheater spray control station & in the common super heater attemperation line.

f) Non return valves in each individual spray leg nearest to the spray point.

g) Welded type attemperation water flow nozzle before/after spray

control valve in the common line along with all accessories for flow measurements and controls.

h) Provision for blow down arrangements after downstream of NRV to clear Spray nozzle blockage.

1.7.2 Each leg of reheater desuperheating spray water system shall be provided with the following:

a) Two (2) pneumatically operated spray control valves each rated for full duty.

b) Two (2) pneumatically/motor operated isolating valves upstream of the spray control valve.

c) Two (2) manual operated isolating valves downstream of spray control valve.

d) Non-return valves in each individual spray leg nearest to the spray point.

e) Drain lines with individual isolating valves.

f) A pneumatically operated quick acting block valve (with solenoid) in common RH attemperation line, upstream of each Reheater spray control station.

g) Welded type attemperation water flow nozzle before/after spray control valve in the common line along with all accessories for flow measurements/ controls

h) Provision for blow down arrangements after downstream of NRV to clear Spray nozzle blockage

i) Non-return valves in the individual spray lines on the downstream of spray control valves

1.8 **VALVES**

All isolating, control, regulating, check and relief valves whether pneumatically operated, motorized valves, hydraulic or manually operated including main steam stop valves, vent valves, drain valves, root valves, safety valves, mountings etc., as required for the boiler integral piping system and piping system are covered in scope of supply. All power operated valves shall be complete with actuator assemblies and accessories like limit switch assemblies, position transmitters, air locks etc. Integral bypass valves with actuators and accessories for all high pressure isolating valves as specified. Any valve/mounting not specifically indicated but required for safe/efficient/reliable operation of the boiler shall also be included. The valves and accessories shall comply with the following requirements and shall include:

a) All drain, vent, air release, instrument root, isolation drains and sampling lines shall be provided with two valves in series if the pressure is equal to or above 40 Kg/cm^2(a) or temperature is above 300^0 C. However, single isolating valve shall be acceptable in the other cases.

b) Main steam stop valves with motor drives along with double motorised integral bypass valves and piping.

c) All necessary level control valves, electro hydraulic operated fast acting valve with safety features, their isolating valves, bypass valves, non-return valves and drain valves etc., for the start up recirculation circuit.

d) One non-return valve and flow element on feed line(s) at inlet and as close as possible to the economizer.

e) Separator safety valves and drain pans.

f) Superheater and reheater safety valves and the drain pans for these.

g) Electromatic Relief Valves (ERV) on SH outlet and RH outlet. Each of these electromatic relief valves at SH and RH outlet(s) shall be composite unit including solenoid valve assembly, pressure sensing device, impulse piping, accessories, and the drain pans etc. A motorised remote operated isolation valve shall be provided on upstream side of each relief valve. The control of ERV along with the motorised valve shall be performed from C&I system.

h) Start-up drain and vent regulating valves with motor drives and position feedback transmitter with control from C&I system.

i) Start-up drain and vent isolating valves with motor drives with control from C&I system.

j) All start-up vents, first lowest & second lowest set pressure spring loaded safety valve and electromatic relief valves at superheater & reheater outlet and lowest set pressure spring loaded safety valves on Separator shall be provided with silencers for each safety valve. The silencers shall enable meeting specified noise levels and the safety/ relief valve floats.

k) All instruments tapping point with root valves. Two root valves in series shall be provided for lines above 40 kg/cm^2 (a) pressure and temperature above 300^0C.

l) Isolating and drain valves for all gauge glasses.

m) Necessary drain system including low noise drain valve to ensure draining of the steam generators in one hour without any assistance.

n) A non-return valve and isolation valve on boiler fill line.

o) Any other valves not mentioned specifically but needed to complete the system with drives, wherever required.

p) Valves on atmospheric flash tank drain cooling water pipelines.

q) The start-up, load maneuvering and shut down of steam generator is proposed from the central control room. The Bidder shall provide all required valves with their actuators and remote operation facilities to achieve this.

r) All other operational requirements specified elsewhere shall also be complied with. The Bidder shall provide all required valves with specified type of actuator to meet such operational requirements.

1.9 Soot Blowing System

Soot blowers and soot blowing system shall be provided to effectively remove all ash deposits from the heat transfer surfaces of the Steam Generator. Short retractable rotary wall blowers shall be provided for the furnace long fully retractable rotary blowers for superheater, reheater and economizer and LRSB for regenerative air preheater. Each blower shall be provided with motor drive with coupling and coupling guards, base plate frame and holding bolts, speed reducers, cam, chain drives and other ancillaries, emergency hand cranks, flanges, gaskets, seals and bearings for each soot blower and its supporting structures. Additional provision for air soot blowing shall also be provided as applicable.

Soot blower piping including supply piping to all soot blowers through pressure reducing station, drain piping, vent piping, relief valves and escape piping with silencer, support & hangers etc. Complete soot blower piping shall have warm up and automatic self draining features to preclude water being blown on to the heat absorption surfaces.

For soot blowing steam shall be taken for cold reheat (left & right) lines. However, in case bidder requires alternate connection from other source than the same shall be provided in addition of above.

Valves for soot blower operation shall include pneumatically operated pressure reducing control valves, (one control valve of 0-40% capacity for wall blowers, one control valve of 0-100% capacity for all types of blowers taken in service in any combinations, one standby 0-100% capacity motorised inching valve with position feedback, drain valves), isolating valves with motor drives up stream of each of pressure control valves, all other valves and steam supply lines as required for soot-blower operation, coupling, air purge, vent and relief valves etc. Manually operated isolation valves on steam supply line shall be provided at each stream of furnace blowers or as per standard proven practice of bidder. These valves shall be designed for full flow and shall be tight shut off type.

Soot blowing steam shall also be taken from main steam line before main steam stop valve for APH soot blowing during light-up.

Complete Soot Blower control system including individual blower/valve/drive control and shall be inclusive of control system components, control cabinets, transmitters, sensors, temperature elements, interlocks, prefabricated cables and all required accessories as elaborated under relevant Control & Instrumentation sub-section.

1.10 Auxiliary Steam Pressure Reducing and Desuperheating Station (Aux. PRDS)

The auxiliary steam pressure reducing and desuperheating station (Aux. PRDS) shall include the following for high capacity and low capacity PRDS.

A high temperature unit header with parameters 16 Kg/cm² (a) and 310°C and a low temperature unit header with parameters 16 Kg/cm² (a) and 210°C shall be provided.

The auxiliary steam shall be sourced for PRDS from Main steam line and Cold Reheat line.

1.10.1 **High Capacity PRDS (HCPRDS)**

Pressure reducing valve with separate desuperheater shall be provided by bidder.

HCPRDS with separate desuperheater

1. One (1) electro-hydraulically/electro pneumatically operated pressure reducing valve with separate desuperheater rated for full duty.

2. One (1) motorised isolation valve with integral bypass at the upstream of the pressure-reducing valve.

3. One (1) non-return valve and one number manual isolating valve at the downstream of pressure reducing valve.

4. One (1) each of pressure and temperature control valve electro hydraulically/electro pneumatically operated on the desuperheating spray water line along with an identical 100% capacity bypass arrangement.

5. One (1) motorised isolation valve at the inlet of each of electropneumatic control valve on the desuperheating spray water line

6. One (1) manual isolation valve at the downstream of each of electropneumatic control valve on the desuperheating spray water line. One number of non-return valve on the common spray water line

Bidder may offer Combined High Capacity (combined pressure reducing cum desuperheating valve) as an alternate one.

1.10.2 **Low capacity PRDS**

1. One (1) electro-hydraulically/electro-pneumatically operated pressure reducing valve rated for full duty.
2. One (1) motor operated pressure reducing valve rated for full duty on the bypass line to the main pressure reducing valve.
3. One (1) motorised isolation valve at the inlet of main pressure reducing valve and one number manual isolation valve on the outlet of the main pressure control valve.
4. One (1) motorised isolation valve at the inlet of the motor operated pressure reducing valve on the bypass line and one number manual isolation valve on the outlet of pressure control valve on the bypass line.
5. One (1) non-return valve on downstream side of low capacity PRDS.
6. One (1) desuperheater in between the interconnection of high and low temperature unit headers.
7. One (1) each of pressure and temperature control valve, electrohydraulically/electro-pneumatically operated on the desuper-

heating spray water line along with an identical 100% capacity bypass arrangement.

8. One (1) motorised isolation valve at the upstream of the pressure and temperature control valve on the main desuperheating spray water line.

9. One (1) motorised isolation valve on the upstream of motorised control valves on the bypass line of desuperheating spray water line.

10. One (1) manual isolation valve downstream of steam pressure reducing valve on each of the main and bypass line along with the downstream non return valve on the common header.

11. One (1) motorised isolation valve, upstream of the desuperheater on the interconnection of high and low temperature unit header along with one number non return valve and manual isolation valve on the downstream of the desuperheater.

12. Complete microprocessor based control system inclusive of control system components, control cabinets, transmitters, sensors, (temperature elements etc.) interlocks, prefabricated cables and all required accessories as elaborated under relevant clauses of this specification.

1.10.3. One (1) pneumatically operated quick acting block valve (with solenoids) upstream of the Desuperheating spray water control station in the common line feeding to the high capacity and low capacity desuperheating spray water control stations.

1.10.4. Necessary piping, draining arrangement with valves, etc., integral to the Aux. PRDS station along with safety valves. The safety valve downstream of the steam pressure reducing valve shall be designed for a flow corresponding to the pressure control valve fully open condition and the upstream mainsteam/cold reheat (as the case may be) pressure being maximum expected.

1.10.5. If PRDS valves are provided with electrohydraulic actuators, the required oil pumps, accumulators, E/H converter instrumentation and other accessories to make the system complete shall be provided. The oil pumps and accumulators shall have redundant facility.

1.10.6. If PRDS valves with pneumatic actuators are envisaged, microprocessor based electronic positioners with other accessories to make the system complete shall be provided.

1.10.7. All instrumentation as per the process requirements for Control/monitoring the plant.

1.10.8. All stub connections on Auxiliary Station unit/station Aux. PRDS headers are to be provided with isolation valves.

1.10.9. Isolation valves with blank flanges shall be provided on both low temperature as well as high temperature station headers for future interconnections.

1.10.10. Pressure Reducing Station for supply of steam to Air Conditioning Plant consisting of (if applicable):

a) One (1) electro-hydraulic/electro-pneumatic operated pressure reducing valve rated for full duty.

b) One (1) motor operated pressure reducing valve rated for full duty on the bypass line to main pressure reducing valve.

c) One (1) motorised isolation valve at the inlet of main pressure reducing valve and one number manual isolation valve on the outlet of main pressure reducing valve.

d) One (1) motorised isolation valve at the inlet of motor operated pressure reducing value on bypass line and one number manual isolation valve on the outlet of pressure reducing valve on bypass line.

1.10.11. Package type (start-up) Boiler shall be arranged by the bidder based on the steam requirement and can be taken back after commissioning.

1.11. **Steam Generator Integral piping**

All integral piping/fittings required for proper, efficient and safe operation of Steam Generator including links, headers, drains, vents and other integral piping. The piping shall be designed to meet the requirements of Indian Boiler Regulations (IBR) and the requirements indicated in Steam Generator Specifications. Any piping not specifically excluded and required for completion of Steam Generator and specification requirements shall be provided.

1. The scope covers all piping upstream and downstream of the Main Steam Stop Valve (MSSV) with by-pass arrangement upto turbine including valves and piping, complete drain piping from various headers, desuperheaters, equipment and Separator etc. to drain collection headers, all piping downstream of and including the NRV on the feed water piping at economizer inlet, all piping associated with start-up recirculation drain system, all auxiliary steam piping to SCAPH, mill fire fighting, fuel oil atomisation etc. and drain piping from SCAPH tank(s) to atmospheric flash tank. Main steam pipeline downstream of MSSV leading to turbine.

2. Drain collection headers and drain connection lines up to atmospheric flash tank.

3. All drain piping from safety valves and drains of vent lines led to and terminated at ground level. All free drains, wash water drains discharge of fire-fighting water etc., shall be taken up to and connected to the nearest drain.

4. All vent pipes and safety valves escape pipes to a level above boiler house roof. The vents on the headers and links shall be provided with drain lines connected to a common trough and further to and terminated at the drain trench at the ground level.

5. All hangers and supports with auxiliary steel structure, including columns and beams, base plates, foundation bolts, nuts and washers wherever applicable, weather hoods for pipes crossing ceiling & walls, drain funnel.

6. Thermal insulation with cladding and accessories for all piping covered herein.

7. Cooling water lines for atmospheric flash tank for cooling of tank drains.

8. Superheater (SH) & reheater (RH) attemperation lines along with attemperation system

9. Boiler-fill lines, SCAPH line & valves
10. Start-up vent piping.
11. Soot blower piping.
12. Instrument air & service air piping.
13. All the above piping systems shall be complete with valves, specialties, stubs including instrument stubs pipe headers, manifold, bends, elbows, reducers/expanders, matching flanges and suitable gaskets, nuts and bolts, etc. T-connections along with root valves in impulse pipes from where tappings are required to be taken for remote measurement in case provision does not exist for separate tapping points from the equipment for remote measurement and control. However, all such T-connections and tapping points shall be subject to approval.
14. Drain lines upto atmospheric flash tank, as applicable.
15. Complete purge/fill piping for Steam Generator start-up recirculation pump and complete drain piping for this pump.
16. The auxiliary steam station headers shall be provided with necessary isolation valves and blank flange(s) for interconnection between the units and for future interconnection with other units.
17. Interconnecting auxiliary steam piping from auxiliary steam station header(s). The complete pipe routing and supporting arrangement shall be in the Bidders scope. In case the finalized routing (subject to approval) calls for yard piping, the Bidder will provide trestle foundation and shall supply the complete supporting arrangement including the trestle structure for the above piping.
18. Interconnecting auxiliary steam piping from pakage boiler to auxiliary steam station headers(s). The complete engineering, routing, hanger, support and auxiliary structure shall be in the Bidder's scope.
19. Complete piping and fittings for high pressure chemical dosing system.
20. All the valves shall be provided at such a location so that these can be operated safely. Where this is not possible suitable operating/ maintenance platform, shall be provided.

1.12 Blow Down and Flash Tanks

One (1) atmospheric flash tank (located in the SG area), One (1) condensate receiving vessel (located in SG area), including level gauges, redundant level transmitters for remote level control through C&I systems, control valves, vents, drains etc. All other local instruments like gauge glass, level switch for high/low level alarms and pressure/temperature instrumentation shall also be provided

1.13 Draft Plant

Complete draft plant for the balanced draft system including the following:

a) Forced Draft Fans

Two (2) FD fans (2X60% BMCR) (Axial type, constant speed variable pitch controlled FD fans each with drive motor, base plates, foundation bolts & nuts, inlet bird and trash screen, suitable arrangement to prevent rain water entry to fan motor, coupling and coupling guard and acoustic silencer. Each fan shall be provided with bearing lubrication and hydraulic blade pitch control unit(s) consisting of:

1. 2x100% oil pumps, each with motor drive, coupling and coupling guard.
2. 2x100% oil coolers.
3. 2x100% filters, differential pressure switches etc.
4. One (1) oil storage tank.
5. Instrumentation, interconnecting piping, valves and fittings including pressure relief valves and NRVs etc.
6. Electrical actuators with all accessories.
7. On line vibration monitoring system for measurement of vibrations shall be provided.

Alternatively, a forced oil lubrication system (consisting of 1 to 6 above) common to bearing lubrication and for servo motor operation to each FD Fan is also acceptable.

Silencers shall be provided at the suction of the fans to limit the noise levels to specified values.

FD fans shall be suitable for the type of foundation being provided.

Adequate numbers of duplex thermocouples or duplex platinum RTDs (100 ohm at 0°C) and temperature indicators shall be provided for bearing metal temperature measurement, control and monitoring.

For mounting of vibration pads/pickups flat surfaces shall be provided, both in X & Y directions, by the Bidder on the bearing housing in such a way, so that welding/screwing of the pads shall be possible.

b) Induced Draft Fans

Two (2) ID fans (2 x 60% BMCR) (Axial type, constant speed, variable pitch controlled, with variable frequency drive) each with drive motor, base plates, foundation bolts and nuts, inlet box, discharge case, coupling, coupling guard and suitable arrangement to prevent rain water entry to fan motor. Each ID fan shall be provided with bearing lubrication and hydraulic blade pitch control unit(s) consisting of

1. 2x100% oil pumps each with motor, coupling and coupling guard.
2. 2x100% oil coolers.
3. 2x100% filters, differential pressure switches, etc.
4. One (1) oil storage tank.
5. Instrumentation, inter connected piping, valves and fittings including pressure relief valves and NRVs.

6. Electrical actuator with accessories etc.
7. On line vibration monitoring system for measurement of vibrations shall be provided.

Alternatively, a forced oil lubrication system (consisting of 1to 6 above) common to bearing lubrication and for servo motor operation to each ID Fan will also be acceptable.

ID fans shall be suitable for the type of foundation being provided.

Adequate numbers of duplex thermocouples or duplex platinum RTDs (100 ohm at 0°C) and temperature indicators shall be provided for bearing metal temperature measurement, control and monitoring.

For mounting of vibration pads/pickups flat surfaces shall be provided, both in X & Y directions, by the Bidder on the bearing housing in such a way, so that welding/screwing of the pads shall be possible.

ID fans shall be suitable for installation on spring supported RCC foundation. The spring supported RCC foundation comprising of steel helical spring units with viscous damper units

1.14 Regenerative Air Pre-heater (RAPH) and Steam Coil Air Pre-Heaters (SCAPH)

a) Regenerative Air Pre-heater (RAPH)

Two (2) Bisector type RAPH for secondary air system and two (2) Bisector type RAPH for primary air system, each complete with following:

Or

Two (2) Tri-sector type RAPH, each complete with following:

1. Two (2x100%) peripheral AC drive connected to drive Air heater along with automatic clutching/declutching arrangement for each APH.

   Alternatively, centrally mounted APH AC drive system having sufficient space for mounting emergency drive and having handling facility with proven experience may also be acceptable.

2. One (1x100%) Independent air motor drive along with automatic clutching/declutching arrangement.

3. Air receiver with storage capacity which can facilitate not less than 10 minutes continuous operation of air motors. Compressed air for driving air motor shall be drawn from service air system.

4. Piping and fittings, air filters, regulators including suitable solenoid valves for automatically admitting air for starting air motors in case of power failure, pressure transmitters on air line to air motor(s) etc.
5. Air heater stand still sensing device with necessary logic components, accessories and indicating lights, housed in the

enclosure. The motions to be precluded up at appropriate location of the rotor shaft.

6. Permanent fire-fighting equipment on both gas as well as airsides and also on both cold as well as hot end sides including, spray nozzles, valves and pipe work connected to fire water system.

7. Thermocouple type fire sensing devices complete with accessories.

8. Dust hoppers with bracing, stiffeners, supporting structure, baffles, access door, matching flanges, expansion joints, RF type ash level switches (for high & low level) etc., and suitable approach platform for each hopper & ash level switches.

9. Oil carry over probe for detection of oil during oil firing for each RAPH.

10. Soot blowers in the flue gas hot end and cold end.

11. Off load water-washing facility along with water supply pipe work (water to be tapped from service water system) & drainage piping to connect drains from air heater to the nearest station drains.

12. Adequate number of thermocouples or platinum resistance temperature detectors (RTD) for measuring cold and hot end bearing metal temperature for interlock, protection and monitoring shall be provided.

13. Forced lubrication system for bearing of each air heater shall be provided and shall include two (2) x 100% capacity oil pumps with motor, two (2) x 100% oil coolers, two (2) x 100% oil filters, one (1) oil tank etc.

14. Any other equipment/accessories/instrument etc., to make the system complete for reliable and safe operation.

15. Temperature switches on bearings for interlock purpose.

b) **Steam Coil Air Pre-Heaters (SCAPH)**

Two (2) Steam Coil Air Preheaters for secondary air and two (2) for primary air systems** suitable for the type of RAPH offered.

The SCAPH shall be installed on the bypass duct at Primary Air (PA) fan and FD fan outlets with necessary dampers, along with drain pipe up to atmospheric flash tank, auxiliary steam piping to supply heating steam to each SCAPH from the auxiliary steam system along with individual temperature control valves shall be provided.

** 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.

1.15 Coal Preparation and Firing System

1.15.1 Raw Coal Chutes and Bunker shut off valves, including following:

i. Motor operated (sliding gate type) Raw Coal Bunker shut off gate at the bunker mouth and manually operated gate at RC feeder inlet (both shall be for each coal feeder).

ii. Chain wheel & chain for manual operation of bunker shut off and RC feeder inlet valve from the feeder floor.

iii. Coal chute between bunker shutoff gate and RC feeder inlet.

iv. Coal chute between outlet of feeder and inlet of mill along with remote cylinder operated shut off gate at RC feeder outlet.

v. Permanent Chutes connection shall be provided from the feeder floor to ground near each feeder for unloading of coal from bunkers on trucks at ground level. A cover to be provided at the mouth of permanent chute when not in use.

vi. Bunker downspout shall have arrangement for fixing a temporary chute for diversion of coal flow to the permanent emptying chute near each feeder. Two (2 nos.) temporary chute shall be provided for each steam generator for the above purpose.

vii. Each feeder shall be provided with arrangement for fixing a temporary chute and diverting the coal from bunker to the permanent chute at feeder floor by running the feeder, for emptying the bunker. Two (2 nos.) temporary chutes shall be provided for each Steam Generator for the above purpose.

viii. Necessary handling/lifting arrangement & suitable platform & approach shall be provided for quick installations and removal of temporary chutes as mentioned at clauses (vi) & (vii) above.

ix. Dresser couplings with 410 stainless steel liner ring one on each chute between RC feeder and mill and one on each chute between coal bunker and RC feeder.

x. Devices to detect choking/flow/no flow of coal in the coal chute between coal bunker and RC feeder.

xi. A continuous operating platform for maintenance/ operation of bunker shut-off valves.

xii. Coal bunker shall be in the scope of bidder. Storage capacity of the bunkers shall correspond to 12 hours requirement of the unit under BMCR condition with design coal firing.

xiii. Necessary access shall be provided for operation of coal gate/ valves / Operation of Coal Flow Diversion valves shall be provided.

xiv. Remote (UCB) operated shut off gate between RC feeder and coal mill.

1.15.2 Raw Coal Feeders

Gravimetric type raw coal feeders with microprocessor based precision weighing and calibration devices, one for each mill. High performance Coal mills shall be provided.The feeders shall be complete with motor, coupling,

coupling guards, base plate, foundation bolts, sliding joints, paddle type switches to detect presence or absence of coal on feeder or choking of feeder, speed variator, auto declutching arrangement to high/low level, speed sensors, coal motion monitors, and strain gauge type weight measuring system with all instrumentation.

1.15.3 Coal Pulveriser

a) The coal pulveriser shall be vertical spindle type (pressurised type bowl mills). The number of coal pulverisers to be provided shall conform to sizing /standby requirement stipulated elsewhere in the specification. Minimum Eight (8) coal pulverisers shall be provided for steam generator.

b) Each pulveriser shall be complete with all wear parts/ grinding elements and shall be provided with platforms around the pulveriser, lubrication systems (comprising of 2x100% pumps, 2x100% cooler and 2x100% filters for each pulveriser) drive motors, auxiliary gear, instrument tapping points with platforms around the pulveriser and any other equipment necessary for safe and efficient operation of pulveriser.

c) The Pulveriser shall also include rotary classifier (dynamic) with VFD control arrangement and all the automatic auxiliary equipment necessary to make the pulveriser self-contained. Adequate number of temperature sensors, temperature transmitters, local indicators and signalling contacts for bearings and lube oil systems shall be provided as per standard practice of Bidder. Independent purge meters, air filter cum regulator sets, local pressure indicators, instruments and sensing device for milling system including the instrument requirements shall be provided.

d) Primary airflow measuring devices shall be provided at air inlet of each coal pulveriser. Adequate number of thermocouple type fire detection system with temperature transmitters as a composite & complete unit with all required accessories with adequate redundancy shall be provided.

e) Proven fire detection and fire extinguishing systems in line with the standard practice of the manufacturer shall be provided. In case of CO_2/N_2 based system, the scope of supply shall also include the required cylinder/piping and valves network etc. In case, the proposed type of mill requires inerting during start-up/ shut-down of the mill to ensure safety of operation with motorised valves in all the coal pulveriser, suitable system along with all piping, valves, instrumentation, interlock system etc. shall also be provided.

f) The control of Mill lubrication system (including mill lube oil pumps) and the logic for Mill Fire detection shall be implemented in SG-C&I System.

g) All required control etc. shall be implemented in SG-C&I System.

h) The coal mill shall be suitable for installation on RCC block type foundations.

1.15.4 **Primary Air Fans**

a) Two (2) numbers of two stage axial PA fans for steam generator, with hydraulic blade pitch control / Radial type with variable speed, with VFD control system each with motor, base plates, foundation bolts, inlet box, inlet bird and trash screen, inlet rain water canopy, inlet cone, diffuser, coupling, coupling guard and silencer.

b) Lubrication and hydraulic blade pitch control unit(s) for each fan consisting of:

i. 2x100% oil pumps, each with motor, coupling and coupling guard.

ii. 2x100% oil coolers.

iii. 2x100% oil filters along with differential pressure switches etc.

iv. One (1) oil tank.

v. Instrumentation, interconnecting piping, valves and fittings including pressure relief valves and NRVs etc.

vi. Electrical actuators with all accessories.

vii. Alternatively, a forced oil lubrication system (consisting of 1 to 6 above) common to bearing lubrication and for servo motor operation to each PA Fan will also be acceptable.

viii. On line vibration monitoring system for measurement of vibrations shall be provided".

c) PA fans shall be suitable for the type of foundation being provided.

d) Adequate numbers of duplex thermocouples or duplex platinum RTDs (100 ohm at 0°C) and temperature indicators shall be provided for bearing metal temperature measurement, control and monitoring.

e) For mounting of vibration pads/pickups flat surfaces shall be provided, both in X & Y directions, by the Bidder on the bearing housing in such a way, so that welding/screwing of the pads shall be possible.

f) PA fans shall be suitable for installation on the Spring supported RCC foundation. The spring supported RCC foundation comprising of steel helical spring units with viscous damper units. The springs shall be provided above the ground level.

1.15.5 **Seal Air Fans**

2x100% Seal air fans common for all the pulverisers of Steam Generating unit shall be provided. The fans shall be complete with motors, base plate, foundation bolts, coupling and coupling guard seal air piping, dampers, supports etc. Each fan shall be provided with self cleaning type filters etc. along with manual isolation dampers at suction and pneumatically operated dampers at discharge for maintenance of fans. The seal air fans shall preferably take suction from cold primary air header. However, if Bidder wishes to take suction from some other source, than Bidder is required to furnish justification and backup for Owner's approval.

1.15.6 **Coal Burners**

Second generation Low NO_x type Coal Burners with burners tilt mechanism, tilt drives, linkages and complete actuator assemblies, burner tilt position transmitters etc.

1.15.7 **Air Nozzles with OFA (OVER FIRE AIR)**

1.15.7.1 **Piping including the following :**

a) Lube oil piping for lubrication units.

b) Seal air piping to coal mills.

c) All piping valves, fittings etc. required for any inerting system for mills.

d) All piping along with necessary valves fittings etc. for mill fire protection.

e) Seal air piping to coal feeders.

f) Any other piping required for the completeness of the system.

g) All hangers and supports with auxiliary steel structure including columns, beams, base plates, foundations bolts, washers where applicable.

1.15.8 **Pulverised Fuel (PF) Piping**

a) Pulverized coal piping from mills to burners including ceramic lined pipe and bends as per the specifications. Ceramic lining shall be extended up to 1M downstream of the bends as per the specifications.

b) Power operated (electric/pneumatic) shut off gate before coal burner and a power operated (electric/pneumatic) flap/knife type mill discharge valve at classifier outlet on pulverised fuel pipe.

1.15.8.1 Rota probe type coal sampling system for obtaining samples from PF outlets of all the mills using the methods specified in ISO 9931 "Coal sampling of pulverized coal conveyed by gases in direct fired coal system". The minimum number of coal sampling systems to be provided for steam generator & shall be equal to at least the number of PF pipe outlets from one coal pulveriser.

Sampling system shall necessarily include the following:

a) Sampling probe with 'Motorized' Rotable head(s), rotated by electric motor, each with four (4) sampling nozzles, suitable for the coal pipe ID along with snap lock/fast lock connector for quick connection to the dustless connector.

b) Portable control unit for 'automatic' start and stop of sampling, adjustment of sampling air velocity & calculation of fuel flow rate, including weighing scale for sample, venturi flow meter, electric heater with controller, main fuse and control valves, Electric components shall be suitable for power supply of 240 Volts, 50 Hz.

c) Calibration curves for venturi flow meter.

d) Cyclone, sample collecting jar, and three (3) disposable backup fabric filters.

e) Suitable Carrying case(s) for control unit, probes, sampling bottles & other accessories.

f) Connecting hoses

g) Dustless connector with fast lock / snap lock, by short turn of handle suitable for connection to 50 mm female pipe thread or matching the sampling port connection shall be provided in all PF pipes. Dustless connector shall be capable of working in conjunction with rotor probe specified above.

1.15.9 Bidder scope shall also include supply of dirty Pitot tube for checking on line pulverized coal/primary air flow balance between PF pipes of each mill. The dirty Pitot tube should also have a fast lock/ snap lock arrangement & shall be capable of working in conjunction with motorized probe sampling system specified. It should be supplied complete with a combined pressure & temperature measuring hand held digital instrument, showing also fuel pipe air velocity etc. & with facility of data transfer through blue tooth from the instrument to control unit. Necessary technical details/calibration curves of the Pitot tube shall be furnished. The number of dirty pitot tubes provided for Steam Generator shall be equal to at least the number of PF pipe outlets from one coal pulveriser.

1.15.10 On line fuel measurement facility for accurate measurement of coal mass flow rate/air fuel ratio in each pulverized fuel (PF) pipe for coal pulveriser. The equipment shall comprise of sensors working on micro wave technology. The error in measuring.

For the purpose of the above fuel measurement, each PF pipe shall be provided with two no's of tapping points of suitable size, with necessary plugs/dust proof dummies etc. as required.

1.15.11 Adjustable valve/orifice of erosion resistant/ceramic coated material suitable for highly abrasive pulverised coal applications. The adjustable valve/orifice shall be provided on each P.F. pipe at pulveriser outlets and shall enable onload adjustment of coal flow in PF pipelines.

1.16 **Ducting**

1. Cold air inlet duct to FD fan suction, from FD fan discharge to RAPH (secondary for Bisector type) or RAPH (Tri-sector type), as applicable, bypass ducting for locating SCAPH down stream of FD fan.

2. Cold air inlet duct to PA fan suction, from PA fan discharge to RAPH (primary for Bi-sector type) or RAPH (Tri-sector type), as applicable, bypass ducting for locating SCAPH downstream of PA fan incase primary SCAPH is offered.

3. Cold air duct from each PA fan discharge to coal mills.

4. Hot air duct from RAPH (secondary air system for Bi-sector type) or RAPH (Tri-sector type), to burner wind box and from RAPH (primary air system for Bi-sector type) or RAPH (Tri-sector type), as applicable, to coal mills.

5. Flue gas duct from economizer outlet to cyclone separator inlet, from cyclone separator outlet to SCR reactor inlet, from SCR reactor outlet

to RAPH (Bisector or Trisector, as applicable) inlet ducts, SCR bypass ducts and from RAPHs (Bi-sector or Trisector, as applicable) outlet to ESP inlets. Economizer dust hoppers, (if applicable) shall be provided with high level Radio Frequency (R.F.) type ash level switches along with suitable access and platform for each hopper & ash level switches.

6. Flue gas ducts from Electrostatic Precipitators (ESP) outlets to ID fans inlets and ID fans outlets to chimney flue inlet including chimney inlet transition piece/ducting. The transition piece/ducting shall connect flue gas duct to vertical chimney flue liners. The design and supply of transition duct at chimney entrance shall be in the scope of Bidder. Bidder to submit detailed arrangement drawing for the transition duct along with all required expansion joints, guide vanes etc., which will be connected to vertical and circular chimney flues. All connections, expansion joints (outside the chimney), supporting structures for transition piece/ducting, mating flanges with adequate stiffening to connect with the chimney flue liners shall be included in Bidder's scope.

7. Gas recirculation ducting (if applicable) from downstream of ID fan to Steam Generator.

8. Adequately sized flow splitters, plates/duct stiffening devices, bracing, side plates, expansion joints, matching flanges, access doors and brackets, sampling points, ash hoppers, etc.

9. Supporting structure and hangers for all Ducting.

10. Suitable metallic type expansion joints wherever necessary shall be installed.

11. Economiser bypass ducting (if required) with gates and ash collection hopper as required along with high & low level RF type ash level indicators along with suitable access and platform for each hopper & ash level indicators.

12. Common air ducting at FD fan, PA fan, SAPH, PAPH (for Bi-sector type RAPH) or RAPH (Tri-sector type) outlets, as applicable and common flue gas ducts at ESP inlet and outlet ID Fan to FGDm FGD to Chimney and FGD Bypass Duct etc.

13. Any other ducting required for the completeness of the system including interconnecting ducting and economizer bypass as indicated in various locations in the scheme of coal, air and gas flow diagram

14. A suitable interconnecting header shall be provided downstream of the Economizer outlet before APHs (bisector/trisector) for equal distribution of the Flue gas flow between the two Flue gas paths to APHs.

1.17 Scanner air Fans

Two (2) (2x100%) scanner air fans (one working and one standby).

The suction for the scanner air fans shall be tapped off from the cold air interconnecting duct at FD Fans outlet. Necessary isolation dampers at the suction side of each scanner air fan shall be provided. The outlet of the fans shall be connected to a common "Auto Transfer Damper". The drive motors

for these fans shall be furnished. Complete ducting/piping with dampers, air filters, supports/hangers from the suction point to the scanner air fans and from the fans to the scanners and complete equipment required for the operation of scanners shall be provided.One fan shall be on AC drive while second ione must be on DC drive.

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

Pressure of scanner air fan shall be provided as required by the system.

Scanner fans should changeover from AC to DC on auto.

1.18 Dampers

The dampers shall include but not being limited to the following:

1. Isolation dampers on all cold air, hot air, seal air, scanner air and flue gas ducting, before and after equipment on these systems and wherever required.

2. Interconnecting dampers on air and flue gas ducting including FD bypass where necessary.

3. Burner air registers (if applicable) with drives at burner wind box.

4. Regulating dampers in cold and hot primary air ducts at each mill inlet for temperature control, at air pre heater outlet on flue gas path and wherever required.

5. Fully gas tight, motor operated, gates before and after each ESP stream, before and after each ID fan, at inlet to each of RAPH on flue gas side, before and after of RAPH on air side, at discharge of each PA fans, FD fans and at economiser bypass duct (if applicable), SCR inlet, SCR outlet & SCR Bypass. Fully gas tight pneumatic operated gates at each hot air & cold air duct to the mills. Vertical Mounted fully gas tight, motor operated, gates before and after each ESP stream & before and after each ID fan shall be provided.

6. Dampers shall also be provided in ID Fan to FGD, FGD to Chimney and FGD bypass.

7. Supporting structure for all dampers & drives.

8. Access and platforms for all dampers and drives including gratings, toe plates and hand rails.
9. Any other dampers required for the completeness of the system to ensure operational flexibility and on-load maintenance of any of the equipment or sections of the air/flue gas path, equipment & personnel safety etc.

1.19 Fuel Oil System

Fuel oil system shall cater to LDO oil firing requirements for the steam generator. Approval is required from statutory authorities for the entire F.O. pumping installation. Bidder shall prepare all necessary

drawings/data/documents as per the requirements of the Statutory Authority and obtain the necessary approval from the authorities.

Light Diesel Oil (LDO) System

LDO preparation and firing system shall be provided having a firing capacity equivalent to 30% BMCR requirements of Steam Generator.

The present scope shall include but will not be limited to following:

1. Two (2) (1W+1S) rotary positive displacement type LDO pumps with motor, coupling, coupling guards etc. Pumps shall have VFD.
2. All Base plates, foundation bolts, nuts and bolts.
3. Fuel oil burners complete with diffusers, tips extension pipes, atomizers, burner shut of valves, flexible hoses and all other ancillaries.
4. Oil connections to each burner from ring main.
5. HEA igniters for each burner.
6. Complete piping along with suitable hangers, support etc, including following
   - i. Interconnecting fuel oil piping integral to the system to make it complete.
   - ii. All drain oil piping from drain point to drain oil tanks, from drain oil tank to drain oil pump and from drain oil pump to discharge pit along with all valves and fittings.
   - iii. Vent piping along with local collection bucket for collecting of leak off oil from vents/relief valves.
   - iv. Blow off piping.
   - v. Recirculation piping around firing aisle.
   - vi. The LDO piping shall be complete with isolating valves, relief valves, check valves, drain valves, vent valves, pneumatically operated control valves, traps, strainers, accumulators, local instruments, sensing device, switches, flow meters, transmitters, controls such as pressure control, flow control, temperature control etc. All controls shall be implemented in fuel oil pump house (FOPH) control system.
   - vii. Necessary instrumentation for oil flow measurement shall be provided.
7. One (1) drain oil tank of 5 M^3 capacity and with one oil transfer pump with motor, duplex filter at suction and other accessories for steam generator to transfer drain oil from boiler area to LDO storage tank(s). Control of the same shall be implemented in SG C&I system.
8. One (1) drain oil tank in pressurizing pump house area having 10 M^3 capacity and one oil transfer pump with motor, duplex filter at suction and other accessories to transfer drain oil from pump house to LDO storage tank(s). Control of the same shall be implemented in FOPH control system.

9. Adequate local and equipment mounted instruments and devices with adequate signalling and connects/connections required for pressure, temperature and other controls for supervision and interlocking with all associated auxiliary during purging, shut down and of sensing device to remain unaffected by oil fill dirt or by ambient conditions where it will be installed.

10. Distribution header at boiler front along with filter,Trip valves on common fuel oil line to boiler and nozzle valves for each individual burner along with all accessories such as air filter, regulators, limit switches, control valves, and connecting fittings to make the system complete.

11. Recirculation valve of heavy duty type to work with the furnace safeguard and supervisory system.

12. Facilities shall be provided for flushing of complete LDO system, transportation, recirculation & firing system (piping, pumps, heaters, filter, valves, etc) using light diesel oil during long shut down of unit(s). Bidder's scope shall include all piping, valves, fittings, pumps hoses etc. needed for this purpose.

13. Supply of one (1) flow meter of positive displacement type including all its accessories.

14. Two (2x100%) sump pumps with motors.

15. All local instrumentation (gauges, switches, transmitters etc.) and associated control devices for LDO system in Bidder's scope.

16. Necessary instrumentation for oil flow measurement shall be provided.

17. Approval is required from statutory authorities for the entire F.O. pumping installation. Bidder shall prepare all necessary drawings/data/documents as per the requirements of the Statutory Authority and obtain the necessary approval from the authorities.

1.20 Garbage Chute

A garbage chute of minimum 600 mm diameter and made from minimum 10 mm thick mild steel pipe shall be provided for Steam Generator, from pent house level to ground level for disposal of debris & scrap generated during erection, operation and maintenance. The chute shall be provided with branch connections with doors & approach platforms at all platform levels. Garbage collection trolleys shall also be provided at the ground level.

1.21 Galleries, Walkways, Roofing, Platforms

1. Galleries, walkways, platforms, staircase, hand rails, ladders and gratings etc. as specified shall be provided at the Steam Generator floors including the interconnecting platforms between the Steam Generator floors and main building at four (4) elevations on either side of boiler (excluding ground floor) and between the Steam Generator and bunker buildings at three (3) elevations on either sides of Steam Generator as per the details given in the Technical Specification. Number of inter-connecting platforms between Boiler and Coal Bunker building for each level / floor shall be two (2) numbers on each side of Boiler i.e. four (4) numbers per elevation.

2. Necessary access, platforms, walkways, handrails, staircase, ladders and gratings etc. for proper approach shall be provided for all equipments and accessories in the scope of this package so that operators and maintenance personnel can function conveniently and safely. The above provision shall include but will not be limited to the following locations:

- Bunker outlet gate.
- Mill discharge valve.
- All maintenance hoist levels.
- All dampers and their drives.
- Furnace seal trough level.
- All fans and associated motors. (Continuous platforms shall be provided around the fans and their corresponding motors).
- SCAPHs (If Applicable)
- Air preheaters
- SCR
- All valves.
- All Observation ports, access manholes etc.
- All soot blowers.
- All Ash hoppers of economizer, Air-Preheaters, economizer Bypass (if provided) and duct (if any) which require fly ash removal by the ash handling system.
- All field control and instrumentation equipments.
- Storage platforms for storing of scaffoldings, APH baskets and other maintenance item during overhaul of steam generator(s). Platforms for removal, handling & storage of Economiser and Reheater/ Superheater sections (all horizontal heating surfaces).

3. Provision shall be made by the Bidder, for adequate space in various platforms, galleries etc. for locating local instrument enclosures under Bidder's scope without encroaching upon specified width. The exact locations for the same shall be finalized during the Contract execution stage and the same shall be indicated in floor plan drawings.

4. For meeting the above requirement in respect of platforms, bidder shall include in his proposal of 20,000 m^2 platform area (clear of all intervening pipes, columns, actuators, instrument enclosures, racks etc. and excluding area covered by stairways & landings and excluding platforms required for ESP & Auxiliary Boiler).

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

6. All supporting structural steel works comprising of columns, beams, girders, bracings etc. shall be provided.

1.22 **Elevators**

Two (2) passenger cum goods elevators having a capacity of 3000 kg (each) for steam generator. For further details, Volume III Chapter: 29. Elevator machine rooms shall be airconditioned.

1.23 **Refractories and Insulation**

Refractories and insulation including cladding, lagging, reinforcement, wire mesh, cleats and supports for all the equipment, auxiliaries, ducting, dampers, piping and valves (excluding coal pulverisers and PF pipes) in the scope of this specification so as to ensure skin casing temperature of any surface in Bidder's scope is not more than 60 deg.C with ambient temperature of 40 deg.C and air velocity of surface air being 0.25 m/s when the boiler is operating at 100% BMCR. For detail refer subsequent section.

1.24 **Field Control & Instrumentation Equipment**

Refer Volume V

1.25 **Pre-commissioning and Commissioning Activities**

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

1. Complete pre-commissioning work including tests of facilities such as line flushing, hydraulic testing of steam generator pressure parts, air and gas tightness tests of steam generator enclosure and duct work, chemical cleaning of pressure parts, steam blow off, etc. and all other tests as mutually agreed in the Bidder's quality assurance program as well as those identified in the specification.

2. Commissioning and initial operation of the facilities.

3. Supply of all consumables (except coal and fuel oil for firing) like chemicals for chemical cleaning, passivation, inhibition etc., nitrogen for blanketing, consumables for air/ gas tightness tests and any other consumable as may be required for above precommissioning/ commissioning activities.

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

d. All temporary equipments and instruments along with the respective control system shall be clearly listed out in the bid.

5. Supply of all labour, skilled/ semi-skilled supervisors, engineers and any other manpower.

1.26 Special Tools & Tackles and Test / Measuring Equipments

A. One complete set for Steam Generator unit, of all special tools and tackles for maintenance of all equipments. Each set of tools & tackles shall necessarily include but will not be limited to following:

Special tools & tackles for mill required for erection, testing and maintenance of equipment system including those required for instruments and controls.

Set of maintenance tools, including following:

1. **General Maintenance tools**

i. Pulling cable, eyebolts, cable slings, chaining falls, snubbing lines or cables.
ii. Bar and sledge hammers.
iii. Brass and lead hammers.
iv. Power type jacks and jacking screws.
v. Feeler gauges and shims.
vi. Dial indicators.
vii. Wire brushes & scrappers.
viii. Bearing and coupling pullers.
ix. Spanners and wrenches of various sizes.

2. **Special Maintenance Tools**

i. Tube expanders for heat exchangers.

ii. Lapping plates, grinding stones and ring cap for the valves.

iii. The burner maintenance trolley with vice, burner.

iv. Spanners and wrenches specific to the equipment.

v. One (1) videoscope suitable for inspection of all steam generator pressure parts. This shall be of the flexible optical fibre pattern appropriate to the design of the headers and shall incorporate low voltage lighting via either a portable transformer or rechargeable battery. A rigid type is not acceptable. It is envisaged that the instrument may be made in section to give adequate variations in reach to suit different headers. The viewing head must permit a vision of 90 deg., forward and/ or rear by interchangeable heads. The degree of magnification desired is 1:1 at a distance of about 70mm to 100mm with a maximum of 3:1 for very close viewing.

vi. Four (4) pneumatic emergency retract drives with matching crank tools for each type of soot boiler shall be provided along with required length of connecting pipe, fitting etc. Service air points for actuation of

pneumatic drive shall be provided at convenient locations.

B. One (1) set of power operated gondola(s) and furnace maintenance cradle / cradles for furnace tube repairs and maintenance.

Each set of gondola/maintenance cradles shall be suitable for complete and simultaneous coverage of all the four walls including reheater & divisional panel tubes of a steam generator and shall be complete with all slings etc. Steam generators shall have suitable provisions for suspending this cradle from above the pent house through tubes in the pent house, so that this cradle can be suspended without accessing the pent house.

C. Complete lifting tools and tackles. Bidder shall provide motorized hoists and trolleys for all items requiring maintenance and weighing 500 kg or more. All auxiliary structures, monorails, runway beams for all lifting tackles, hoists etc. are included in Bidder's scope of supply. Access ladders with suitable platform shall also be provided for approach to all motorized hoists/trolleys mounted on their runway beams for the maintenance of hoists/trolleys. Items weighing more than 50 kg and required to be replaced for maintenance shall be provided with manual hoists/trolleys with runway beams/supporting structure etc.

D. One (1) set of quick erect scaffolding erectable inside of the Steam generator ensuring full height coverage for capital overhaul. The scaffolding system shall be made of light weight material and man days required for erection shall not exceed 4 (four) considering the workforce deployed for 24 hours in 3 shifts a day. The locking arrangement shall not call for any welding.

E. One (1) set of Igniter Testing kit shall be provided for the purpose of testing healthiness of (a) solenoid valve, power cylinder, limit switches of the ignitor carriage assembly (b) ignitor cable, rod and spark tip of the sparking system. This shall include stand for holding / fixing the igniter carriage assembly, LED for ignitor advance/retract feedback, necessary air line accessories for solenoid/power cylinder operation, Pushbutton for advance/spark command, etc. Required power supply point and instrument air connection point shall be provided by the customer. Installation and commissioning of the Testing kit shall be in the bidder’s scope.

F. Scope shall include instrument for tube thickness measurement as follows:

The scope shall include 12 ultrasonic thickness gauges suitable for measurement of the pressure part tube/pipe thickness. The above ultrasonic thickness gauge(s) shall also have a built in data logger to facilitate quick/automatic transfer of the measured data. The data logger shall have adequate memory and shall be programmable to configure the tube location geometry as required for automatic down loading to compatible PC based software like Boiler Maintenance Work Station (BMW) of EPRI (USA) or equivalent.

G. One (1) coal abrasion test apparatus along with all necessary accessories for steam generators for testing YGP index of coal,

complying with the requirements of BS 1016 Part 111. The apparatus shall be complete with following basic components and accessories:

a) Mill pot or mortar
b) Drive Unit
c) Four blades (in addition to the blades fixed in the apparatus for abrasion testing, a set of four blades shall be supplied extra as spare).
d) Gauges for checking gap between the edges of the blades and the internal wall and bottom of the mill pot.
e) Heavy duty balance
f) Analytical balance
g) Jaw crusher (hand fed, electrically operated)
h) Mechanical sample divider.
i) Test sieves of woven wire cloth with nominal aperture size 6.70 mm and 16.0 mm and of perforated plate, square hole, with nominal aperture size 25.0 mm, complying with BS 410.
j) Hot air dryer.
k) Small brass brush.
l) Any other item to make the test set up complete.

H. The material/construction/accuracy/specifications of the above items shall completely comply with the requirements of BS 1016 Part 111.

1.27 Base plates, foundation bolts, Anchor materials, matching pieces, inserts & packing shims etc. as required for steam generator and auxiliaries & associated equipment.

1.28 Auxiliary steel for piping supports, including base plates, foundation bolts, nuts, washers, 'U' bolts and hangers for separator, superheaters, reheaters, furnace rear pass tubes (if applicable)

1.29 **Selective Catalytic Reduction System (SCR)**

1.29.1 The scope of supply include design, engineering, manufacture, supply, erection, commissioning and testing of complete mechanical, electrical, C&I and associated civil foundation and structural work for Selective Catalytic Reduction (SCR) System along with ammonia unloading, storage and handling system, Cyclone Separators complete in all respects with all components and accessories etc., for one (1) steam generator as detailed in this specification. The SCR System is intended to reduce the emission of NOx in flue gas produced by coal being fired in boiler to the limits specified elsewhere in the technical specification.

1.29.2 The scope of supply identified for SCR System along with ammonia unloading, storage and handling system, Cyclone Separators here are minimum requirements and unless excluded from the Bidder's scope, any equipment/system not included in the specification but integral to the system offered to meet the intent of this specification, shall also be included in the scope.

1.29.3 The scope for SCR System along with ammonia unloading, storage and handling system, Cyclone Separators shall include all items. All ducting,

dampers, expansion joints, valves, pumps, supports, structure, trestle etc. as required for completeness of this system shall also be in the scope of Bidder.

1.29.4 The scope of supply and services for SCR System along with ammonia unloading, storage and handling system, Cyclone Separators shall include all items indicated below but will not be limited to that.

1.29.5 **System Description**

1) Flue gas from downstream of economizer shall be taken through two (02) independent streams. Each stream shall have one (01) number of cyclone separator and one (01) number of SCR Reactor. Cyclone Separator shall be used to reduce inlet dust concentration at the inlet of SCR reactor. Air diluted gaseous ammonia shall be injected before SCR reactor and the mixture of flue gas & ammonia shall be passed through the catalyst placed in layers inside reactor for reduction of NOx present in flue gas to nitrogen.

2) Flue gas after NOx removal shall be taken to the Air Pre-heater. SCR bypass duct i.e., Economizer to APH shall be provided for facilitating operation of unit without SCR in case of any emergency requirement. This shall also facilitate the online maintenance of SCR system and associated equipment. Economizer flue gas bypass shall also be provided to maintain required flue gas temperature at the SCR reactor inlet at partial load conditions. Anhydrous ammonia shall be supplied through tank truck and unloaded in ammonia storage tanks with the use of ammonia unloading compressors. Liquid ammonia from the storage tank is sent through ammonia vaporizer and diluted with air before injection on upstream of SCR reactor.

1.29.6 **Scope of Supply SCR System**

SCR System shall have two (02) independently operated SCR reactors (gas streams) along with catalyst modules housed in SCR reactor casings including outside shell, structural steel supports & frame work, access doors & ladders, platforms, safety rails, stairways, walk ways etc. SCR System will be complete in all respects including all components and accessories.

1.29.6.1 **SCR Reactor and Auxiliary System**

i) SCR reactor shall have three (03) working catalyst layers and one (01) spare (future) catalyst layer

ii) Catalyst modules with test sample for all working layers along with sealing system.

iii) SCR reactor shall include, but not limited to the following:

a) Inlet and outlet hood with guide vanes.

b) Static Mixer (if required).

c) Flue gas flow straightener / rectifier at inlet of SCR reactor.

d) Connection nozzles for media (e.g. flue gas, steam, pressurized air etc.).

e) Ash hoppers for SCR reactors/duct (if required) complete with level monitors and indicators, poke holes, access doors, walkways beneath the hoppers along with associated ash handling system.

f) Catalyst module support structure.

g) Access for Catalyst module loading/ unloading for each catalyst layer.

h) Control & instrumentation.

i) Inspection opening(s) for every catalyst layer.

j) Gas sampling system including online gas analysers at inlet and outlet of SCR reactor for measurement of NO_x, SO_x, O_2, CO_2 etc.

k) In-situ type or extraction type ammonia analyser at the outlet of SCR reactor.

l) NO_x grid measurement (if applicable).

iv) **Catalyst De-dusting System**

a) Adequate number of Rake retractable type steam operated Soot blowers shall be provided for each catalyst layer (including future layer) complete with structural supporting frame, access platform, motors, piping, control & instrumentation, insulation etc.

b) In addition to steam type soot blowers, bidder to provide additional Sonic horns & Air Cannons for each catalyst layer (including future layer) complete with structural supporting frame, access platform, compressed air storage vessel, piping, control & instrumentation, insulation, acoustic enclosures etc.

v) **Handling System**

a) Complete catalyst handling system including platforms for temporary storage of catalyst, monorails with electrically operated hoists including monorail beams for each catalyst layer (including future layer) for lifting of catalyst module from grade, storage & placement inside the reactor.

b) Handling system with monorail and electrical hoist for other equipments which are weighing more than 500kg and requires to be handled for maintenance/replacements.

vi) **Ducts and Dampers**

a) The scope of ducting and damper as per tender drawing and shall include but not limited to the following for SCR system for steam generator:

1) Inlet duct from economizer outlet to SCR reactor inlet.

2) Outlet Duct from SCR reactor outlet to APH Inlet.

3) SCR bypass duct i.e. Economizer to APH.

4) Economizer bypass duct from economizer inlet/ intermediate position to SCR inlet duct.

b) Flue gas ducting system shall be complete with adequately sized turning vanes, deflector plates, flow splitters, guide vanes and all necessary gas flow control devices of suitable erosion resistant material, metallic type expansion joints, complete duct stiffening devices, interior bracings, slide plates, access doors, brackets, supporting structures, hangers, sampling connections, etc.

c) Isolation gates at inlet of cyclone separator, SCR outlet and SCR bypass duct of SCR reactor and isolation gate & control damper in economizer bypass duct to SCR inlet duct.

d) Ash hoppers for duct, if required based on layout, complete with low and high ash level switches etc.

vii) **CFD and Physical modeling**

a) Bidder's scope shall include Computation Fluid Dynamics (CFD) and Physical modelling for SCR reactor, upstream duct work from economizer outlet (including economizer bypass) along with cyclone separator and downstream ductwork from SCR reactor outlet upto Air preheater inlet. Based on the outcome of the model test, Bidder has to take corrective action by installing flow splitters/guide vanes etc. as required to improve flue gas flow distribution to desired level.

b) Bidder's scope shall also include conductance of laboratory/ shop test to establish and demonstrate the activity of the catalyst selected for Indian coal/ash. Further, such test shall be conducted and report shall be provided to customer before supply of catalyst to site.

1.29.7 **Cyclone Separators**

i) Two (02) independently operated Cyclone Separators housed in independent casings shall be provided including outside shell, structural steel supports and frame work, stiffeners, bracings, access ladders, platforms, safety rails, stairways, walk ways, access doors, insulation etc. One (01) cyclone separator shall be provided in each stream of flue gas duct from economizer outlet to SCR reactor inlet.

ii) Ash hoppers complete with level monitors and indicators, poke holes, access doors, walkways beneath the hoppers along with associated ash handling system shall be in the Bidder's scope.

iii) Sampling ports for off-line measurement of ash concentration in flue gas at the inlet and outlet of Cyclone separators.

1.29.8 **Ammonia Injection and Dilution Air System**

i) Complete Ammonia Injection system for SCR system consisting of, but not limited to, nozzle lances or ammonia injection grid, ammonia-air mixer, piping for distribution of ammonia/air mixture, valves etc.

ii) 2x100% dilution air fans with drive motors, coupling, coupling guard, silencer, filter and suitable arrangement to prevent rain water entry to fan motor, air heating system (electrical) if required, dampers etc. for SCR System. Alternatively, dilution air may be tapped of from Secondary air duct in place of dilution air fans.

1.29.9 **Ammonia Unloading, Storage and Handling System (Common for all units)**

Ammonia unloading, storage and handling system shall be provided. The ammonia unloading, storage and handling system shall be designed for Anhydrous Ammonia.

The scope for above shall include but will not be limited to following:

a) One (1) anhydrous ammonia unloading system to unload ammonia from trucks, including two (02) ammonia unloading compressor skids (1W+1S) with all necessary equipment, fittings, hose connections, monitoring and safety devices.

b) One (1) ammonia storage tank including all supports and other accessories with all fittings, monitoring and safety devices. The storage tank capacity shall be of 14 days ammonia requirement of SCR system.

c) Two (2) (1W+1S) ammonia forwarding pump skids to pump ammonia to ammonia vaporizer (if required). Each pump shall be capable of forwarding ammonia to meet the requirements of SCR system.

d) Two (2) (1W+1S) Ammonia vaporizer and associated systems. Each ammonia vaporizer shall be capable of vaporizing the ammonia to meet the requirements of SCR system.

e) Two (2) ammonia accumulators and associated systems. Each ammonia accumulator shall be capable of handling the ammonia to meet the requirements of SCR system.

f) 2x100% Glycol-water recirculation pumps with common water/ glycol heater for each ammonia vaporizer and common overhead make up water/glycol tank. Make up shall be tapped from suction header connecting the Condensate storage tank (CST).

g) One (1) waste ammonia dilution tank of minimum 10 m^3 storage capacity along with service water connection, outlet pipes, valves, instrumentation etc.

h) A dyke shall be provided around storage tank area with storage capacity, for collection of liquid ammonia in case of emergency. This dyke shall be connected to waste water retaining basin.

i) One (1) Waste water retaining basin near ammonia unloading & storage system along with 2x100% waste water/ ammonia disposal pumps with motors for transferring drains CMB. Chemical dosing system for controlling PH of waste water before sending to CMB.

j) Associated control and instrumentation system, auxiliary systems, nitrogen purging system, complete piping system, hoses for ammonia unloading and necessary piping, heat tracing etc.

k) Parking pad for tank truck along with bulkhead.

l) Valves such as manual valves, pressure relief valves, excess flow valves, emergency shut-off valves, check valves, Control valves etc.

m) Platform, walkways for maintenance and inspection shall be provided.

n) Ammonia leak detectors with annunciation system

1.29.10 Thermal Insulation, Lagging, Cladding & Refractories for SCR System

i) Thermal Insulation along with aluminum cladding, lagging, reinforcement wire mesh, cleats and supports, shall be provided for all the equipments/surfaces having skin temperature more than 60^0 C. The insulation shall be as specified in relevant chapter.

ii) Corrosion protection painting for structures and equipments/system as described in the specification.

iii) Sheathing work for roof/ canopy/ side cladding of SCR system.

iv) Necessary access, platforms, walkways, handrails, staircase, ladders and gratings etc. for access/approach and safe mobility shall be provided for all equipment and accessories in the scope of this sub-section so that operators and maintenance personnel can function conveniently and safely.

1.29.11 Special Tools & Tackles and Test / Measuring Equipment

One (1) complete sets of all special tools and tackles required for erection, testing and maintenance of all equipments including those required for instruments and controls for SCR system.

1.29.12 General Safety Requirements

Bidder's scope to supply/services related to all safety equipment/system required for Anhydrous Ammonia system. Scope shall include but not limited to following

i) Bidder shall design the Ammonia unloading, storage and handling system complying to the requirements of IS: 4544, CGA G 2.1—2014 6th Edition (formerly ANSI K61.1), OSHA etc.

ii) Necessary approval is required from statutory authorities for the entire Ammonia unloading, storage and handling system.

iii) Complete ammonia unloading, storage & forwarding system shall be suitably fenced with gate control entry to ensure safety.

iv) Two (2) Safety cabinets with PPEs (Personnel Protection equipment), Sprinkler system, Emergency showers & eyewash and safety gear/equipment/kits.

v) Civil work including all structural and construction along with foundation shall be in the scope of Bidder.

vi) Associated Electrical and Control & Instrumentation systems for SCR system.

CONTENTS

SECTION – 2

DESIGN BASIS

1.0 STEAM GENERATOR AND AUXILIARIES

1.1 General

The design/specifications/sizing of various plants/systems/equipment offered for Steam Generator(s) & Auxiliaries shall comply with the requirements detailed hereinafter:

1.2 Steam Generator Type and Other Features

a) Type

Steam Generator shall be of single pass (Tower type) or two pass type using either spiral wall (inclined) or vertical plain / rifled type waterwall tubing.

b) Other Features of Steam Generator Design

Steam Generator shall be direct pulverized coal fired, ultrasupercritical, top supported, single reheat, radiant, dry bottom, with balance draft furnace and shall be suitable for outdoor installation. The evaporator of Steam Generator shall be suitable for variable pressure operation from sub-critical to supercritical pressure range.

1.3 Rating of Steam Generator(s)

Steam Generator shall be designed to cater to duty requirements specified below:

Capacity of Steam Generator(s)

The steaming capacity of the Steam Generator (steam flow at superheater & Reheater outlets) at 100% Boiler Maximum Continuous Rating (BMCR) conditions at rated steam parameters shall be the following:

BMCR Parameters

1.	Steam flow at superheater outlet at BMCR is atleast 102% of the turbine VWO steam flow requirement at worst condenser pressure and 1% make up, rounded to next integer divisible by 5	
2.	Pressure at superheater outlet header	Not less than 270 $kg/cm^2(a)$
3.	Steam temperature at superheater outlet	603^0C
4.	Steam temperature at reheater outlet	603^0C
5.	Feed water temperature at economiser inlet	Bidder will decide as per feed back from STG, but not less than 293°C

1.4 Fuels

1. Coal

For Coal analysis, refer Volume II.

(a) The primary fuel for the Steam Generator(s) shall be coal (coal characteristics of design coal, worst coal, best coal and range of coal for the project to be considered for boiler design).

(b) The Steam Generator shall be designed to give the guaranteed maximum efficiency when firing the coal having the characteristics on as received basis and other characteristics for Design coal as given in Vol II.

(c) The Steam Generator and its auxiliaries shall also be capable of obtaining the boiler maximum continuous rating (BMCR) as specified in above when firing the worst coal.

(d) Steam Generator and its auxiliaries shall also be capable of obtaining maximum continuous rating when firing range coal. System redundancies / margin's 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 in to factors of safety as per specification/ codes.

(e) The Steam Generator and its auxiliaries shall be designed for efficient and trouble free operation when firing the design, worst and best coals and the adequacy range of coal supplies.

2. Fuel Oil

i. Description of Fuel Oil Unloading, Storage System

The fuel oil requirements for steam generator package shall be drawn from LDO tank being provided and covered in Chapter 22. The fuel oil pressurizing, heating (as required) and firing system shall be in the scope of Bidder. Bidder shall include all required piping valves, fittings, instrumentation etc.

ii. Fuel Oil Firing System

Light diesel oil (LDO) firing facilities shall be provided for start-up, coal flame stabilization, low load operation, cold start up of the steam generator, black start of unit. LDO characteristics are given in Volume II.

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

1.5 Codes & Standards

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.

The design of Steam Generator shall meet or exceed all the requirements of latest editions of Indian Boiler Regulations (IBR).

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.

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

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

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.

1.6 Statutory Approval

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

It shall also be the responsibility of the Bidder to furnish the requisite documentation as required by the owner for getting the boiler registered under IBR

1.7 Limiting Parameters for Steam Generator Design

The Steam Generator design shall comply with the following limiting parameters with 'design coal' firing, under stipulated ambient air condition i.e. 27 degree Celsius temperature and 60% relative humidity:

1)	Excess air at economizer outlet at Turbine Maximum Continuous Rating (TMCR) (800 MW) load	20% (minimum)
2)	Flue gas temperature at air-heater outlet (corrected) at TMCR (800 MW) load & 105% TMCR load	125^0C (minimum)
3)	Heat loss due to unburnt carbon in ash at all loads	1% (minimum)

Bidder to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests or performance predictions

etc., if the values considered by the Bidder for parameters as specified are lower than those specified in this clause.

1.8 **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% BMCR load while firing any coal from the range specified, with any combination of mills / adjacent mills (to Owner's choice) in service. This shall be guaranteed and demonstrated by the Bidder.

1.9 **Operating Capabilities**

1.9.1 The Owner envisages to have following major operating capabilities for the unit/plant:

i. The maximum continuous rating of the unit is 800 MW (TMCR) with peak output of approx. 105% TMCR.

ii. Sliding Pressure Operation from rated pressure down to 30-40% of rated pressure with as well as without any throttle reserve. At any operating load, the throttle reserve shall be sufficient so as to achieve an instantaneous increase in turbine output by 5% of the corresponding load, by opening all turbine control valves wide open. The throttle reserve shall be adjustable to minimum 0% for pure sliding pressure mode of operation.

iii. Operate continuously with HP heaters out of service with maximum specified cooling water temperature 1% make up and normal auxiliary steam requirement being tapped from cold reheat line, to generate maximum output without over stressing any of the equipment/ components. The power output of the unit under this pressure conditions shall be commensurate with boiler capacity.

iv. In case of sudden reduction in demand (load throw off), the unit should get safely unloaded and stabilized for continuous operation at house load.

v. HP-LP bypass operation under rated steam conditions with Bypass valve open to full capacity and turbine on house load.

vi. The equipments and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz.

1.9.2 Steam Generator and all the equipment and auxiliaries shall be designed to cater and enable to the above operating conditions. Unless specified otherwise in the detailed technical specification, all the equipments and auxiliaries shall be designed to cater to the above operating conditions with adequate margin as per standard practice prevailing in the fossil fired power plants.

1.9.3 The continuous operation of the plant under two shift and cyclic modes during certain periods of the year is also envisaged. The design of steam generator and auxiliaries shall cover adequate provision for quick startup and loading of the units to full load at a fast rate. The main plant and its auxiliaries with their controls would be designed to permit operation of the units on house load without there being any necessity to shut down the units in the event of sudden loss of total load due to tripping of transmission lines or any other

grid disturbances. The design of the plant equipments and control system would permit participation of the plant in automatic load frequency control.

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

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

S. No.	Type of Starts	No. of Starts
1.	Hot start (after shut down period less than 10 hours)	4500
2.	Warm start (after shut down period between 10 hours and 72 hours)	1000
3.	Cold start (after shut down period exceeding 72 hours)	455

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

c) Steam Generator shall also be capable of satisfactory, stable and safe operation in case of rapid load changes in downward direction due to external disturbances or equipment malfunction. Under such conditions the system shall stabilize itself through proven concepts and controls and within the recommendations of National Fire Protection Association, USA, NFPA-85.

d) In case of sudden load throw-off, in worst case from 100% BMCR, the Steam Generator shall be capable of automatically bringing down the steam generating capacity to match with HP-LP bypass capacity. Bidder to indicate minimum load of Steam Generator to which it can be brought down under such condition, during short turbine outages or export load rejection, with a view to save fuel and reduce heat losses. The boiler design shall ensure balanced draft condition, avoid overheating of reheater tubes and such other conditions that jeopardize the safety and life of boiler.

e) 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.

1.11 **Operation without High Pressure (HP) Heaters in service**

Steam generator shall be capable of operation with HP heaters out of operation. The steam generator heat output under HP heaters out condition shall be at least 100% BMCR heat duty. Steam generator shall also capable of sustained operation with HP heaters out of operation so as to generate at least rated power output by the unit.

Under this condition the superheater and reheater outlet steam temperature shall be maintained at rated values within the whole control range of steam generator load. Further, during such operation the metal temperature of

various pressure parts shall not exceed the limits stipulated in their design/selection

1.12 **Operation with/without High Pressure (HP) and Low Pressure (LP) Turbine Bypass System**

1.12.1 HP turbine bypass system shall be sized for 65% BMCR (minimum) steam flow (at Super Heater Outlet) with rated mainsteam parameters at the upstream of valve and CRH steam parameters corresponding to 60% TMCR on the downstream. The LP bypass capacity shall be adequate to accommodate total steam and spray water coming from HP bypass valve, as stipulated above. HP and LP bypass valves shall also be provided by Bidder.

1.12.2 The HP & LP turbine bypass system is envisaged to be used;

a) For house load operations
b) Quick hot start, following a turbine trip
c) To reduce starting and loading time of Steam Generator.

1.12.3 Irrespective of the fact that HP-LP bypass system is provided for smooth start-up, fast loading & house load operation of unit, the steam generator shall also be capable of start-up without HP-LP by-pass system in service.

1.12.4 Steam Turbine trip will call for boiler operation in HP/LP bypass mode, with SH flow corresponding to capacity of above mentioned HP/LP bypass system and feedwater temperature at economiser inlet shall be the saturation temperature corresponding to deaerator pressure to be optimized by the bidder. For such condition the economizer shall be suitably designed to take a thermal shock of sudden change of feed water temperature from rated value(s) to saturation temperature corresponding to deaerator pressure to be optimized by the bidder. The superheater and reheater outlet temperature shall be maintained during HP/LP bypass operation at above mentioned superheater outlet flow.

The superheater and reheater outlet steam temperatures, during such operation shall be maintained at the rated value without the metal temperature for various pressure parts exceeding the safe limits stipulated for their design/ operation manuals.

Steam Turbine trip will call for boiler operation in HP/LP bypass mode. Under this condition, the boiler shall be capable of operating with SH flow corresponding to capacity of HP bypass system and feed water temperature of approximately 140°C at economiser inlet.

1.13 **Mode of Steam Generation Operation and Rate of Loading**

1.13.1 In line with the plant operating capability requirements indicated at Clause 1.9 above, Steam Generator shall be designed for variable pressure operation. Thermal design of Steam Generator and the selection of materials of pressure parts shall be suitable for variable pressure operational modes.

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

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

Bidder shall clearly bring out in his offer the maximum rates of loading/ unloading achievable with Steam Generator offered and the corresponding limiting variations (±%) of boiler parameters such as Oxygen in flue gas, SH/RH steam temp., furnace draft, etc.

1.14 Steam Generator Control Range

The superheater and reheater shall be of proven design and shall be designed to maintain superheat and reheat steam temperatures at superheater and reheater outlet over the entire steam temperature control range (i.e. from 50% TMCR to 100% BMCR rating for SH & RH) under the following conditions:

- With the steam generator heat absorption surface condition varying from clean up to normally expected and permissible fouling limits.
- With minimum possible use of de-superheating spray.
- With permissible and normally expected unbalance or stratification in flue gas flow.
- With all specified mode of fuel burning.

1.15 Control and Instrumentation

All control and instrumentation equipment shall be designed to meet specification requirements with respect to power supplies, instrument air, ambient and environmental conditions, performance and other requirements stipulated in Volume V of the specification. The Bidder shall also take into account all interface requirements with the equipment furnished by the others, during the detailed engineering.

1.16 Electrostatic Precipitator

Refer Section – 3 of this chapter.

1.17 Ash Handling System

Refer Volume III – Chapter 21 for AHP Chapter. The height of boiler shall be fixed in such way that the entire ash handling arrangement underneath does not go underground. No underground installation below boiler shall be allowed. Accordingly sufficient clearance shall be maintained below boiler and after bottom ash seal plate.

1.18 Installation of FGD System

1. A Wet type Flue Gas Desulphurization (FGD) system without GGH shall be installed to meet the requirements of pollution control.

2. Following shall be taken care of in the ducting for installation of FGD:

   a) Suitability of duct between ID fan and chimney for interconnection of FGD system.

b) The ducting and supporting structure to be designed to take care of Guillotine damper to be installed between the two tap offs before chimney.

c) Any other provisions/precautions/arrangements to be incorporated for easy/simple/quick installation of FGD. Bidder shall supply FGD as per the technical details indicted in Volume – III, Chapter 36 of the specification.

1.19 Materials for Steam Generator Components

The material used for Steam Generator components i.e. boiler pressure parts including boiler tubing, headers, separators, piping, vessels, valves & fittings etc. and other components shall be equal to or better than the following unless specified otherwise:

S. No.	Design Metal Temperature	Material
(i)	Upto & including 400 °C	Carbon steel to ASME SA:106 Gr. B/C or SA 210 Gr. C or approved equivalent
(ii)	Upto & including 550 °C	Alloy steel to ASME SA-335: P-11/P-12/P-22 ASME SA213:T/11/T-12/T-22/T23/ or approved
(iii)	Upto & including 601 °C	Alloy steel ASME SA-335/213: P-91/T-91 or approved equivalent.
(iv)	Upto & including 610 °C (*)	Alloy steel ASME SA-335:P-92/T-92 or approved equivalent
(v)	Above 610 °C	Austenitic stainless steel, super 304H, TP347H or approved equivalent

* Note:

i) Bidder may use ASME SA-335: P-92 or approved equivalent material up to 610°C for the components which are outside the flue gas path for Superheater, Reheater tubes, headers and interconnecting piping as applicable.

In case it is proposed by the bidder to use ASTM-A-335 P-92 or equivalent material, Bidder shall be required to furnish operating references.

ii) Maximum allowable -stress values for ASME SA-335: P-92/T-92 or approved equivalent material as per code shall be reduced by 10% for calculating the thickness of pressure parts.

1.20 Limits of NO_x Emission

Combustion system along with wind box, air ducting and other associated parts shall be designed for guaranteed maximum NOx emission of 100 mg/Nm^3 at 6% O_2 on dry gas basis at Selective Catalytic Reduction (SCR) outlet.

Bidder will demonstrate its guaranteed maximum NOx emission of 80 mg/ Nm^3 on part load operation.

Further NOx reduction shall be achieved through suitable SCR system by the Bidder to limit NOx emission value to the guaranteed conditions as specified elsewhere in the technical specifications.

Bidder to submit details of NOx emissions achieved by him at other stations using similar fuels burner/furnace designs, to substantiate his claims.

1.21 Capital Overhaul of Steam Generator

Owner envisages to carry out the capital overhaul of unit once in three (3) years. The design and materials for various equipment/auxiliaries etc. shall be selected by the Bidder keeping in view the above requirement of the customer, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.

1.22 Maintenance

1. The Bidder shall provide adequate handling facilities & approach as for carrying out online 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.

2. A minimum of two accesses and clean out doors shall be provided to permit access to the furnace, superheater, reheater, area between tube bank, Separator, economizer and any other area requiring maintenance.

3. 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, fuel oil pumps etc.

4. A vertical & straight garbage chute of minimum 600 mm diameter and made from minimum 10 mm thick mild steel pipe shall be provided for 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.

1.23 Noise level

The equivalent weighted average of sound level measured at a distance of 1.5 M above floor level in each elevation and 1 M horizontally from the base of any equipment furnished and installed under these specifications, expressed in decibel to a reference of 0.0002 microbar, shall not exceed 85 dB (A). Noise level for motors shall be specified in motor specification.

1.24 Equipments and Systems Specifications

Specified hereafter are the minimum acceptable functional requirements of the Owner, and all components, equipments and systems for the Steam Generator shall be designed to cater to these requirements. Compliance to various stipulations of the Technical Specifications, functional requirements of Owner and utilization of various parameters and their values in the

specification by the Bidder shall in no way relieve the Bidder 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 Owner.

1.25 **Design Of Pressure Parts**

a. The design of all pressure parts (tubes, headers, separators, vessels etc.) shall be as per Indian Boiler Regulations (IBR) or other international codes with the approval of the Owner. It is however, the responsibility of the Bidder to get various calculations and other technical documentations approved by the statutory authorities in the state and country of location of the plant.

b. Design pressure of the Steam Generator pressure parts shall be atleast 1.05 times the maximum operating pressure, or as required by IBR/other international codes, whichever is higher.

Further, design pressure of the steam generator pressure parts upstream of separators shall be atleast 1.05 times the maximum operating pressure, or as required by IBR / ASME, or pressure arrived based on lowest set pressure of spring loaded safety valve on the separators plus the pressure drop from separator to the respective pressure part; whichever is higher.

c. The thickness of the pressure parts (steam and water tubes/headers, separators, pressure vessels etc.) shall be calculated using IBR formulae/factor of safety etc. (and not as per codes/formulae acceptable to IBR). Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the straight tubes. For this purpose appropriate thinning allowance shall be considered by the Bidder while calculating the thickness of the bends. Additional erosion allowance on the calculated tube thickness shall be provided at specified locations as specified by the Owner in this specification

d. The working fluid temperature to be considered for design of boiler tubes, headers, separators and other pressure parts upto first stage of attemperation shall be arrived by adding an additional margin of minimum 40°C to the maximum predicted/expected fluid temperature in these pressure parts. The margins as per IBR and other codes shall be taken over and above the working fluid temperatures so arrived.

2.0 **Steam Generator Enclosure**

1. Steam Generator enclosure shall form air/gas tight envelope from secondary air and primary air inlet points to chimney inlet.

2. 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 water walls 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.

3. 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.

4. Any penetration(s) into the Steam Generator enclosure shall be sealed for gas tight integrity.

5. The Steam Generator enclosure shall be provided with:

   a) Compressed air cooled observation ports for each oil/coal burner and at various platform levels on all the walls.

   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 alongwith ladders from nearest platform level

   d) Seal plates of stainless steel (type 430) or better corrosion and erosion resistant steel material of minimum 6 mm thickness, all round the furnace bottom, to prevent ingress of air.

6. 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.

7. 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.

8. Wear bar at hopper panel tubes area to protect tubes shall be provided. Lower side of hopper panel exposed to water to be protected with shield plates.

3.0 Furnace/Evaporators and Water Walls

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

a)	Net Heat Input (NHI)/Plan area (Maximum) of furnace	4.75 x10^6 kcal/hr/m²
b)	Heat Liberation rate	106920 kcal/hr/m³ (Maximum)
c)	Burner Zone Heat Release Rate (BZHRR)	1.9 x 10^6 kcal/hr/M² (Maximum)
d)	Maximum FEGT (MHVT value	60 deg.C below Minimum IDT of ash
e)	Heat Input per burner(*)	700 x10^5 kcal/hr
f)	Furnace Cooling Factor	1.9 x 10^5 kcal/hr/M² (Maximum)
g)	Furnace residence time(**)	2.0 sec. (Minimum)
h)	No. of burner elevation being fed from one mill	1 (Maximum)

i)	Pressure withstanding capability	±660 mmwc (Minimum) at 67% yield strength or Maximum conceivable head of fans, whichever is higher
j)	Buckstay spacing	To ensure that its natural frequency is sufficiently away from the flame pulsation frequency.
k)	Buckstay support	Self-support from furnace walls. No interconnection with boiler structure is allowed.
l)	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) load cells shall be installed in the furnace roof enclosure to give indication of ash build up in the furnace bottom hopper.

(*) Minimum number of coal pulverisers to be provided for steam generator shall not be less than Eight (8).

(**) Selected Furnace Residence time by the Bidder shall be "COAL SPECIFIC" as per this tender document.

1. Furnace / Evaporator shall be designed for variable pressure operation over 30% to 100% BMCR load range. Furnace shall be water/steam cooled on all four sides and the bottom by means of closely spaced tubes with welded ligament membrane wall construction. Furnace roof tube may be either steam or water cooled.

2. Water / steam walls shall be of membrane wall construction and shall be made of seamless 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 trial 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 Bidder. Bidder in his proposal shall indicate the approximate time required for such readjustment of tube mass flow and the period of unit shut down.

3. Elevation of Furnace Bottom Hopper shall be at least 10.25 M above grade level and opening of bottom hopper shall be 110 cms (min.) wide.

4. 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.

5. Maximum allowable tube skin temperature for evaporator section shall be 40^{o}C below oxidation limit for tube metal.

6. Flame impingement on steam/water walls is not permitted.

7. 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.

8. 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 or adequate additional thickness shall be provided to take care of erosion.

   In case of spiral tube arrangement, wear bars shall be welded on each of 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, Bidder can also provide 1.0 m 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.

9. 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 4 & 7 above. For this purpose appropriate thinning allowance shall be considered by the Bidder while calculating the thickness of the bends.

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

11. Incase water wall orifice are provided, these should be supplied with indexing holes and index pins.

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

S. No.	PARAMETER	REQUIREMENT
i.	Soot Blowing Frequency	(1) Once daily (max.) for Furnace (2) Once in each shift for Air pre heater.

S. No.	PARAMETER	REQUIREMENT
ii.	Preferred mill combination	Any combination of mills (to Owner'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	40% BMCR
viii.	Maximum gas temperature variation across furnace width and depth.	30°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 pressure unbalance (steam side)	6% (Maximum)
xii.	Air ingress from furnace bottom hopper	As per manufacturer's Predictions

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 parts materials.

13. 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.

c) Scaffolding door at height of starting point of second pass or at suitable place.

14. Provide the following:

    a) Provision for future installation of additional Soot Blowers shall be made in the furnace. For this purpose the furnace construction shall preferably be provided with wall box openings. Necessary space provision in layout for providing approach and platform for future soot blowers shall be kept in the original design itself so that 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 Bidder shall install these soot blowers and associated access and platforms without any cost implication to the Owner.

    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.

15. Panel to panel welding in burner zone to be avoided to maximum possible extent.

16. 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. Expansion indicator shall be provided on all four furnace valves at different elevations in second pass also.

17. For continuous monitoring of water wall tube metal temperatures provide 100 thermocouples outside the gas path as per specification specified elsewhere in the Technical Specification.

Note:

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.

Alarm set point for tube metal temperature shall not exceed the design temperature of respective tube

Definitions of Acronyms/Terms used

"NHI/Furnace Plan Area"

Net Heat Input (NHI) or heat available in furnace is obtained by considering the GCV of the fuel minus the radiation losses, loss due to unburnt combustible, moisture in air & fuel, moisture in air & fuels, latent heat of

moisture in fuel & that formed by combustion of H_2 in the fuel plus the sensible heat of combustion air (Primary plus Secondary air), all above 30°C.

Furnace Plan Area is the product of Furnace Width and Depth.

"BURNER ZONE HEAT RELEASE RATE" (BZHRR)

Burner Zone is defined as the centre line distances between the Top and Bottom burner plus 3.05 M of furnace height. Further, heat input is the input from coal.

"FEGT (MHVT)"

FEGT is the Furnace Exit Gas Temperature in degree Celsius.

MHVT Value is the flue gas temperature as measured by a Multi Shielded High Velocity Thermocouple (MHVT).

BIDDER TO NOTE:

Furnace exit plane shall be defined as the plane, vertical for two pass Steam Generator and horizontal for single pass (tower type) Steam Generator, above the furnace nose tip or the plane beyond which the transverse tube pitching is less than 600 mm whichever is positioned first in the flue gas flow path. Further, all the predicted/guaranteed gas temperature including FEGT indicated by the Bidder shall be the actual MHVT value and not the HVT values.

"FURNACE COOLING FACTOR"

Furnace Cooling Factor in Kcal/hr/sq.m., is the ratio of NHI or heat released and available and Effective Projected Radiant Heat Absorbing Surface (EPRS). For arriving at Furnace Cooling Factor the calculated EPRS shall be reduced by at least 10% to account for deterioration of furnace walls surface condition due to fouling/slagging etc.

"FURNACE RESIDENCE TIME"

Furnace Residence Time shall be defined as the residence time of the fuel particles from center line of the top elevation coal burners to the furnace exit plane. For the purpose of residence time the exit plane shall be defined as the horizontal plane at the furnace nose tip for two pass boiler & the horizontal plane at the entry to the radiant superheater/ reheater for single pass/ tower type boiler. Further, Furnace Residence Time shall be calculated by dividing the furnace volume between the center line of top coal burner and furnace exit plane by the flue gas volume at mean gas temperature in the above furnace volume.

4.0 Steam Generator Casing and Framing

1. Steam Generator casing/pent house (as applicable) shall be provided. The casing/pent house design shall ensure:

   a) Complete enclosure of Steam Generator including superheater, reheater & economizer headers.

b) The casing/pent house 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 unit), 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 1600 kg/m³.

c) Temperature upset due to maximum gas temperature variation across furnace shall be considered while selecting pressure parts materials.

2. Steam Generator casing/pent house 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.

3. Provide at least two pent house ventilation/cooling/pressurizing fans with their air inlet openings at opposite ends.

4. The casing/pent house 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.

5.0 Steam Seperator(s)

a)	Design Code	IBR
b)	Design Temperature	Max. fluid temperature plus 40°C (Min.)
c)	Design Pressure	1.05 times the max. operation pressure or highest set pressure of the spring loaded safety valve for full discharge whichever is higher

Steam Separator construction shall have:

a) Materials as specified shall suit maximum design pressure/ temperature.

b) Fusion welded 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) Hand hole with forged steel cap.

f) Minimum load with separator dry shall be 30-40% TMCR (As per Manufacturer's proven practice).

6.0 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. 2x100% 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.

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

   a) 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.

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

   c) 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 6.0 (1) (b) above. Design of the flash tank shall conform to the specification as stipulated elsewhere in the specification.

2. 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.

3. 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:

a)	Number of pumps	1x100% (sized for maximum flow as specified
b)	Type of pump	Gland less zero leakage type with overhung impeller.

c)	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 Owner's approval. Motor windings shall be of non-hygroscopic material and shall be designed to withstand continuous water pressure & temperature variation. The insulation shall have sufficient dielectric strength to withstand rated phase to earth voltage in slot portion and phase to phase voltage in end windings. The insulation material shall not have any tendency to plastic deformation even under extreme operating condition like the conductor temperature, mechanical forces, vibrations etc. The cooling circuit shall be provided with a reflux pressure compensation device at the bottom of the water to guard against any rise in pressure. Power & instrumentation leads shall be taken out of the motor through water tight sealing glands & shall be run in flexible metal conduits or metal cable sheathing along the length of the pump body. The design of the seals shall allow for effects of differential expansion between insulation conductor and pressure casing, over the entire range of operating temperature.
d)	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 66^0 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.

4. 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.
   Construction of start-up drain recirculation pump shall meet following requirements:

   i. Pumps & motors shall be hermitically sealed.

   ii. Heavy duty design & construction suitable for operating pressure & temperature

   iii. Pumps to be mounted & supported directly from the Steam Generator recirculation piping system.

   iv. Motor to be mounted beneath the pump.

   v. Pump casing shall be one piece casting with end suction & dual side discharges.

   vi. Impellers shall be of one piece casting secured to the shaft in over hung position on the extension of the motor shaft.

   vii. Impeller mounting shall allow the hub to freely expand & contract independent of the shaft.

   viii. Material selected shall minimum erosion & construction. Design shall also eliminate electrolytic action.

   ix. Bearings: Common shaft of the pump and motor shall be guided and supported on spherically seated journal guide bearings and spherically seated tilting pad type double action thrust bearings, respectively.

   x. All bearings shall be lubricated by liquid in motor cavity.

7.0 SUPER HEATERS & REHEATERS

7.1 Superheater(s) and Reheater(s) shall be designed, suitably sectionalized and positioned to comply with the following, for the specified load(s), coal(s) and for normal, upset, most adverse and other operating conditions. (refer as specified at clause 1.3 of this section also)

S. No.	Parameter	Requirement
1.	Rated Steam Temperature	
a)	At Super heater outlet	Refer cl.1.3 of this section
b)	At Reheater outlet	Refer cl. 1.3 of this section
Note: Steam temperatures at superheater and reheater outlets shall be guaranteed to be maintained within ±5°C of the above rated steam parameters over complete control range of Steam Generator with whole range of specified coals.		
2.	Maximum average flue gas velocity in section/tube banks with transverse tube pitching 600 mm or less and with 25% excess air at economizer outlet	10 M/sec. (The maximum localized velocities across the cross- section shall not exceed 12m/ sec.)
3.	Maximum allowable tube metal skin temperature	40^0 C below oxidation limit for the tube metal
4.	SH/RH outlet steam temperature characteristic below control range	a) As close as possible to each other b) Minimum drop from rated steam temperature
5.	Means of Temperature Control	
a)	Super Heaters	Spray Water attemperation, (utilizing water tapped off from downstream side of HP heaters or intermediate banks of economizer or Economizer outlet). Tapping of spray water upstream of top HP heater is not allowed
b)	Reheaters*	Tilting of burners/gas biasing/gas recirculation (gas to be tapped off after ID fans), spray water attemperation (utilizing water tapped off from interstage of BFP)
*Note : In case gas recirculation system is offered for reheat temperature control, minimum 2x100% gas recirculation fans with atleast 20% margin on flow and 44% margin on head over calculated maximum requirement of fan flow and head respectively shall be provided for steam generator.		

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

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
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 Bidder 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: For tower type boiler - 1000 mm For two pass boiler - 762 mm
3.	Maximum depth of tube banks/sections in the direction of gas flow:
a)	2 Meters or maximum soot blowing radius, whichever is lower.
4.	Supporting arrangement
a)	All horizontal heat transfer surfaces shall be supported by steam/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
a)	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 3 mm or higher thickness. The arrangement of headers shall be such that it does not cause the high localized 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 1.25 of this section) 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 1.25 of this section) 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 Bidder 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 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)	Bidder 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 not be allowed for site welding
9.	Max no. of material grades in flue gas path inside the boiler can be used in one bank:- Three (3)
10.	Space Provision
a)	Keep provision of space for atleast 20% addition of additional economizer surfaces in future. Structure/hanger design shall be suitable for loads due to these additional surfaces (filled with water) also.

7.3 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.:

1.	SH outlet Steam temperature	Refer cl. No 1.3 of this section
2.	RH outlet Steam	Refer cl. no.1.3 of this section
Note: The control system for SG shall be able to maintain SH/RH outlet temperatures within ± 5°C of above values over complete control range of Steam Generator. For continuous monitoring of tube metal temperatures of SH and RH elements, adequate number of thermocouples shall be provided as per standard and proven practice of the OEM. A suggested criterion for provision of thermocouples is indicated as below: a) For supherheaters and reheaters elements placed before furnace exit plane (in the direction of gas flow), chromel-alumel thermocouples on at least two elements of every fifth assembly between the two headers shall be provided. b) In addition to the above, adequate number of chromel-alumel thermocouples for measurement of tube metal temperatures outside the gas path shall also be provided. Total number of thermocouples including those at (a) above shall, however, not be less than 2 (two) thermocouples per RH/SH assembly between the two headers".		
3.	Preferred mill combination	Any mills (To Owner's choice)
4.	Maximum permissible spray attemperation flow (as percentage of mainsteam flow at superheater / Reheater outlet)	
a)	Superheater attemperation	8% of mainsteam flow at superheater outlet
b)	Reheater attemperation	3% of Reheat flow at reheater outlet. However, at normal operating condition, reheater spray tending to zero with design coal.
	Above permissible limits shall be applicable to all boiler loads with any combination of Mills in service and shall be guaranteed by the Bidder. The SH/RH attemperation system shall, however, be sized for 12% of the rated mainsteam flow requirement for superheater and 8% of the spray flow rated reheat flow for reheater, both at 100% BMCR load. The steam temperature downstream of desuperheater shall have at least 10°C superheat to ensure proper evaporation.	
5.	Spray water carryover	Nil
6.	Maximum steam side header pressure unbalance	6%
7.	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.		

7.4 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 Bidder as per the proven product is acceptable.

iv. Arrangement for internal inspection of attemperators / headers

v. Arrangement (structural steel/runway beams, motorized hoists, walkway platform alongwith runway beams etc.) for removing, handling and placement of tubes banks/section at ground level for repair/replacement.

vi. Headers and pipes, if made using X-20 Cr MO V 121 to DIN 17175 material, shall have provisions to ensure that no site welding of this material with similar or dissimilar material is needed.

8.0 **Economisers**

i. Economizer design shall conform to the following criteria/requirements under all conditions of operation and for the complete range of specified fuels.

	CRITERIA	**REQUIREMENT**
1.	Economizer Type	Non-steaming type with parallel cross flow or counter flow arrangement.
2.	Approach Temperature within control range	17°C (minimum)
3.	Maximum average flue gas velocity through the Economizer tube banks, with 25% excess air at Economizer outlet.	10 M/sec. (The maximum localized velocities across the cross-section shall not exceed 12 M/sec) With any coal from specified range
4.	Economizer tube thickness	(i) Provide erosion allowance of 1mm (minimum) in addition to thickness calculated as per IBR formulae.

	CRITERIA	REQUIREMENT
		(ii) 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 (i) above. For this purpose appropriate thinning allowance shall be considered by the Bidder while calculating the thickness of the bends
5.	Maximum allowable tube metal skin temperature	Oxidation limit for the tube metal.
6.	Maximum depth of tube banks / sections in the direction of gas flow:	2 M or maximum soot blowing radius, whichever is lower.
7.	Thermal shock aspect	The economiser shall be suitably designed to take a thermal shock of sudden change of feed water temperature from rated value to approximately 140^{o}C during HP/LP bypass operation.

ii. Economiser 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) Fabricated from seamless tubes in suitable modules (each module complete with its own spacers and supports) to facilitate block erection at site.

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/ water cooled hanger tubes/headers 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.

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.

j) Provision should be made for removal and replacement of entire economizer coil. Platform must be provided outside the furnace for repairing/ replacement of the entire coil.

Bidder shall ensure sufficient head room below the economizer/economizer by pass hoppers to accommodate the ash handling equipment. A minimum headroom of 2.5 m (tentative, to be finalized during detail engineering) shall be kept between hopper flange and platform to accommodate the ash handling equipments. Bidder shall include necessary platforms, access to platforms and supports for the ash handling equipments.

To enable the ash/slurry pipes from economizer/ economizer by pass hoppers to be routed with minimum bends, it may be required to pass vertically through the air/flue gas ducts. In such a case it is envisaged that Bidder shall provide a pipe sleeve within the ducts through which the ash/slurry pipes may be routed. Details of the pipe sleeves required will be finalized during the detail engineering.

iii. 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 (structural steel/runway beams, motorized hoists, walkways platform alongwith runway beams etc.) for removing, handling and placement of tubes banks/section at ground level for repair / replacement. The size of platforms shall be adequate to store 5-6 economizer assemblies as well as adequate space for handling them.

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

e) 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

iv. 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.

9.0 Regenerative Air Pre-Heaters (Bisector type or Tri-sector type) & Steam Coil Air Preheaters (SCAPH)

9.1 Regenerative Air Pre-Heaters

I. Regenerative Air Pre-Heaters (Bisector type RAPH)

Air preheater shall be sized/designed to cater to following requirements:

S. No.	DESCRIPTION	BISECTOR TYPE	
		Primary Air Preheater (PAPH)	Secondary Air Preheater (SAPH)
1.	No. of Air Preheaters per Steam Generator	Two	Two
2.	Sizing shall be based on following criteria, all conditions considered to be occurring together		
i)	Design Ambient Air Temperature & Humidity	30°C· & 75% RH	30°C· & 75% RH
ii)	Type of Coal Firing	Worst coal, with max. moisture	Worst coal, with max. moisture
iii)	Air Temperature Rise across Air Preheater	Adequate to achieve the required coal/air mixture temperature at burner inlet at all loads and for complete range of specified coals	Adequate to achieve the required secondary air temperature for stable combustion at all loads and for complete range of specified coals
iv)	Load Range	a) 60% BMCR With Design/Best/worst coal and maximum moisture, whichever gives maximum flow with one set of PAPH & SAPH	
		b) 100% BMCR with Design/ Best/worst coal and maximum moisture whichever gives maximum flow with both sets of PAPH & SAPH	
v)	Minimum average cold end metal temperature at 100% BMCR (with SCAPHs out of service)	76 ^{0}C	76 ^{0}C
3.	AH flue gas exit temperature (corrected) at 100% TMCR (800 MW unit	125 ^{0}C	125 ^{0}C

S. No.	DESCRIPTION	BISECTOR TYPE	
	load) with range of specified coal		
4.	Min. flue gas exit temperature (for complete range of specified fuels)	5^0C above acid dew point of flue gas	5^0C above acid dew point of flue gas
5.	Air Leakage (at 100% TMCR i.e. 800 MW unit load for complete range of coals)	Less than 7% of the Flue gas weight entering airheater	

II. Regenerative Air Pre-Heaters (Trisector type RAPH)

Air preheater shall be sized / designed to cater to following requirements:

S. No.	DESCRIPTION	TRISECTOR TYPE
1.	No. of Air Preheaters per Steam Generator	Two
2.	Sizing shall be based on following criteria, all conditions considered to be occurring together:	
a)	Design ambient air temperature & humidity	30 °C & 75% RH
b)	Type of coal firing	Worst coal, with mix. Moisture
c)	Air temperature rise across Air preheater	Adequate to achieve the required coal/air mixture temperature at burner inlet at all loads and for complete range of specified coals
d)	Load Range	a) 60% BMCR with worst coal and maximum moisture with one set of RAPH in service. b) 100% BMCR with worst coal and maximum moisture with both sets of RAPH in service
e)	Minimum average cold end metal temperature at 100% BMCR	76°C
3.	Minimum AH flue gas exit temperature (corrected) at 100% TMCR (800 MW unit load) with range of specified coal	125°C
4.	Min. flue gas exit temperature (for complete range of specified fuels)	5°C above acid dew point of flue gas
5.	Air Leakage (at 100%	Less than 7% of the Flue gas

S. No.	DESCRIPTION	TRISECTOR TYPE
	TMCR i.e. 800 MW unit load for complete range of coals)	weight entering air heater

III. For meeting the requirement of rated coal/ air mixture temperatures at burner inlet at part load operations of steam generator with coals of excessive moisture and under conditions of low ambient temperatures the Bidder shall provide economizer bypass duct incase of bisector airpreheater along with necessary dampers, expansion joints, structures etc. and sufficient tempering air reserve is provided by the Bidder, the sizing of air preheaters shall ensure that the rated mill outlet temperatures are achieved, for complete range of specified coals, from 100% of TMCR (800 MW) to 100% BMCR loads with economizer bypass closed and without reducing tempering air reserve. Further, the bidder shall indicate the quantity of tempering air reserve. Further, the bidder shall indicate the quantity of tempering air reserve considered for Trisector air preheater design for loads 100% TMCR (800W) to 100% BMCR loads for complete range of specified coals.

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

V. Air preheater Construction shall conform to following:

S.No.	Design	Requirements	
1.	Type	Rotary regenerative (Bisector Type), (Ljungstrom or approved equivalent), with vertical axis of rotation, enclosed with air/gas tight casing, Sacrificing basket.	
2.	Heating Elements	a) Cold end	Made of corten steel, minimum 1.2 mm thick
		b) Hot / Intermediate end	Made of carbon steel minimum 0.8 mm thick.
3.	Bearings (forced lubricated and oil cooled)	c) Cold end d) Hot end	Spherical roller thrust Radial guide bearing.
	Note: Only metallic hoses shall be used for bearing cooling/lubrication. Rubber hoses are not acceptable.		
4.	Air heater seals	i. Externally adjustable and easily replaceable seals.	
		ii. The maximum air-in leakage to flue gas after 3000 hours continuous operation of the boiler with coal shall be guaranteed and demonstrated. The Bidder shall also demonstrate that the drift in air heater leakage (percentage change in air-in-leakage) does not exceed 1%, one year after demonstration of above guaranteed air-in-leakage. Within this period of operation till all air heater leakage demonstrations are completed only external adjustments of seals, without needing any shut down for replacements and without internal adjustments, shall be allowed. The seal design/construction shall be such that the above requirements are satisfied.	

S.No.	Design	Requirements
		iii. Seals shall have life not less than 2 years (with leakages not exceeding guaranteed limits)
5.	Air Heater drive	i. 2x100% peripheral AC drive, with gear box and automatic clutching/declutching facility
		ii. 1x100% 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.
6		Two nos. inlet oil carryover detection probes shall be provided for each APH

VI. Regenerative Air Pre-Heaters (Trisector type RAPH)

Air preheater shall be sized / designed to cater to following requirements:

S. No.	DESCRIPTION	TRISECTOR TYPE
6.	No. of Air Preheaters per Steam Generator	Two
7.	Sizing shall be based on following criteria, all conditions considered to be occurring together:	
f)	Design ambient air temperature & humidity	40°C & 60% RH
g)	Type of coal firing	Worst coal, with mix. Moisture
h)	Air temperature rise across Air preheater	Adequate to achieve the required coal/air mixture temperature at burner inlet at all loads and for complete range of specified coals
i)	Load Range	a) 60% BMCR with worst coal and maximum moisture with one set of RAPH in service. b) 100% BMCR with worst coal and maximum moisture with both sets of RAPH in service
j)	Minimum average cold end metal temperature at 100% BMCR	76°C
8.	Minimum AH flue gas exit temperature (corrected) at 100% TMCR (800 MW unit load) with range of specified coal	125°C
9.	Min. flue gas exit temperature (for complete range of specified fuels)	5°C above acid dew point of flue gas
10.	Air Leakage (at 100% TMCR i.e. 800 MW unit load for complete range of coals)	Less than 7.5% of the Flue gas weight entering air heater

S. No.	DESCRIPTION	TRISECTOR TYPE
11.		Two nos. inlet oil carryover detection probes shall be provided for each APH

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

VIII. 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.

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

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

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

XII. Provide:

a) Sufficient space provision for future installation of minimum additional 15% of APH heating surface are 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.

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

d) Basket removing facility along with/without removal gear if applicable as per vendor's standard design.

e) 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.

f) 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.

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

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

i) 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

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

k) Sufficient space & platform provision for storage of Hot end & intermediate baskets shall be made in design for overhauling / maintenance of APH.

XIII. 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 of air preheaters. Necessary water draining system, connected to station drains shall also be provided.

Steam Coil Air Preheaters (SCAPH)

i. SCAPH shall be designed *I* sized to increase the air heaters inlet air temperature based on following criteria:

S. 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.
(ii)	Design ambient air temp.	6°C	6°C
(iii)	Type of coal firing	Worst coal	Best coal
(iv)	Air temperature at SCAPH outlet		
(a)	At 100% BMCR	30°C (min)	30°C (min)
(b)	At 30%BMCR	100 °C (Min.)	100 °C (Min.)
(v)	Air temperature at the inlet of each Air Preheater	To keep average metal temp. (Cold end) atleast 76°C with coal firing and 100°C with oil firing	

I. Design SCAPH and connected air ducts to handle flows corresponding to 60% BMCR loads with one of the two streams working without any undue noise/vibration.

10.0 Coal Preparation and Firing System

10.1 General

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.

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.

10.2 Bunker Shut Off Gates & RC Feeder inlet & outlet gates gate

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 & RC Feeder outlet gates shall be pneumatically / motor 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) Gate Design shall ensure dust tight enclosure.

d) The gates valves shall be self-cleaning type.

e) Manual isolating SS rod type needle gate before bunker shut off gate shall be provided.

The Bunker shut off gates and feeder inlet & outlet gates shall have:

a) Totally enclosed construction to prevent leakage

b) Gate and shaft bearings, suitable for pressure lubrication

c) Stainless steel material for following:

i. All components coming in contact with coal
ii. Gate and shaft roller bearing

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.

The bunker shut of gate shall ensure 100% closure of bunker outlet even "bunker full of coal" & "static column of coal in the chute between bunker & feeder" conditions without its motor getting overloaded.

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

Adequate provisions shall be kept for sampling of coal.

10.3 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

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 'Owner's' approval.		

Chutes shall be made of minimum 12 mm thick stainless steel SS-410 material and shall be of full welded construction. Chute above shall be of minimum 6 mm thick and provided with suitable liner at bends and suitable reinforcements.

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

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

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

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.) temporary chute shall be provided 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.

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.

10.4 Raw Coal Feeders

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

2. Provide the following minimum features in the RC feeder(s), in addition to complying with all the stipulations of NFPA (latest edition).

1.	Feeder Type	Gravimetric, belt type with minimum size of 36"
2.	Raw Coal Feeder Sizing	1.2 times maximum capacity of coal pulverizer.
3.	Environment Withstand capability	
a)	Ambient temperature	70°C (min.)
b)	Explosion pressure	3.5 Kg/cm² (min.)
c)	Other environmental conditions envisaged	

4.	Feeder Accuracy	
a)	In-situ weighing Accuracy	± 0.5%.
b)	Repeatability	0.1%
c)	Shall have in-built facility for calibration	
5.	System shall be capable of tolerating large supply voltage variation	
6.	All site equipment shall be suitable for 70°C ambient temperature and other environment conditions envisaged	
7.	"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

3. The feeder casing shall be designed to withstand an explosion pressure of 3.5 Kg/cm^2 (g).

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

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

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

7. Provide suitable arrangement to adjust belt tension.

8. Provide following facilities for the feeders.

9. Spraying water inside the casing

10. Providing purge air to the feeder

11. 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.

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

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

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

10.5 Coal Pulverizers

I. Pulverizer Type:

Each pulverizer shall supply coal to only one burner elevation Bidder may offer any one of the types of pulverizers indicated below:

Classification	Type
Vertical Spindle	Bowl Mill

II. Sizing of Coal Pulverisers

Selection, sizing and total number of Coal pulverisers to be provided for Steam Generator shall confirm to following stipulations:

S. No.	DESCRIPTION	CRITERIA TO BE SATISFIED
1.	Number of mills for Steam Generator	Adequate to achieve 100% TMCR for all specified coal(s) and all operating conditions but not less than eight (8) mills.
2.	Number of standby mills	
a)	At 100% of TMCR, (800 MW unit load) worst coal firing	One
b)	At 100% BMCR worst coal firing	Nil
c)	At 100% BMCR design coal firing	One
3.	Sizing of coal pulverizers confirming to clause 10.5 (II) (1&2) above shall be under following conditions all occurring simultaneously:	
a)	Maximum permissible mill loading for deciding mill capacity (selection of mill typre/model) complying with requirement at clause 10.5 above	85% or the mill loading achievable corresponding to the near worn out conditions of mill grinding rolls/balls/tyres etc. whichever is less. This condition shall be complied for the range of specified coals including the adequacy range of coals.
b)	Unburnt carbon loss to be considered at various steam generator loads, for sizing / selection of coal pulverizers	1% or actual expected value, whichever is higher.
c)	Rated Pulverized coal fineness* at rated capacity of the pulverizer, not less than	>70% thru 200 mesh (75 microns) and 99% thru 50 mesh (300 microns)
d)	Input coal size	Upto 50 mm

Note:

* To be demonstrated at site for each mill by coal sampling as per ISO 9931 & with grinding elements within the guaranteed wear life of respective wear element.

Side Ways arrangement for pulverizer shall be considered.

III. Classifier design

a) Provide rotary (dynamic) classifier capable of maintaining rated conditions of fineness [as per clause 10.5 (II) (3) above] under all conditions of operation, load changes and specified fuels. Further the classifier vanes speed shall be adjustable and shall be lined with approved wear resistant material to ensure the guaranteed wear life.

b) Fineness adjustment shall be possible while the mills are in service, through stepless speed adjustment of its VFD drive.

c) The rotary (dynamic) classifier, of proven design, shall ensure improvement in quality of fineness and ensure uniform sizing and distribution of particles at all loads and with all types of fuel blending as specified.

d) Aerodynamic shape for vanes will be provided for effective classification. The classifier vanes and cones shall be lined with approved wear resistant material to ensure the guaranteed wear life. If required, wear lining may be provided at wear prone areas of the classifier.

e) The classifier should impose minimum possible pressure drop across it. An energy efficient drive will be selected to ensure least possible power consumption of the drive motor.

IV. Ensure adequate vibration isolation of mills so that no adverse effects are transmitted to the nearby structure/installations.

V. **Mill Sound Level**

It 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.

VI. **Seal Air System**

a) 2x100% centrifugal seal air fans common for all the mills of Steam Generator unit shall be provided.

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

c) Following margins shall be provided for each fan over and above the calculated values under maximum duty conditions as per specification requirements:

Margin on flow	25%
Margin on pressure	30%

Above margins shall be based on an ambient temperature of 40 degree Celsius, relative humidity of 60% and system leakages with mill operation at maximum duty.

d) The seal air fan speed shall not exceed 1500 rpm under test block condition.

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

f) The seal air fans shall be suitably located at ground level away from economiser hopper evacuation systems, milling systems & ESP hoppers without disturbing the maintenance space of around equipment.

VII. The design shall ensure that each mill shall supply coal to only one burner elevation.

VIII. The design of lubrication system shall ensure continuous operation of mill bearings.

IX. Mill 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 mill.

X. Mill Motor Capability: Ensure minimum mill motor capability to restart the mill after a trip with mill full of coal. Such restart shall not call for any emptying of mills.

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

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

XIII. **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. 1.4 (1) of this section.

S. No.	MILL COMPONENT	SPECIFICATION
1.	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 minimum specified wear life

S. No.	MILL COMPONENT	SPECIFICATION
2.	Grinding Rings/Race	Material with hardness 550 BHN (min.) at surface (with adequate chilled depth)
3.	Grinding rollers	Material with hardness 350 BHN (min.) (Insert Type)
4.	Minimum difference in hardness of rings/ rolls and race/ balls	100 BHN

XIV. **Minimum Guaranteed Life of Coal Pulverizer Wear Parts**

The guaranteed life of different mill components in "equivalent hours" of continuous mill operation at its rated capacity, while firing the specified range of coals and meeting the requirements as specified at clause no 1.4 (1) of this Sub-Section and without requiring any in between repair or replacement shall be as under:

S. No.	Item	Minimum Life In Equivalent Hours
a)	Seals	20000
b)	Grinding elements (Rolls and Rings/Race)	15000 [See note (a) below]
c)	Mill discharge valves	15000
d)	Classifier cone and other items lined with Ceramic material	25000
e)	Classifier vane (if applicable)	25000

Note:

a) The expected wear life of mill grinding elements (Rolls and Rings/Race) in equivalent hours, under conditions stipulated above shall be atleast 15000 hours.

b) The YGP index for the specified coal is indicated in subsequent section when measured as per BS Standard BS-1016 Part-111. The Bidder shall furnish a curve alongwith his offer indicating the variation in guaranteed wear life with variation in YGP index of coal fired. Separate curves for different wear elements of mill shall be furnished e.g. for grinding rolls, grinding rings, clearly indicating its relationship with YGP index of coal. The curve shall be subject to Owner's approval.

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

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

XVII. Ensure minimum mill turn-down ratio(s) of 3.5:1.

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

XIX. For pulverized coal sampling for fineness and distribution:

a) Provide tapping points on each PF pipe at mill outlet suitable for coal sampling as per ISO 9931.

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 ISO 9931 sampling.

c) Provide

Rota Probe for coal sampling as per ISO 9931 and ASME respectively.

Four (4) nos. Dirty Pitot tubes shall be provided for each steam generator for measurement of coal-air velocity in coal pipes.

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

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

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

XXII. **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 Owner's approval.

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

XXIII. **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 Owner) to a dense phase pneumatic conveying system.

b) Mill rejects collection & discharge system shall be designed 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.

d) The entire mill reject system including accessories for conveyance will be located above ground. This is to facilitate mill reject collection in the unlikely event of failure of pneumatric conveying system. Bidder will ensure that Mill reject chute pyrite hopper outlet shall also be above ground.

Details of mill rejects system shall be given in subsequent chapter in the specification.

XXIV. Fire Detection and Extinguishing System shall be provided for the complete coal preparation firing system including coal feeding system.

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

XXVI. **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 acceptable.

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

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

XXVIII. **Access Doors/Windows**

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

b) Oil pumps & filters shall be readily accessible.

XXIX. **Approach platforms**

Access & platform shall be provided to carryout maintenance of mill for replacement & removal/installation of mill wear parts. Necessary ladders and approach platforms for mill bay hoist shall be provided to carry out any maintenance activity on hoists.

10.6 **Pulverised Coal Pipes**

i. 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.

ii. Fuel air mixture velocity in coal pipes - minimum - 15 m/sec and maximum - 28 m/sec.

iii. The coal air mixture velocity in the coal pipes shall not be lower than the critical fallout velocity under all conditions of mill operation from start-up of boiler onward.

iv. The pipes shall be designed for an explosion pressures of 3.5 kg/cm2 (min.).

v. Maximum permissible design stress shall be yield or 0.2% proof stress.

vi. The piping system shall be designed for a continuous operating temperature of 110 degree Celsius (minimum).

vii. Calculated static loading of each support of the PC 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.

viii. The guide plates, wherever provided in the coal pipe, shall be removable, and access to them shall be obtained through detachable cover.

ix. The guide plates shall be made up of suitable abrasion resistant material.

x. Coupling and toggle section arrangement for fuel piping shall be provided to take up the furnace expansion.

xi. 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 downstream 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).

xii. The pipe/bend base material thickness, wherever ceramic liners are provided, shall not be less than 8 mm.

xiii. The straight unlined PC pipe length shall be of mild steel having a thickness not less than 13 mm with a minimum wear allowance of 4 mm.

xiv. Ceramic material specification: Alumina content of not less than 90% and guaranteed life 25000 hrs (minimum).

xv. Mill discharge valve on pulverized fuel line shall also have provision of manual operation locally and provision of its external local position indication.

xvi. Suitable devices shall be provided in each pulverized coal pipes to enable on load adjustment for equalizing flow.

xvii. Purge air connections shall be provided after the mill outlet valve to clean pulverized coal pipes of any deposits etc.

xviii. Fuel pipes shall be arranged and supplied so that they are easily replaceable.

10.7 **Coal Burners**

I. Coal burner design:

a) Turn down ratio of coal firing system 3.5:1 (min.).

b) The coal burner design shall ensure a steady log mean density of coal air mixture distribution as it enters the combustion zone without allowing the coal dust to settle down.

c) The burner design shall minimize erosion.

d) The burner shall be designed to ensure smooth variation in the fuel flow without affecting the air fuel ratio.

e) The air/fuel ratio around the burner shall be optimized to ensure low emission of NOx. Total NO_x emission from the unit at SCR inlet shall not exceed the value as specified elsewhere in the specification.

f) Burners shall be provided with centralized automatic control with flame scanner and safety protection.

II. 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.

III. Compartmented wind box shall be provided for supply of secondary air for combustion.

IV. The material and construction of burner shall withstand radiation from the furnace, when not in use and shall not get damaged.

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

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

VII. Burner design shall ensure freedom from deposits.

VIII. Burner shall not require adjustment to maintain flame shape.

IX. 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.

X. 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.

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

XII. Minimum operating life of burner parts without requiring any maintenance and replacement shall be 16000 hrs.

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

XIV. Scanner Air System

2 x 100% scanner air fan for all the scanners of steam generator unit shall be provided preferably at firing flow and away from economiser hopper ash evacuation system to avoid any ash ingress in scanner air fan system.

10.8 Primary Air Fans

I. Fan Design

a)	**Fan Design**	
b)	Type of Fan	Two stage, constant speed, variable pitch, axial type
c)	No. of fans	Two
d)	Type of fan blade	Stream lined/Aerofoil bladed type, designed to withstand high bending and axial load.
e)	Fan suction	From atmosphere
f)	Fan rotational speed	1500 (max)

II. Fan Sizing Criteria

a) Each fan shall be rated to meet requirement of 60% BMCR load (one stream in operation) with following conditions all occurring together.

1. Worst coal firing with maximum moisture content.
2. Power supply frequency - 47.5 Hz.
3. Ambient air temp. – 40 degree Celsius & RH 90%.
4. Air-heater leakage of 15% of flue gas flow entering in case of Bi-sector APH or 10% of flue gas flow entering in case of Tri-sector APH or guaranteed whichever is higher.

b) In any case the margins on flow & pressure shall not be less than 25% and 30% respectively over the calculated values at 100% BMCR condition. Above margin shall be under conditions indicated below all occurring together:

1. Worst coal firing with maximum moisture content.
2. Power supply frequency - 50 Hz
3. Ambient air temp. – 40 degree Celsius & RH 90%
4. Air-heater air-in-leakage of 15% of flue gas flow entering PAPH & 10% of the flue gas flow entering SAPH in case of Bisector or 12% of the flue gas flow entering Trisector APH or actual guaranteed value, whichever is higher
5. All mills including standby mill shall be in service.

Note: PA fans shall have a minimum stall margin of 10% over the design duty points.

III. **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 (800 MW load) operating point of fan.

IV. **Fan control System:**

a) Fan flow control

1. By Blade pitch control.
2. The final control element shall be electrically operated.
3. 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

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

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

V. **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 mill as well as at the suction of each fan.

c) PA Fan inlet flow measurement shall be provided using fan inlet elbow. However, if such an arrangement is not possible flow element (venturi/aerofoil system) shall be provided with three pair of tapping points at suction of each PA Fan.

d) Location, type and design of flow measuring devices shall be subject to Owner's approval.

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

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

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

VII. **Material of Construction**

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

b) Base plate - cast iron or welded steel.

c) Casing - sheet steel of suitable thickness.

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

VIII. **Special construction Feature**

a) Fan components shall be designed for torsional stresses of three times the normal full load motor torque at all speed. (Note: Bidder shall submit detailed calculations, for Owner's approval, to confirm compliance with above requirements for all fan components, specifically for fan shafts, impeller hubs and impeller as a whole. Areas of high stress concentration and residual stresses, like welded attachments shall be avoided on the fan rotor/shafts. Combined static, dynamic as well as residual stresses shall be demonstrated to be within allowable limits. These fan components shall last the life of the plant with such combined stresses present in them).

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

c) Pulsation shall be avoided by suitable design of fan and connecting ductwork.

d) 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.

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

IX. **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 Bidder on the bearing housing.

c) 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) Two nos. Duplex RTDs (100 ohm at 0^0 C) and temperature indicators shall be provided for each bearing as per standard practice of the OEM for local as well as remote monitoring of bearing metal temperature.

X. **Fan lubrication System**

a) The lubricating system shall be complete in all respect, compact and frame mounted.

b) The lube oil pressure shall be higher than cooling water pressure.

c) Sealing shall be provided at each end of the bearing housing to prevent leakage of oil.

d) Each bearing shall be provided with an oil level indicator and screwed drain plug if applicable as per vendor’s standard design.

XI. **Fan Vibration Monitoring**

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

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

XIII. 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.

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

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

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

XVII. Both PA fans shall operate with highest possible efficiency which shall be nearly equal at the 100% TMCR (800 MW) & test block points.

11.0 FUEL OIL SYSTEM

11.1 GENERAL

LDO firing requirements of Steam Generators as per characteristics is specified in Volume II.

The fuel oil system shall comprise of:

a) Fuel oil preparation and firing system.

b) Fuel oil drain system

c) Fuel oil condensate system

11.2 Fuel Oil Preparation and Firing System

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

a) LDO Firing System

The LDO firing system shall be provided to facilitate initial start-up, low load operation, secondary fuels for pulverized coal flame stabilization at the startups/low load operation, black start of units when no auxiliary steam is available from external source. (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 during initial black start-up of boiler into the condenser of turbine. Bidder shall, therefore, make necessary arrangement of draining of boiler startup drain to facilitate the black start of the unit.) LDO firing system shall also be used for cold start up of Steam Generators, generation of auxiliary steam using auxiliary boiler. LDO system including pumps, piping, valves etc. shall be sized to facilitate simultaneous cold/black start.

b) 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 steam generator. The oil collected in this tank shall be periodically pumped back to the fuel oil storage tanks. Drains from the oil pressurizing pump house and common oil piping shall be taken by gravity to one common drain oil tank in the pump house area and pumped to fuel oil storage tanks.

11.3 Fuel Oil Preparation and Firing System

1. The Fuel oil preparation and firing system shall be sized based on following criteria.

S. No.	Description	LDO Firing
a)	Purpose of fuel oil firing	To facilitate Initial start up, Coal flame stabilization at start up/low load, black start of unit, when no auxiliary steam is available from external sources.
b)	Type of fuel oil	LDO (As per characteristics given in subsequent chapter)
c)	Oil firing system capacity	To cater to 30% BMCR requirements of Steam Generators without coal firing
d)	No. of independent oil firing streams	1 (catering to requirements of steam generator)

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

3. The Light Diesel Oil (LDO) firing system, shall have following design features:

   (a) Oil relief valves, on larger section of fuel oil pipes which can be isolated.

   (b) For all in line items on fuel oil lines like pumps, flow meters, filters, control valves etc., required to be taken out for maintenance, following shall be provided both upstream and downstream sides:

      (1) Single isolation valve up to suction of pressurizing pumps.

      (2) Double Isolation valves from discharge onwards of pressurizing pumps

   (c) Adequately sized pressure accumulators, on fuel oil lines to Steam Generator for maintaining oil pressure constant accumulator shall be complete with a pressure gauge, stop cock and isolation valves to ensure maintainability of Nitrogen pressure.

4. Air flushing points with isolation valves for cleaning during commissioning. Design/Sizing of various pump shall be based on following Criteria:

S. No.	Design Criteria	Requirement		
		LDO pumps	Drain pumps	Sump pumps
1.	Type of fuel oil to be handled	LDO	LDO	Oil and Water
2.	Pump Suction Temperature	Ambient	Oil pour point temperature	Ambient
3.	Max. Temperature of fuel oil to be	Atmospheric	90°C	50-85°C

S. No.	Design Criteria	Requirement		
		LDO pumps	Drain pumps	Sump pumps
	handled			
4.	Pump design / construction code	HI Standard, ASTM, ASME or equivalent		
5.	No. of pumps	2 (1 W + 1S)	2 (1W+1S)	2 (1W + 1S)
6.	Capacity of each pump	To cater to 30 % BMCR requirements of steam generator without coal firing plus 10%	$5M^3$/hr	$10M^3$/hr
7.	Pump suction head	Considering zero tank level (flodded suction)	Considering zero tank level (flodded suction)	---
8.	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 @ 5m3/hr, whichever is higher	50 MLC (minimum) or suiting site requirements whichever is higher

5. Construction of LDO pressuring pumps and drain oil pumps shall comply with following:

1.	Type of Pump	Rotary, positive displacement, horizontal pump fitted with relief valves
2.	Pump/motor base plate	Common
3.	Type of Drive	Constant speed squirrel cage, induction motor with flexible couplings. VFD shall be provided on both the pumps should be provided individually.
4.	Materials	
a)	Casing	Close grained Cast Iron
b)	Shaft	Carbon steel
5.	Type of bearings	Antifriction

6. **Filters**

a) Following filters shall be provided in the LDO line:

(i) Coarse filters at each pressurizing pump suction
(ii) Fine filter in the common line in boiler area supplying oil to the burner.

b) Maximum oil pressure drop across filters shall be as below:

(i) 0.1 kg/cm² when filter is clean.
(ii) 0.3 kg/cm² when filter is 50% clogged.

c) Aperture size for fine filter shall not exceed 108 micro meter or at least 30% smaller than smallest oil orifice or passage to the burners.

d) Material of filtering mesh shall be stainless steel.

7. **Trip and Nozzle Valves**

1. LDO trip valves & individual burner nozzle valve solenoid shall be:

2. Of single coil heavy duty construction having class 'H' insulation.

3. Having closing time less than one (1) second

4. De-energized/air fail to close type.

5. Designed for operating voltages as under:

a) Trip valve solenoid 24 Volts DC
b) Nozzle valves solenoid 24 Volts DC

LDO 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.

8. **Oil Burners/Burner Components**

a) Type - Air atomized to be able to operate together with pumping system offered for LDO.
b) Burner tips shall be provided as per following table:

S. No.	Description	LDO Firing System
i.	Type of burner	Air Atomized (terminal point)
ii.	Burner cooling medium	Air
iii.	Burner tip material	Resistant to corrosion due to oil containing sodium, vanadium, sulphur, chloride etc.

S. No.	Description	LDO Firing System
iv.	Minimum life of burner tips, before needing any maintenance / replacements	16000 hrs
v.	Hardness of atomizer (The hardness to be retained even at 400°C)	Minimum vickers hardness number of 400
vi.	Type of oil igniters	High Energy Arc Igniters
vii.	Oil burner turndown	4:1

9. 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.

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

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

10. 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 systems 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. Following features shall be provided for interfacing with other systems/ equipment:

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

11.4 Fuel oil drain & condensate system

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

S. No.	Description	Drain Oil Tank
1.	Medium to be Stored	Oil (LDO)
2.	No. of tanks	One for Steam generator in SG area and one in FO pressurizing pump house area
3.	Tank capacity	5m^3 in SG area and 10m^3 in FO pressurizing pump house area
4.	Dimensions	Bidder to specify
5.	Design and construction code	IS:800
6.	Design temperature	120 deg.C (min)
7.	Tank design pressure	-
8.	Type of construction	Rectangular
9.	Material of Construction	As per IS:2062 plates
10.	Corrosion allowance in tank thickness	1.8 mm
11.	Insulation	Required
12.	Nominal Venting capacity	-
13.	Heater tube material	50 NB steel tubes as per IS1239 (Heavy grade or ASTM 106 Gr. B)
14.	Painting & Protective coating	As per Volume II of specification
15.	Tank design, fabrication, erection, commissioning and testing	IS 803/ API 650

II. Piping fitting and valves in fuel oil (LDO) firing system:-

a) The Piping in LDO firing shall confirm to following codes:

S.No.	Piping	Code

1.	Fuel Oil Piping	API-5L GR B or ASTM-A-106 Gr. B (before pressurizing pump). IS1978 or approved equivalent (from discharge of pressurizing pump to boiler).
2.	Piping/Valve sizing	**LIGHT OIL:** All LDO piping system shall be sized to meet the fuel oil requirements of 1 (one) number Steam Generator operating simultaneously at 30% BMCR load.

b) Piping fittings shall be of carbon steel butt welded connection (where possible) conforming to ASTM-A 234 (or approval 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.

c) Valves shall conform to following requirements:

S.No.	Parameter	Requirement
1.	Type of valves (for oil services)	Plug type (metallic seated), leak proof, fire safe as per the requirement of API 6FA
2.	Material of valves on oil lines	
a)	On pump suction side	Cast Iron
b)	On pump discharge side	Cast Carbon Steel
3.	Material of valves on steam/ condensate lines	Cast Iron

d) Instrument root valves on heavy oil lines shall be of 40 NB size, flanged OS & Y type, with body rating in ASA as per process condition.

12.0 Draft Plant

The forced draft (F.D.) and induced draft (I.D.) fans shall be capable maintaining balance draft conditions in the furnace over the entire load range with any one or both F.D. fans and any one or both I.D. fans in operation while firing the specified range of fuels.

12.1 Fan Sizing Criteria

FD & ID fans shall be sized such that they satisfy the criteria stipulated below.

S.No.	Description	FD Fans	ID Fans
1.	Type of fans	Constant speed, axial type	Single / Double stage, Constant speed axial
2.	No. of fans	Two	Two
3.	Fan sizing criteria with all the following conditions occurring together :	Each fan to be sized for 60% BMCR load (one stream in operation) calculated taking into account following factors	Each fan to be sized for 60% BMCR load (one stream in operation) calculated taking into account following factors

S.No.	Description	FD Fans	ID Fans
		occurring together	occurring together
a)	Type of coal firing	Design / Best / Worst whichever gives maximum FD fan air requirement	Design / Best / Worst whichever gives maximum flue gas flow
b)	Power supply frequency	47.5 Hz	47.5 Hz
c)	Excess air	20% over the stoichiometric air	20% over the stoichiometric air
d)	Fan inlet air/flue gas temperature	40°C with 60% relative humidity	Gas temperature corresponding to 40°C ambient temperature and 60% relative humidity
e)	Air-heater air-in-leakage	Min. 7.5% of flue gas flow entering Bisector APH or Trisector APH or actual guaranteed whichever is higher	Based on min. 15% of flue gas flow entering PAPH & 10% of the flue gas flow entering SAPH in case of Bisector or 12% of the flue gas flow entering Trisector APH or actual guaranteed value, whichever is higher
f)	Pressure drop through Cyclone Separator	Not applicable	50 mmWC or actual whichever is higher
g)	Pressure drop through SCR System	Not applicable	150 mmWC or actual whichever is higher
h)	Pressure drop through ESP	Not applicable	25 mm WC or actual whichever is higher
i)	Pressure drop through FGD	Not applicable	200 mm WC or actual whichever is higher
j)	Air in leakage	Not applicable	1% of ESP inlet gas flow & 2% of gas flow at common APH outlet through ducts
k)	Pressure required at chimney inlet	Not applicable	+ 40 mmWC

12.2 The fans shall also fulfill following sizing criteria in addition to those mentioned at S.No. 10.1 above. Each fan to be sized for 50% BMCR flow calculated taking into following conditions occurring together:

S No	Description	FD Fans	ID Fans
1.	Margin over 100% BMCR flow	20%	20%
2.	Margin over 100% BMCR pressure requirement	44%	44%

S No	Description	FD Fans	ID Fans
3.	Type of coal firing	Design / Worst / Best coal whichever gives maximum FD fan flow	Design/Worst/Best coal whichever gives maximum flue gas flow
4.	Excess air at economizer outlet	20% over stoichiometric air requirement	20% over stoichiometric air requirement
5.	Fan inlet air/flue gas temperature	40°C and 60% relative Humidity	150°C or actual gas temperature corresponding to 40°C ambient and 60% relative humidity, whichever is higher
6.	Air-heater air-in-leakage	Min. 10% of flue gas flow entering Bisector APH or minimum 8% of flue gas flow entering Trisector APH or actual guaranteed whichever is higher	Based on min. 15% of flue gas flow entering PAPH & 10% of the flue gas flow entering SAPH in case of Bisector or 12% of the flue gas flow entering Trisector APH or actual guaranteed value, whichever is higher
7.	Power supply frequency	50 Hz	50 Hz
8.	Pressure drop through Cyclone Separator	Not applicable	50 mmWC or actual whichever is higher
9.	Pressure drop through SCR System	Not applicable	150 mmWC or actual whichever is higher
10.	Pressure drop through ESP	Not applicable	25 mm WC or actual whichever is higher
11.	Pressure drop through FGD	Not applicable	200 mmWC or actual whichever is higher
12.	Air in leakage	Not applicable	1% of ESP inlet gas flow & 2% of gas flow at common APH outlet through ducts
13.	Pressure at chimney inlet	Not applicable	+40 mmWC
14.	Air & flue gas control	Blade Pitch Control	Blade pitch control for axial type fans

Note to 10.1 & 10.2: ID/FD fan shall have a minimum stall margin of 10% over the Design duty points.

12.3 Both FD fans and both ID fans shall operate with highest possible efficiency which shall be nearly equal at the 100% TMCR (800 MW) and test block points.

12.4 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.

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

S No	Description	FD Fans	ID Fans
1.	Type of fan blades	Stream lined, aerofoil shaped section	Stream lined, aerofoil shaped section
2.	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
3.	Fan rotational speed	1500 rpm (max.)	750 rpm (max.)
4.	Air/Flue gas flow	Blade pitch control	Blade pitch control
5.	Fan critical speed	not less than 125% of fan maximum operating speed	not less than 125% of fan maximum operating speed
6.	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
7.	Fan casing material thickness	Carbon Steel, 6.0 mm (min.)	Abrasion and wear resistant, high BHN steel having minimum 8.0mm thickness or 12mm mild steel with liner of thickness 10mm (min.). Alternatively, 22 mm thickness casing of 22 mm thickness casing of mild steel is also acceptable.
8.	Fan Housing design	for shut off head of fan	for shut off head of fan

*Note:

a) Bidder shall submit detailed calculations, for Owner's approval, to confirm compliance with above requirements for all fan components, specifically for fan shafts, impeller hubs and impeller as a whole. Areas of high stress concentration and residual stresses, like welded attachments shall be avoided on the fan rotor/shafts. Combined static, dynamic as well as residual stresses shall be demonstrated to be within allowable limits. These fan components shall last the life of the plant with such combined stresses present in them.

b) Although Owner envisages to install 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/Nm3. The minimum wear life of ID fan components shall not be less than 25000 hours of operation from the date of commissioning.

12.6 **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) Cooling air circulation to be provided across main bearing if applicable as per vendor's standard design.

12.7 **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 component are very rigid and have very high natural frequency compared to the operating frequency of respective fans giving justification.

e) Duplex Pt-RTDs (100 ohm at 00 C) and temperature indicators shall be provided for each bearing as per standard practice of the OEM for local as well as remote monitoring of bearing metal temperature.

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

12.8 FD and ID fans shall meet following operational requirements.

S. No.	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

S. No.	Description	FD Fans	ID Fans
		ii. The final control element shall not have any black-lash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Boiler MCR.	ii. The final control element shall not have any black-lash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Boiler MCR.

12.9 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

12.10 **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 Owner's approval.

c) The necessary tapping points for temperature compensation shall be provided.

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

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

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

12.11 **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.

12.12 **Drain Connection:**

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

12.13 **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 Owner's approval.

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

13.0 **Duct Work and Dampers:**

13.1 **Duct Work**

I. **Sizing Criteria:**

a) Allowable velocities in the duct work.

i. Maximum velocity for cold air and hot air shall be 16 m/sec and 20 m/sec respectively.
ii. Maximum gas velocity shall be 13 m/sec except flue gas duct from ID fan outlet to chimney inlet.
iii. Maximum Flue gas velocity from ID fan outlet to chimney inlet shall be 16m/sec.

b) The velocities in the ducts shall not exceed the above limits under the following conditions, all occurring together:

i. Design/best/Worst coal firing at 100% BMCR load whichever gives maximum flow.
ii. 25% excess air over and above the stoichiometric air at economizer inlet.
iii. Design ambient temperature of 30 degree Celsius and 75% RH.
iv. For Bisector air preheater, air in leakage 10% of flue gas flow at inlet of secondary air preheater and 15% of flue gas flow at inlet of primary air preheater or actual guaranteed whichever is higher.

In case of Trisector air preheater, air heater air in leakage 12% of flue gas flow at inlet of air preheater or actual guaranteed whichever is higher.

c) Interconnection in cold air duct (primary & secondary) as applicable shall be provided with suitable damper arrangement.

The above velocities shall not be exceeded even in case of operation with one stream of ID, FD, PA fans and air heater operation at 60% of BMCR load.

II. **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 1600 kg/m3.

d) Expansion joint reaction.

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

Temperature ^{0}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

f) The ductwork and its structure shall take into account loads due to addition of FGD interconnection ducts and dampers in the duct between ID fan outlet and chimney inlet transition piece.

III. **Duct Design Pressure**

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

IV. **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.

V. **Type of duct construction:**

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

a) Minimum 8 mm thick steel plates for gas ducts from APH outlet to ESP inlet and minimum 6 mm thick steel plates for gas ducts from ESP outlet to the chimney inlet. Interconnection ducts shall be provided in air and gas system for flexibility of plant and equipment operation as necessary.

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) Duct stiffening shall be by means of rolled sections.

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.

f) Wear resistant plates for diverting/ deflecting the flow will be provided in ducts.

VI. **Material of Construction:**

i.	Duct plates, turning vanes perforated plates	ASTM A 36 or equivalent (For ducts operating above 400ºC gas temperature, suitable Alloy Steel material shall be provided to Owner's approval)
ii.	Structural shapes	ASTM A 36 or equivalent
iii.	Pipe struts, trusses, bracing	ASTM A 53 or equivalent seamless steel pipe.
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.	Access & inspection doors	Reinforced Steel Plates.

VII. **Insulation & Lagging**

a) Thermal insulation shall be applied to all air/gas ducts to comply with the requirements as specified in this chapter and Volume III, Chapter 26.

b) Acoustic insulation shall be used on air and gas ducts to restrict the noise level to specified values.

VIII. **Specific Requirements**

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

b) The flanges at the bolted joints shall have adequate stiffeners to avoid damages to the flanges.

c) All necessary wall boxes and floor collars shall be provided where the ductwork pass through walls, floor and roof.

d) The floor collars shall be fitted with a high combing to prevent water and dust falling through the hole.

e) The ductwork shall be fitted with a steel hood to cover the opening.

f) Weatherproof flashing shall also be provided wherever necessary.

g) The configuration and design of ducts shall be coordinated with the pulverizer parts removal requirement.

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

i) Duct plates shall be designed for one-way beam action over stiffeners and considered fully continuous over all supports.

j) The deflection of the plate, assumed continuous, shall be less than one-half the plate thickness.

IX. **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:

i. 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.

ii. 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.

iii. The number of internal trusses shall be limited to the minimum required for structural integrity and shaped so as to offer least resistance to gas flow and to minimize the accumulation of fly ash in the bottom of duct.

iv. Conceptual data of internal stiffeners of the ducting shall be furnished along with the offer.

v. All the detailed design data shall be furnished to the Owner before the duct support column foundation data submission.

c) Corner angles shall be used on all inside corners of all ducts to provide adequate continuity.

d) Inside welds of corner angles to duct plate shall be continuous and seal welded. Where inside surface of ducts will be coated, welds shall be full throat.

e) 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.

f) The duct, plates, trusses, stiffeners, bracings and ductwork shall be designed as structures in accordance with relevant Indian Standards.

g) All openings in ducts shall be reinforced for all design loads.

h) Ductwork supports may be hangers or sliding bearing, guides and anchorages. A coefficient of sliding friction of 10% can be used with self-lubricated plates such as "LUBRITE" or "MECHANITE", a coefficient of sliding friction of not less than 35% shall be used for steel-on-steel contact. The allowable bearing stress for self lubricated plates shall be 70 Kg/sq.cm.

X. Fabrication Requirements

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

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

c) Ducts shall be strength welded and seal welded to produce a gas tight duct. Alignment holes shall be provided in mating flange sections.

d) Ducting shall be detailed and fabricated in a few pieces as practical, taking into account, shipping and erection considerations.

e) Materials improperly detailed or fabricated necessitating extra work during erection on field, shall be the responsibility of the Bidder.

XI. Expansion Joints

a) 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.

b) Expansion joints shall not support the ductwork.

c) 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.

d) 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.

e) 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.

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

g) The expansion joints shall be tested as per requirements specified elsewhere in the Technical Specification.

h) Bidder shall furnish the complete ducting system drawings clearly specifying the location of all anchors, guides, supports, fixed points and expansion joints. The anchors and guides must be suitable for the highest pressures to be applied to the system. Anchors, guides and duct supports shall be installed in strict accordance with the ducting system drawings.

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

j) Expansion joints weighing more than 250 kg shall be provided with lifting lugs.

k) Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

l) Every expansion joint shall be provided with installation instructions which shall describe the simple, straightforward requirements that must be followed to insure a trouble-free installation. Further, shipping bars shall be installed on the expansion joint to maintain the proper shipping length. Shipping bars shall be painted yellow.

m) Expansion joints in the flue gas side after air preheater shall also be designed to withstand the excursions in flue gas temperature upto 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.

XII. **Blanking Plates**

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

XIII. The horizontal flat surface of air and gas ducts shall be pitched for drainage. Where necessary, stiffeners shall be arranged to avoid formation of pockets.

XIV. Access & Inspection doors of hinged type with matching heavy duty surface shall be provided.

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

XVI. The door closing devices should be designed to force the doors to make an air or gas tight seal when closed.

13.2 Dampers

I. Power operated gas tight isolation dampers along with their drives shall be provided at all locations required for carrying out internal repair and maintenance of 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/gates:

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 at least six ESP streams, with twelve inlets and twelve outlets)

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

d) At inlet & outlet to each of the Regenerative Air Pre-Heaters on flue gas side.

e) At each of the Regenerative Air Pre-Heater, SCAPH bypass duct & after each SCAPH on air side.

f) At discharge of each of PA fans.

g) At discharge of each of FD fans.

h) At economizer by pass duct, SCR inlet duct, SCR outlet duct (only incase of Bi-sector APH) & SCR bypass duct.

i) Bypass duct of FGD

II. 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:

a) Before SCAPH on air side.

b) 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 RAPH outlet to ESP on flue gas side in case of Tri-sector RAPH.

c) Flue gas bypass damper in boiler second pass (if applicable)

III. Pneumatically or motor operated control dampers shall be provided at the following locations and a minimum:

a) Hot and cold air inlet to each mill.

b) At air preheater outlet on flue gas path (only in case of Bisector APH).

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

a) Guillotine Gate Type at locations Cl. no. 13.2 (I) (a), (b), (c), (d), (g) & (h). Also at location (g) if economizer bypass duct is provided.

b) Double multi louver (Biplane) type at location Cl. no. 13.2 (I) (e) & 13.2 (II) (b).

c) Multi louver Type at location Cl. no. 13.2 (II) (a) & 13.2 (I) (f*)

In addition to Guillotine gate, a fast acting pneumatically operated Bi-plane damper shall be provided between guillotine gate and 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.

V. **Damper Gas Tightness**

The dampers at mentioned at Clause No. 13.2 (IV) (a & b) 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 follows:

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

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

VI. **Pressurization Fans (if applicable)**

a) All dampers/gates 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 Owner's review and acceptance.

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

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

VIII. The multilouver dampers shall be capable of effectively stopping the flow when in closed position and while in full open position shall cause minimum pressure drop. The isolating damper design shall provide positive shutoff when closed.

IX. All regulating dampers/vanes/blade pitch controls coming under auto regulation shall be able to provide the desired relationship between percentage opening and the flow.

X. The auto regulating dampers shall be capable of being operated between 20% to 80% opening as per the optimal requirements of control systems to achieve stable, steady and smooth automatic control of the plant and processes under all operating conditions.

XI. 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 16000 hours.

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

XIII. Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

XIV. Outlet dampers of seal air fans, scanner air fans and emergency dampers of scanner air shall be pneumatically operated, suitable for remote manual operation.

XV. All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves. For open and close feedback of hot air gates, Proximity (i.e. non–contact) type limit switches (2NO+2NC)

shall be provided. These shall be suitable for working hot & dust environment.

XVI. **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. 13.2 (IV) on flow without seal air and with seal air.

b) **Multilouver Dampers & Double multilouver (Bi-plane) dampers**

i. The damper shall be of heavy duty construction.

ii. Shall operate without bind or fluttering under all operating conditions.

iii. The damper/louver shaft shall be rigidly constructed to prevent bending, vibrations and distortion.

iv. The spindles shall be adequately sized and bearings suitably insulated to protect overheating.

v. The shaft bearings shall be mounted outside the damper box channel and arranged for convenient inspection.

vi. Stuffing boxes shall be provided on all damper blade shafts.

vii. The damper shaft shall be rigid and shall have side bearing, plate.

viii. Horizontal shaft shall be provided wherever possible.

ix. For preventing hot air or gases from escaping around damper shaft, double gland type stuffing boxes with graphite impregnated asbestos packing material acceptable to the Owner shall be provided on all damper blade shafts.

x. The dampers in flue gas paths shall be so located that the buildup of grit behind the damper blades is reduced to a minimum.

xi. The double multilouver type damper sealing efficiency shall be as per Cl. no. 13.2 (IV) on flow without seal air and with seal air.

c) Weather hood to prevent rainwater entry & accumulation shall be provided at each damper top.

d) If grease lubrication is required, grease connection shall be accessible. Further suitable approval & platforms etc. for greasing shall be provided.

e) Open and closed positions shall be clearly marked on the dampers. Also a mechanical position indicator shall be provided in order to check the position of the damper.

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

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

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

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

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

k) Suitable all round approach and platform for manual operation of dampers and for carrying out maintenance on damper shall be provided.

l) Attachment of all louvers to the dampers spindles shall be by means of key fittings.

m) All bearings for spindles or damper operating gear shall be arranged for efficient grease lubrication.

n) Grease lines of copper/steel shall be run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.

o) Proper handling arrangement shall be provided for dampers, having weight more than 500 kg for maintenance purpose.

14.0 Steam Generator Integral Piping, Valves, Fittings and Mountings

14.1 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.

14.2 In addition to the stipulations of as specified at clause no 14.1 of this chapter above, the following requirements shall also be complied, for piping/valves:

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

S.No.	VALVE	MINIMUM DISCHARGE CAPABILITIES
a)	Spring loaded safety valves	

S.No.	VALVE	MINIMUM DISCHARGE CAPABILITIES
i.	Separator & Superheater	Combined capacity 105% BMCR.
ii.	Reheater System	Combined capacity 105% of reheater flow at BMCR
b)	Electromatic Relief Valve at:	
i.	Super heater outlet	15% BMCR
ii.	Reheater outlet	20% of Reheat flow at BMCR

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

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

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

V. 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 & second lowest set pressure safety valves.

c) Temperature elements 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% at turbine start-up pressure.

Note: Bidder to submit the following documents for Owner's approval:

i. Complete valve schedule in Owner'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.

VI. 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:

S.No.	Parameters	Requirements

S.No.	Parameters	Requirements
a)	Sizing of Drainage system	To enable drainage of complete pressure parts in one (1) hour
b)	Type of drain valves	Low noise, erosion resistant
c)	Limiting noise level through regulating drain valves	90 – 115 dBA
d)	Flow velocity through valves	90 m/s

VII. 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.

VIII. 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.

IX. Provide two in series, blowdown valves, at the lowest point of each water wall header comprising of one electrically operated isolation valve and one motorized regulating valve. Valves shall have plugging/locking keys as indicated as specified at clause no 14.2 (V) 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.

X. 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 with100%, local operated control valve.

XI. 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.

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

XIII. 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.

XIV. Provide all required sampling points along with root valves including that for feed water at economizer inlet, separator drain, separator outlet steam pipes, superheated steam, reheated steam. The sampling probes shall be provided as per relevant section of the latest ASME

power test code. For laboratory samples, necessary sample coolers with valves and cooling water pipes shall be provided. In addition two spare coolers shall be provided. The root valves shall be of stainless steel. The impulse pipe size shall be to the approval of the Owner. 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 except the reheater inlet and outlet where single valve will be acceptable.

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

XVI. 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.

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

15.0 Soot Blowing System

15.1 Type of Soot Blowers:

a)	For furnace chamber	Short Rotary, Single nozzle retractable type
b)	For horizontal heat exchanger section	1. Long rotary, multiple nozzle, retractable type for high temperature zones. 2. Short rotary, multiple nozzle, retractable type for low temperature zones.
c)	Air-preheaters	Power driver swinging arms / sweep action / Long retractable and non-rotating soot blower or retractable multi-nozzle soot blowers

a. Soot Blowing System shall be

a) Capable of effectively removing deposited ash from steam generator heat transfer surfaces with on- load cleaning devices. The soot blower design shall be of self draining type.

b) Fully automatic & sequentially controlled through SG C&I control system. Alternately, a SMART Soot Blowing system based on heat flux sensors and flue gas exit temperature may be implemented with a fall back to sequential control, if required.

b. 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. 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.

c. 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 Bidder.

d. The soot blower design shall be of self - draining type.

e. Material of Construction

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

f. 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.

g. Retractable Soot Blowers (RSB)

Shall be retractable even during emergencies such as :

a) Drop in steam supply pressure,

b) Low steam flow, etc.

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

a) Double helix cleaning pattern shall be used.

b) 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.

c) Controlled from soot blower panel.

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

i. Soot blowers Motor Control Centre (MCC) shall be as per Electrical in subsequent chapter.

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

k. 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.

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

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

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

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

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

q. Provision shall be made to maintain the soot blower heads free of deposits during the periods when they are retracted and not in operation.

r. 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), Bidder shall install additional soot blowers(s) along with proper approach and platform(s), as specified for other soot blowers, without any cost implication.

s. While deciding coverage of LRSBs the maximum coverage of LRSB shall not be considered more than 2 m.

16.0 Auxiliary Steam Pressure Reducing & Desuperheating Station

16.1 General

To meet the continuous and startup auxiliary steam requirements of the unit), two auxiliary pressure reducing and desuperheating stations, one High Capacity PRDS taking tap off from Mainsteam (MS) and other Low Capacity PRDS taking tap off from Cold Reheat (CRH) lines shall be provided. A high temperature unit header (For parameters refer subsequent chapter) by taking steam from both the above PRDS stations and also a low temperature unit header (for parameters refer subsequent section) by taking steam from the high temperature unit header though a desuperheater shall be provided. During cold startups when mainsteam pressure is more than 90 kg/cm^2 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.

If steam for the Steam Generator unit auxiliaries is required at pressure/temperature other than that of the auxiliary steam headers, suitable arrangements shall be made by the Bidder in design of the Steam Generator to meet such requirements. Further, availability the high temperature 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 high temperature 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 280 deg. C to 340 deg. C depending on unit load. Bidder is advised to take note of this and provide suitable arrangement of charging high temperature header if high temp. auxiliary steam is continuously required for any use.

In addition to the above, a pressure reduction station shall also be provided to supply steam at required parameters for Owner's Air Conditioning plant requirements. The pressure reducing station shall draw steam from a tap off provided on low temperature auxiliary steam station header.

Auxiliary steam pressure reducing and desuperheating stations, alongwith all pipings etc. shall be supplied.

16.2 High Capacity PRDS shall be sized for auxiliary steam requirement of 150 TPH (minimum) with main steam parameters corresponding to 60% load. However, the exact capacity shall be finalised 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) Air heater soot blowing.

c) FGD

d) SCR

e) SCAPH.

f) Boiler feed pump turbine.

g) Deaerator pegging.

h) Turbine gland sealing.

i) As standby to low capacity PRDS station.

j) Capable of delivering at least 25 tonnes per hour steam to low temperature auxiliary steam station header.

k) For coal mill inerting (if required).

l) Bidder to consider for any other requirement.

Low Capacity PRDS shall be sized for auxiliary steam requirement of 25 TPH (min.) and supply steam for normal continuous requirements of its own unit. However, the exact capacity shall be finalised during detailed engineering stage.

Sharing of Load requirement between high capacity station header and low capacity station header shall be possible in case low capacity PRDS is unable to meet Auxiliary steam requirement on its own. The change over from HPRDS to LPRDS & vice verse shall be automatic.

During cold startup the deaerator pressure shall be maintained at 1.5 ata with steam from auxiliary steam header. During hot and warm startup deaerator pressure shall be maintained at 3.5 ata. However, in case startup

drain circulation pumps are not in service and startup drains are routed through condenser, deaerator pressure shall be maintained 1.5 ata. Steam supply shall be from auxiliary steam header.

17.0 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:

S.No.	Description	Minimum clear width***
a)	Main access walkways	1500 mm
b)	Maintenance access walkways	1000 mm *
c)	Staircase	1200 mm
d)	Ladders **	450 mm
e)	Platforms	1500 mm

Note:

* Maintenance access walkways are applicable only to areas identified in clause no. 15.5, 15.6 & 15.14. 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 Owner except at places where ladders have been specifically specified.

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

17.1 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.

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

17.2 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.

17.3 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 and 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 500mm from the platform/intermediate platform.

17.4 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.

17.5 All around platforms of adequate size to permit at least two persons to simultaneously work (1.5m2 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. Suitable access to above platforms with walkways, stairs/ladders etc. shall be provided.

17.6 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.

17.7 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.

17.8 Annular platforms of 1200 mm clear width accessible by stairs/ladders shall be provided for Mill discharge valves & Bunker outlet gates.

17.9 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.

17.10 **Storage Platforms**

In addition to maintenance platforms, walkways etc. specified above the Bidder shall provide storage platforms for storing of scaffoldings, APH baskets and platforms for removal and handling of Economizer and Reheater and other maintenance items required during overhaul of steam generator in accordance with the following:

a) Scaffoldings

Platforms around scaffolding entry point for storing of maintenance cradle/quick erected scaffoldings (minimum 50m^2 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 m^2 of platforms for each set) with proper approach near APH(s) for storage of APH baskets shall be accounted in the structure and platform design.

Note:

Weight of APH baskets indicated above shall be including the weight of elements.

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

c) Economizer and Reheater/Superheater

Platforms for handling of at least 3 rows of largest size coils and storage of at least 8 rows of largest size coils of Economizer and Reheater / Superheater (all horizontal heating surfaces in second pass) coils. Adequate platforms, walkways, access/stairs shall also be provided for removal of second pass water walls/casing, buckstays and installation of monorails, hoist etc. Weight of above coils and equipments required for handling shall be accounted in the structure and platform design.

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

17.12 Bidder 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, Bidder shall provide proper procedure to facilitate Owner erect scaffolding, temporary ladders, platforms and safety nets to safely perform the replacement/repair of coal pipes.

17.13 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 Owner to erect scaffolding, temporary ladders, platforms and safety nets to safely perform the work involved.

17.14 Access to all penthouse cooling doors shall be provided through maintenance walkways of minimum 1000mm width.

17.15 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 2.3m.

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.

f) Gratings shall comply with all requirements specified.

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.

17.16 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.

17.17 For meeting the above requirement in respect of platforms the Bidder shall include in his proposal platform area of 17,000 m^2 (clear of all intervening pipes, columns, actuators, instrument enclosures, racks etc. and excluding area covered by stairways)
Bidder shall furnish detail floor plan drawings covering all platforms and shall clearly indicate all the dimensions of platforms and clear platform floor area in each drawing.

18.0 **Elevators**

18.1 Elevators shall be designed based on following criteria:

1.	Type of service	Two (2) passenger cum goods elevators
2.	Design/construction/ installation codes	Latest edition of IS:14655 (All parts) AND also meeting any additional requirements of IS:4666, IS:1860 and IS:3534
3.	Load carrying capacity	3000 Kgs. for each passenger cum goods elevator
4.	Rated speed	1.0 M/sec
5.	Total Travel	As per Steam Generator supplier's recommendations subject to Owner's approval
6.	Number of floors to be served	Twelve (minimum)
7.	Entrances	Twelve (12) (minimum) (all on same side)
8.	Entrance and platform size	As per design/installation codes at (2) above
9.	Drive/motor	As per Electrical Specifications
10.	Method of control	As per Electrical Specifications
11.	Position of machine room	Directly above the lift shaft.
12.	Elevator landings (min.)	a) Ground floor
		b) Mezzanine floor of STG hall
		c) Main operating floor of STG hall
		d) All Burner platforms
		e) Alternate soot Blower levels
		f) Coal Gallery
		g) Steam Separator
		h) At all regularly operating platforms
		i) Laboratory floor
		j) Coal Bunker
		k) Coal Bunker Roof
13.	Machine room and lift Shaft	Pressurized dust proof or Air conditioned machine room as per the requirement of lift manufacturers.

14.	Power Supply	As detailed in Electrical Specification

Automatic Rescue Device (ARD) - (Battery Drive):

Bidder to provide a Modern Advanced electronic drive system of "RESCUING Passenger Trapped in ELEVATOR".

Emergency Safety Devices:

The rift 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.

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

18.3 Construction of the elevators shall specifically meet all requirements of the codes indicated at Clause 16.1 and shall have following additional features:

a)	Flooring of Cabin	Passenger elevator and passenger cum goods elevator - 6 mm thick Checkered Plate flooring
b)	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
c)	Car entrance and landing doors	As per BS:476 (Part 20 & 22)
d)	Door construction	Hollow metal construction from 16 gauge thick steel sheet spray painted
e)	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.
f)	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).

18.4 Technical requirements of Electrical items shall be as per details given in Volume IV

18.5 Provide sound reducing material below machines in machine room.

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

18.7 Elevators shall have provisions to meet following operational requirements:

i. Selective collective, automatic operation with or without operator through illuminated push button station located inside the lift car.

ii. Power operated with automatic opening/closing car and landing doors.

iii. Two push buttons, one for upward movement and the other for downward movement at each intermediate landing, and one push button at each terminal landing shall be provided in order to call the car.

iv. Push buttons shall be fixed in the car for holding the doors open for any length of the time required.

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

19.0 Painting

Supply of paints including painting of all surfaces, equipment's and structures for Steam Generator shall be as per Volume II.

20.0 Blow Down System

I. The blow down system shall comprise of an atmospheric flash tank and drain receiving vessel, 2x100% condensate transfer pumps located in Steam Generator area and shall be complete with all necessary valves, piping, level control system etc.

II. The atmospheric flash tank shall be sized to receive following:

a) Maximum possible start up recirculation & drain flow under all possible normal, abnormal, upset, accidental conditions and even with startup recirculation pump out of service.

b) All drains from Steam Generator such as drains from water wall headers, attemperators headers, soot blowers drains, superheater, reheater etc.

c) Alternate drains from main steam lines, CRH lines, HRH lines, as required.

d) Any other drains from High Pressure piping.

For sizing, combination of all the above occurring simultaneously to be considered. Atmospheric tank shall be located at suitable level in the Steam Generator area.

III. Drain receiving vessel shall be sized to receive drains from atmospheric tank and shall have storage for atleast 10 minutes.

IV. 2 x 100% condensate transfer pumps to be provided. For arriving at the size of pump all drains as indicated in clause 20.0 (II) shall be considered. This pump shall be used to transfer condensate from receiving vessel to main condenser either directly or through condenser flash tank located in TG area.

V. 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 size of vent pipe shall ensure no pressurization of atmospheric flash Tank. 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.

21.0 **Blow Down Tank**

a) Tanks shall be designed and fabricated as per requirements of IS: 2825/BS: 806.

b) Provide wear plates in the tank to prevent erosion due to high pressure/ velocity drains.

c) All drain connection to the Tanks to be tangential.

d) Provide mating flanges for level switches and other instruments.

e) Provide manholes with bolted doors on BDT. Doors shall be hung on hinges.

f) Stub connections, where required shall be welded to the tank.

22.0 **Type Test**

22.1 Full scale type tests using actual equipment shall be conducted by the Bidder for the equipment mentioned in the subsequent clauses below:

22.2 Full range and full scale performance testing shall be conducted at shop for each type and size of the following Fans as per BS 848, Part-1:

a) Induced Draft Fan

b) Forced Draft Fan

c) Primary Air Fan

d) Seal Air Fan

e) GR Fan (if applicable)

22.3 The performance testing at shop shall be conducted using actual fans

22.4 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 the specification.

22.5 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

22.6 Following tests on Coal Feeder

a) Explosion proof test at 50 psi as per NFPA codes

b) Weighing accuracy, calibration and repeatability test at various speeds with coal flow.

c) Degree of protection test as per relevant Indian or equivalent International Standards.

22.7 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 Owner's Engineer.

22.8 The type tests shall be carried out in presence of the Owner's representative. Bidder shall inform the Owner about his readiness for conducting the type test and issue such notice to the Owner 30 days in advance, along with schedule of the type tests. The Bidder shall obtain the Owner's approval for the type test procedure before notifying the Owner 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.

22.9 Irrespective of the requirement of conducting the type tests under this contract, the Bidder shall submit the reports of the type tests listed 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 Owner. The Owner 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 Owner.

22.10 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.

23.0 SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM AND AUXILIARIES

23.1 GENERAL

Selective Catalytic Reduction (SCR) System shall reduce overall NOx (oxides of nitrogen) produced in the Steam Generator to the specified values in tandem with Second Generation low NOx burners and in-furnace combustion staging. SCR system shall be based on catalysts which will enable reduction of NOx by ammonia (NH_3). The complete SCR system shall be designed for outdoor location connected to the coal fired steam generator designed to operate under two shifting and load cycling regime. Catalyst selection and its design shall factor-in Indian coals which characterize uniquely by it's high and erosive ash content. The SCR system shall be designed to contain ammonia slip to specified values under all operating conditions. Ease of maintenance, repair and overhaul shall be a central consideration in the SCR equipment design/arrangement, assembly, access, provisions for spares/tooling etc. Safety of limb and life shall be an over-arching consideration in the SCR system design specifically in view of use of ammonia as the reagent. The design/specifications/sizing of various plants/systems/equipment offered for

the SCR System & Auxiliaries shall comply with the requirements detailed hereinafter.

23.1.1 DESIGN CRITERIA FOR THE SCR SYSTEM

1) The design of the SCR system shall be based on proven concept of reduction of NOx in the flue gas emanating from pulverized coal fired steam generator through mixing ammonia and passing it through catalyst bed placed in reactor. Ammonia shall be mixed to the flue gas upstream of the SCR reactor. The flue gas shall flow from top to the bottom of the reactor. A reactor gas side by-pass shall be provided for operational flexibility. The total catalyst requirement shall be arranged in minimum three (3) layers, on horizontally arranged support frames inside the reactor. Further provision for one spare future layer of catalyst shall be made within the reactor. The catalyst will be plate type with stainless steel mesh substrate and tungsten-vanadium based catalyst coating. Cyclone Separator shall be provided in the flue gas duct between economizer and SCR reactor to reduce the dust burden. Anhydrous ammonia shall be used as the reagent for the SCR system and it shall be delivered to site by tank truck. Unloading, Storage and forwarding facility for ammonia shall be provided including facility for its evaporation (vaporization) and dilute air-ammonia mixture preparation for feeding in to the flue gas through an injection grid.

2) The design of the SCR System shall be carried out taking following into consideration:

   a) All operating conditions of steam generator (e.g. gas temperature, ash, start/stops, load cycling) from start-up to 40% TMCR without ammonia injection and from 40% TMCR to 100% BMCR with ammonia injection for complete range of specified coal and specified ambient air condition.

   b) Duct design for reduced gas stratification and effective gas-ammonia mixing for minimization of ammonia consumption and slip.

   c) Prevention of formation of ammonium bisulfate (ABS) and other ammonia components, which deactivate or plug up or mask the catalysts and other downstream components.

   d) Minimization of SO2 to SO3 conversion.

   e) Prevention of any kind of disturbances in downstream equipment APH, ESP, fans, FGD etc.

   f) Prevention of plugging of the catalyst by ash particles, especially "popcorn ash".

   g) Design life of 25 years (excluding catalyst).

   h) Modular construction to enable catalyst management plan (CMP) and periodic maintenance/inspections.

3) **Operating service Conditions/requirements**

1) The SCR system shall be designed for efficient and trouble free operation for the normal operating conditions, start-up and shut down regime as specified elsewhere in the specification.

2) Bidder shall minimize formation of ammonium salts specifically Ammonium bisulfate by suitable design features and margins, equipment selection and operation and control regime. The overall thermal design of the steam generator shall factor-in the gas temperature window best suited w.r.t. NH_3 reactivity, SO_2 to SO_3 conversion as well as formation/deposition of ammonium salts on the catalyst. The Bidder shall bring out in detail in the bid proposal its experience/practice and rationale for such sections. For control of flue gas temperature within the preferred temperature window economizer flue gas bypass shall be provided.

4) **Start-up**

The design of the catalyst shall factor in impact of masking and plugging. Temperature-rise rates and limits shall be clearly identified in the bid proposal. Specifically, the temperatures which can set-in the mobilization of catalyst poisons from the dust phase to the active center of the catalyst (causing reduction in catalytic activity) shall be flagged. Switching of the ammonia injection shall factor such temperatures for setting suitable limits. Formation of explosive ammonium nitrate shall be obviated under all operating conditions. Any operating conditions when reactor needs to be bypassed shall be identified. Suitable measuring point for representative working temperatures within the reactor shall be identified.

5) **Shutting down**

Bid proposal shall clearly describe the shutting down sequence. Ammonia residence within catalyst volume shall be factored-in. NOx-conversion, water/acid dew points shall be avoided when the minimum working temperature is reached.

6) Applicable Codes & Standards

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.

7) **Noise level**

The equivalent weighted average of sound level measured at a distance of 1.5 m above floor level in each elevation and one meter horizontally from the base of any equipments furnished and installed under these specifications, expressed in decibel to a reference of 0.0002 microbar, shall not exceed 85 dB(A).

8) **Statutory Approval**

It shall be the responsibility of the Bidder to obtain the all necessary approvals/permits from the inspection/regulatory authorities etc. on behalf of the Owner, as may be required for design/calculations,

manufacturing and erection procedure, testing etc. As called for under the statutes, regulations and the safety codes. All such documentation required to be submitted to the statutory authorities shall be submitted to the Owner for its review.

9) **Integration with other systems**

a) The ash from cyclone separator, duct & SCR hoppers shall be extracted through the ash handling system being provided by the bidder.

b) The service air, instrument air, auxiliary steam, various types of water required for the SCR system and cyclone separator shall be integrated as per the scope of work & terminal point & Exclusion.

10) **Design Maturity for High Ash Indian Coals**

1) 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.

2) The Bidder shall submit with the bid proposal, comprehensive information on how basic sizing for the reactor and the catalyst of the proposed design has been arrived at. Basis for the basic sizing selections like pitch, plate thickness, space velocity, catalyst module depth etc. shall be discussed in the light of earlier experience of the bidder and within the power plant industry. The Bidder shall also submit along with the offer, a detailed write up on the proposed design features with recent design modifications, if any, and their specific advantages over the previous designs.

3) The Bidder shall submit with its offer details of experience with very high ash (>35 g/NM^3 of ash concentration at SCR inlet) SCR system where SCRs having similar catalysts, as offered, has been utilized. The offer would include technical details of such reference SCR supplied/designed by the bidder. The information is sought to understand bidder's design strategy to provide SCR design features suitable for Indian coal ash which characterize uniquely in terms of its high percentage of highly erosive ash and catalyst poisons which have not been experienced so far. Accordingly, the bidder may also include technical details of reference SCRs supplied by the Bidder which may not be of same type/size as offered but have relevance to the high ash context. The bidder shall however submit correction curves for gas temperature and for other performance impacting elements like catalyst poisons, ash content and erosivity etc. to demonstrate the adequacy of the selected design and size.

4) The bidders are advised to collect coal samples for independent analysis of erosion, catalyst poisons etc. to satisfy themselves about the nature of Indian coal ash w.r.t. its impact on the selected catalyst formulations so as to meet all specified requirements and performance guaranteed by the Bidder.

23.1.2 EQUIPMENTS AND SYSTEMS SPECIFICATIONS

1) Specified hereafter are the minimum acceptable functional requirements for all components, equipments and sub-systems for the SCR system which shall be designed to cater to these requirements while adhering to the standard practice of the Bidder. Compliance to various stipulations of the technical specifications, functional requirements of Owner and utilization of various parameters and their values in the specification by the Bidder shall in no way absolve the Bidder of its responsibilities to meet all guarantee requirements or of providing completely safe and reliable operating equipment/systems.

2) The specified requirements shall be complied for the most stringent conditions resulting either from the range of coals (design/worst/best) specified or from the range of operating conditions specified for the steam generator (like 100% BMCR), or from both occurring simultaneously, unless specifically mentioned otherwise by the Owner.

23.1.3 SCR REACTOR AND CATALYST MODULES

1) SCR Reactor Configuration

i) The Bidder shall configure two (02) independently operated SCR reactors, for steam generator.

ii) The reactor shall house the catalyst modules in separate layered elevations. The reactor shall be vertically arranged. Flue gas after getting mixed with ammonia flow downwards wherein the NOx gets reduced on the catalyst surface/pores reaction sites.

iii) SCR reactor shall be provided with:

a) Connecting nozzles for flue gas, steam, pressurized air, etc.

b) Openings with required adapters for instrumentation, electrical connections, ports for tests and measurements, grid measurements where appropriate etc.

c) Fixture for catalyst de-dusting system for each catalyst layer including that for future layer.

d) Support beams for catalysts and handling system inside the reactor.

e) Support for hoists, catalyst cleaning devices, measuring grids, insulation, piping, platforms, stairs etc.

f) Openings for entry of catalyst modules for every layer including that for future layer.

g) Inspection access opening for every catalyst layer.

h) Complete structure steel works, platforms, stairs and ladders.

i) Other arrangements to meet the intended functional requirements.

iv) The flue gas velocity in the reactor shall not be higher than 5 m/s. The reactor should be sized to accommodate minimum three (3) catalyst layers with provision for one (1) future catalyst layer for future addition. Following shall be considered for developing the reactor geometry and arrangement:

a) The reactor shall be designed for the required catalyst layers including future layer provision. Future layer shall be the bottom most layer of the reactor housing. SCR reactor design and its supporting system shall be suitable for accommodating all catalyst types (i.e. plate, honeycomb, corrugated) for both current and future catalyst installation.

b) The vertical clearance distance between top edge of catalyst module and bottom edge of the bearing support structure for the next layer above it or the layer of flow modification device shall be at least 2000 mm.

c) Suitable space for inlet and outlet hoods, flow straightener and straight length requirement for flow stratification shall be considered.

d) The design of the reactor internals shall ensure minimization of the dust accumulation anywhere inside the reactor. The cross section of the SCR reactor should be as close to a square aspect ratio as possible to achieve least gas stratification, good gas/ammonia mix and ash distribution.

2) **Reactor Housing Design**

i) The SCR reactor shall be built in the form of a rigid structure with a rectangular cross-section made of steel plate with adequate stiffening. The reactor casing shall be fabricated from all welded reinforced, 6 mm minimum thickness, carbon steel plates conforming to ASTM A36.

The design of the reactor housing, among other things, shall comply with the following requirements:

a) The SCR reactor shall be weatherproof and water tight construction for protection from monsoon rains/winds and have drainage arrangement like gutters, drain pipes etc., as applicable, connected to plant drainage system at ground level.

b) The design of the housing shall provide sufficient elasticity which incorporates the thermal expansion at the maximum gas temperature without exceeding the permitted material stress.

c) A temperature gradient of 100 °C between catalyst support beams and inner part of the reactor wall shall not be

exceeded. The maximum gradient reached during start stop of the unit and rapid load changes shall be ascertained through modelling of the housing and internal support structure. The same is applicable for the temperature difference between two layers.

d) The reactor load shall be transferred from the reactor side walls, equally distributed via springs and external slide bearing pads, to the supporting steel structure. The SCR reactor shall be preferably anchored at the centre to expand outwards to minimize horizontal movements. The bid proposal shall include a sketch indicating the housing frame, structure and support/anchor points along with expansions to clarify scheme proposed by the Bidder.

ii) The SCR reactor shall be designed to avoid uneven flue gas flow among the reactors and within the reactor.

iii) Design Pressure: The reactor shall be designed for ± 660 mmWC or maximum conceivable pressure of the relevant fans, whichever is higher, at 67% of yield strength of material used for reactor frame/stiffeners/plates.

Design Temperature: The reactor shall be designed for maximum flue gas temperature for whole range of operation and fuel.

The SCR reactor and its supporting system shall be designed for the following:

a) Capable of taking additional loads due to accumulations of ash upto 150mm height above catalysts for each layer including future layer.

b) Catalyst modules including the future layer 50% filled with ash and ash hopper (if applicable) filled up to the top of the hopper partition plane. This additional load shall be considered over and above other loads considered for reactor casing and frame design. The ash density for the purpose of ash loading shall be at least 1600 kg/m³.

c) Reactor support frame for catalyst module shall be suitable for holding/supporting modules with height higher than originally envisaged by the Bidder. Additional height of the module shall be suitable to accommodate 10% higher catalyst volume. Accordingly, the reactor structure shall have 10% margin in the total weight of the modules.

iv) Flow straightener/ flow rectifier of suitable erosion resistant material shall be installed between the inlet hood of the reactor and the reactor housing for directing the flue gas perpendicular to the plane of the catalyst. The pitch, material and design of the flow straightener shall be a proven design of Bidder and shall be suitable for high ash flue gas conditions. The suitability of the design of the flow straightener /rectifier shall be demonstrated through CFD modelling.

v) The wall of the reactor housing shall be furnished with a sufficient number of inspection openings and catalyst loading doors at each catalyst layer elevation. The purpose of the catalyst loading door shall be to load and unload the single catalyst modules at a time. The height of a door opening shall be sufficient for the selected depth for the catalyst module. Size of inspection opening shall be sufficient for entering the maintenance personnel.

vi) Each catalyst elevation shall be provided with grated platform inside the reactor housing to support and place the catalyst modules. The opening of the grating shall be sufficiently large to prevent ash pluggage / accumulation. The elevation of platform outside the reactor shall match the elevation of inside the reactor platform to facilitate the easy removal/placement of catalyst modules.

vii) Ash hoppers below SCR reactor, if required based on layout requirements, shall be provided complete with RF type low ash level & high ash level switch. Storage capacity of each ash hopper shall be at least for eight (8) hours at 100% BMCR.

3) **Catalyst modules**

i) The catalyst for the reactor shall be plate type arranged in cassettes which are further arranged as stand-alone modules. Catalyst shall be arranged so as to avoid gas drift, ash contamination and flue gas sneakage around the cassettes/modules.

ii) The catalyst composition shall be selected for the target reduction, gas composition, temperature profile etc. specially for the abrasive and high ash environment. The base carrier for the catalyst shall be mesh of stainless steel suitably formed for the purpose on which the catalyst compound is coated. The upper edge of the catalyst shall be hardened to minimize ash erosion.

iii) The size of the catalyst cassette/module shall selected in line with practice of the bidder/catalyst supplier. Cassettes shall be banded together to form modules which shall be suitable for easy handling during replacement. Depth of the module shall be determined based on cleaning efficiency of the selected catalyst dedusting system but shall not be higher than 1300 mm. The catalyst elements shall be arranged in layer in each catalyst module and no. of sub layers shall not exceed two in any case. The selected depth for the catalyst shall also be established before manufacturing on a test rig where in conditions of blowing/dislodging of ash settled on fouled catalyst shall be simulated.

iv) The minimum thickness of the stainless steel substrate shall be 0.3 mm and after deposition catalytically active material, its thickness shall not be less than 0.7mm. The coating thickness of the catalyst layer should be sufficient to meet performance guarantees and catalyst life. The minimum catalyst plate pitch (summation of catalyst plate thickness and gap between plates) shall be 7 mm.

v) Catalytically active material shall not delaminate from metallic substrate due to stresses induced by thermal forces, pressure or any combination thereof.

vi) Catalyst sizing shall be carried based on catalyst supplier's experience with SCR fitted on steam generators within the similar gas temperature window and for coals with high ash content. Steam generator performance over full load range, coefficient of variation expected for gas velocity, temperature and ammonia/gas mix for the steam generator design (upstream of the catalyst) shall be factored-in the catalyst sizing. Basic selection parameters for the catalyst like space velocity, area velocity etc. shall be brought out along with the experience basis for the same. The bidder shall keep 15% margin on the total calculated catalyst volume due to pluggage / masking / poisoning by ash (unrecoverable performance after recommended in-situ cleaning cycle).

vii) The selected catalyst shall have minimum life of 16000 hours of continuous operation under any operating condition of the steam generator and range of coal specified. Life of set of catalyst will deemed to be consumed when ammonia slip cannot be limited to maximum specified value with catalyst originally placed in the reactor.

viii) The catalyst shall have a mechanical life of 60000 hours. During the mechanical life of the catalyst the integrity of module/cassette frame, catalyst carrier stainless steel plate/mesh and catalyst coat (nearly 90%) shall be maintained.

ix) The catalyst module dimensions must be of industry standard size. Bidder shall use standard size modules so that alternate catalyst types or manufacturers can be used in the future without adverse effects.

x) The Bidder shall submit along with the bid its catalyst management plan (CMP) to reduce the overall consumption of the catalyst over the service life of the SCR system. CMP shall be based on filling up the future space provision for the future catalyst, swapping catalyst modules between layers at different elevations and replacement of spent catalyst by new catalyst. Partial replacement of catalyst modules can be recommended to fully utilize the catalyst life, however, the same shall not be admissible for measuring life or performance for guarantee purposes- which shall be based on full addition/replacement of catalyst layer. Regeneration of spent catalyst while envisaged by the Owner shall not be utilized as part of the CMP.

xi) The catalyst shall have enough strength and durability physically, chemically and thermally for long time use conforming to the DeNOx equipment inlet gas characteristics. The design of the catalysts shall consider coal ash, typical poisons, SO2 and SO3 content of the flue gas. Bidder shall collect typical Indian coals to test them for identifying potential poisons and reactivity profile for the catalyst composition selected for the project. The catalyst shall be suitable for cleaning by specified catalyst dedusting devices. The design of the catalysts shall take into account the

minimization of the effects and impact of the operation of the NOx reduction system on downstream plant components, specifically air preheater.

xii) Suitable cover screen in each module shall be included on top of the catalyst elements. This screen cover shall be demountable/mountable without any requirement of unwieldy disconnection or cutting work. The screen shall be suitable for walking required for inspection purposes.

xiii) Catalyst shall be shop assembled into standard size modules consistent with the duct cross section and shipping clearance. Catalyst casing shall be high-acid-proof, wear-resistant and heat-resistant material. Catalyst Module type and dimensions shall facilitate installation into and removal from the reactor housing. The module shall have the rigidity for transport and installation. The standard module shall be designed that a sufficient packing pressure exists at all operating conditions to guarantee a safe anchorage of the catalyst among each other.

xiv) The catalyst module design shall minimize leakage of untreated gas past a modules. The sealing of the modules shall take place on the upstream and/or downstream side of the catalyst modules. To this effect sealing plates/channels shall be used to block the gaps in between the modules. The fitments of such sealing elements shall be designed so that it remains secure in its location against gas flow or soot blower/sonic horn/air cannon when the reactor is in service.

xv) Design of the catalyst modules shall permit inspection of catalyst and reactor interiors without damaging the catalyst. Sample blocks or removable cassette sections of catalyst on the front face (upper cassette deck of the module) shall be provided at each layer of the catalyst. Such cassettes shall be put under laboratory tests for assessing erosion, poison accumulation, predict the remaining active life of the catalyst etc. The number of extractable cassette samples and their locations shall be finalized during detail engineering. In situ measurement of catalyst activity shall also be envisaged. The Bidder shall be responsible to perform the sample laboratory test twice a year within the guarantee period.

4) **Catalyst De-dusting System**

The SCR system shall be provided with a robust catalyst de-dusting system considering very high ash content of Indian coals. The effectiveness of the catalyst de -dusting system shall be the foundation of catalyst performance over longer term periods due to very nature of chemical reduction of NOx on reaction sites on the catalyst surface. The catalyst de-dusting system shall use rake type steam soot blower. In addition to steam type soot blowing, sonic horn and air cannon for blowing/dislodging accumulated/sticking ash and fouling on catalyst surface shall be provided. Type of de-dusting system shall be offered based on Bidder's standard practice/ past supply experience. The Bidder shall establish/ recommend de-dusting device frequency and their performance tuning based on the actual operation through controlled tests/measurements. Cleaning effectiveness shall target recovery, as measured through gas

pressure drop and visual inspection, up to a near pressure drop value with reference to completely clean reactor as measured at the time of commissioning. In case if above dedusting systems are not sufficient for effective cleaning of the catalyst than the bidder may provide Dry Cleaning System for in-situ cleaning of the catalyst in addition to above.

i) **Rake type steam soot blowers**

a) Soot blowers shall be provided for cleaning all catalyst layers, including the future layer. Adequate number of soot blowers shall be provided so that it should cover complete catalyst surface area. The steam shall be blown from top of the catalyst layer to blow away ash and dislodge ash/fouling from the catalyst plates.

b) The Bidder shall source steam for the soot blowers from suitable location in its scope of work. If required a steam pressure reduction station with condensate separation shall be provided. At no time condensate should enter the reactor.

c) The arrangement of soot blowers shall be as per standard practice of the Bidder. The bid proposal will include information as to the experience in respect of soot blowers type, cleaning efficacy, jet penetration range, use frequency, references etc.

d) The soot-blowing medium must be completely free of particles and droplets. The soot blowing system will therefore include necessary superheat for all operating conditions and the system design shall have automatic water draining system to maintain the system in hot standby state.

e) Soot blowers arrangement shall be designed in such a way that it shall reach all parts of the catalyst layer for deep penetrative cleaning purpose. The cleaning effectiveness and depth of the soot blowers shall be demonstrated.

f) The soot blowing system should be complete with:

- Rake soot blower with motor drive
- Guide rail for soot blower in the reactor
- In feed units
- Piping for steam/condensate including insulation and fabrication of the connections to the steam blowing source
- Pressure control and reduction (if necessary).
- Pressure indicator
- All required fittings.

g) The Bidder shall provide recommended soot blowing regime. However, the soot blowing frequency shall be kept to the absolute minimum necessary in order to avoid undue mechanical stress on the catalyst.

ii) **Sonic Horn**

a) Sonic horn shall be provided for cleaning all catalyst layers, including the future layer. Adequate number of sonic horn shall be provided so that it should cover complete catalyst surface area. Sonic horns may be arranged on the single wall or opposite walls of the SCR reactor based on its cleaning intensity.

b) Sonic horns shall be provided to generate low frequency and high energy sound waves to resonate and dislodge ash deposits/fouling which develops on the catalyst modules/cassettes. The horns shall be driven using service air available at site sequentially at regular frequency. The horns shall be constructed of stainless steel having diaphragm of titanium alloy. Diaphragm shall have a minimum life of five (05) years.

Each horn shall be provided with acoustic enclosures to reduce ambient noise. The arrangement and type of sonic horns shall be as per standard practice of the Bidder.

c) Each Sonic horn shall be provided with separate solenoid operated isolation valve along with associated piping. Adequate number of moisture traps shall be provided at each catalyst layer for removal of moisture from instrument air supply line.

iii) **Air Cannons**

a) Air cannons shall be provided for cleaning all catalyst layers, including the future layer. Number of air cannons shall be provided so that it should cover complete catalyst surface area. Air Cannon may be arranged on the single wall or opposite walls of the SCR reactor based on its cleaning range.

b) Two (02) multiport air cannon system with fan jet nozzles shall be provided for each catalyst layer including the future layer.

c) Air Cannon shall be operated in combination with sonic horn. Initially air cannon shall discharge to break any adhered material loose and then acoustic cleaner shall continue to sound to keep ash deposits in suspension. Air Cannon discharge nozzle shall preferably be placed directly below the sonic horn.

iv) Dry Cleaning System for in-situ cleaning shall include removal of the particulates and plug(s) on the catalyst using a blasting stream of a pressurized carrier gas having a particulate blasting medium (dry ice) directed at the SCR catalyst. Complete pressurization system for the carrier gas along with feeding/mixing of the blasting medium shall be provided along with necessary injection lances for in-situ cleaning of catalyst at each layer elevation.

v) **Handling System**

Complete handling facility for addition and replacement of catalyst modules shall be included. Catalyst modules are envisaged to be stored at the lay down area at the plant grade level in the steam generator area. The modules shall be moved, lifted and brought to the reactor platform levels provided at each catalyst elevation. Such platforms shall act as intermediate storage areas to be used during reactor revision for rapid replacement of the modules. The handling facility shall be complete with structural steel, runway beams, trolley/hoists (electrically operated), lifting jig and fixtures, monorails, trolley carts for carrying the modules etc. for lifting of catalyst module from grade level to placement inside the reactor and vice versa.

23.1.4 DUCTING SYSTEM

1) Specification requirements for ducting indicated elsewhere in the specification shall also be applicable to the complete duct system provided as part of the SCR system. The ducting system for the SCR system shall connect the steam generator outlet (gas side economizer outlet) to the reactor through the cyclone separator, from the outlet of the reactor to the air-preheater inlet, SCR bypass duct and Flue Gas duct from economizer inlet / intermediate position to inlet duct of each SCR reactor (Economizer bypass duct to maintain suitable flue gas temperature at SCR inlet for part load conditions).

2) The flue gas duct at the economizer outlet shall be widened shortly downstream of the steam generator outlet after the economizer. The dimensions as to the transition from rectangular to near square shape shall be established based on CFD analysis to obtain a homogenous incoming flow at the catalyst face as specified. CFD analysis report containing all options w.r.t. target mixing efficiencies shall be furnished within 4 weeks of the award of contract for finalizing the selection of basic duct profile.

3) Economizer bypass duct shall designed to maintain required flue gas temperature at SCR inlet beyond 40% TMCR operating conditions for specified range of coal(s).

4) The flue gas ducts at critical locations shall be preferably provided in corrosion resistant material or be protected against corrosion by suitable measures. Guard rails inside the flue gas ducts at the bends shall be provided, as a safety measure, to prevent fall while maintenance work is in progress.

5) The flue gas ducts shall be arranged and provided that an eventual condensate formation in the flue gas ducts can be safely led away. All necessary pipes and devices to discharge the condensate in a proper and safe way shall be in the scope of supply.

6) All required nozzles e.g. for temperature measurements, pressure manometers, analyzers etc. as well as drainage shall be included in the scope of supply. All nozzles shall be provided with such a length that they stick out of the insulation/cladding and ensure the installation of

the measurement instrumentation and the mounting of other fittings without any other negative impact.

7) All ducts shall be equipped with access doors to allow access to all duct sections. Moreover a fair level access for all duct sections shall be implemented. Access and cleaning openings shall be considered in sufficient quantity in line with prevailing practice.

8) Turning vanes and other flow modification devices (like vanes, vortex enhancers, baffles etc.) shall be suitably and adequately placed to minimize pressure drop across duct, improve gas/ ammonia mixing, minimize gas flow and temperature stratification/ imbalance, reduce ash accumulation zones etc. Bidder shall provide suitable means to dislodge and remove ash collected/sticking to the flow modification device in line with its practice.

9) Ash hoppers for duct, if required based on layout, shall be provided complete with level switch. Storage capacity of each ash hopper shall be at least for eight (8) hours at 100% BMCR while firing worst coal.

10) **Static Gas Mixer (if required based on bidder's standard practice)**

Due to uneven flue gas flow profiles (temperature and gas composition, velocity etc.) improvement of mix of the flue gas is required for the SCR system installation. An advanced static gas mixer system to minimize the variations and to improve uniformity of the flue gas stream to values, required for optimized catalyst performance shall the provided by the bidder downstream of ammonia injection grid. The static gas mixer will improve mixing of the gas properties through initiation of flow turbulence which will improve mixing through eddies cascade. The design and wear resistant material of the static gas mixer shall be as per the proven design of the Bidder and shall be suitable for the inlet flue gas conditions while firing any coal from the range specified. Bidder shall provide suitable means to dislodge and remove ash collected/sticking to the static gas mixer in line with its practice.

11) **Expansion joints**

i) All plant components shall have the ability to expand at all operating conditions and at breakdowns that at no location of the plant unallowable tensions, stresses and movements occur. A proper compensation must be ensured at each portion of the SCR system specifically the gas ducting system. Metallic expansion joints and anchor points for the system shall be selected by the Bidder in line with such over-arching requirement of system design.

ii) The expansion joints for expansion absorption shall be designed according to the operating conditions (pressure, temperature, expansion, acid flow, etc.) as well as the local conditions. The connecting elements between duct and expansion joints shall ensure a liquid and gas tight connection.

iii) In addition to the above the specification requirements for expansion joints elsewhere in the specification shall also be applicable for SCR system.

12) **Dampers and Gates**

i) Motor operated gas tight gates along with their drives shall be provided at inlet, outlet and bypass duct of the SCR system for carrying out internal repair and maintenance of complete SCR system when the Steam Generator is on load. Pneumatic operated control damper and motor operated gate shall be provided in economizer bypass duct for regulation and isolation of economizer bypass flow.

ii) The motor operated gates shall be guillotine gate type and shall be provided with 2x100% pressurization fans to achieve 100% sealing efficiency. Leak tightness efficiency of gate on flow shall be 99.95%. Leak tightness testing of dampers for each type and size of damper at shop to demonstrate the guaranteed gas tightness efficiency (on flow).

iii) These gates and dampers shall be made up of erosion resistant material. In addition to the above the Specification requirements for dampers elsewhere in the specification shall also be applicable for SCR.

13) **Cyclone Separator**

i) Cyclone Separator shall be installed in the flue gas duct after economizer. A bank of small & multiple separator to be provided inside the Cyclone Separator in such a manner so that pressure drop across the cyclone separator shall not exceed the specified value.

ii) Cyclone Separator shall be installed in two parallel stream. Each cyclone separator shall be connected to each SCR reactor and shall be capable of handling flue gas flow corresponding to 50% BMCR load.

iii) For multi separator design, separators shall be arranged inside the module in such a way that it shall be easily approachable for inspection and maintenance.

iv) Ash separated from flue gas in the cyclone separator shall be collected in the hoppers at its bottom. Ash hoppers shall have a storage capacity of minimum of eight (8) hours at 100% BMCR flow with worst coal. These hoppers shall be provided with RF type low and high level switch.

v) Cyclone Separator vanes and bottom conical portion shall be lined with ceramic to minimize its erosion.

23.1.5 CFD and Physical Flow Modeling

1) CFD modelling as well as physical modelling for SCR reactor, upstream duct work from economizer outlet (including economizer bypass) along with cyclone separator and downstream ductwork from SCR reactor outlet upto Air preheater inlet shall be carried out to examine and finalize the design options for the duct system, flow modification devices, Ammonia Injection Grid (AIG), etc. Modeling shall be carried out with the following objectives:

a) Achieving flow uniformity upstream of AIG and first catalyst layer

b) Achieving uniformity in gas temperature distribution at the inlet of SCR reactor

c) Reaching homogenous mixing between ammonia and flue gas

d) Minimizing pressure drop throughout the SCR system

e) Preventing dust precipitation/accumulation in the system

Additionally, the physical flow model shall be used to evaluate the performance of the system for the CFD narrowed down design options for the various components of the SCR system specifically duct routing/design, flow modification devices, AIG, cyclone separator and static mixer (if required). CFD and physical modelling shall be interdependently used with respective focus area on gas mixing tracking and ash fall out going by the strengths of simulation techniques.

2) For CFD modelling underlying equation and mesh type/size shall be selected such that the model is able to resolve turbulent flow over large part of the system (i.e. all critical locations like near AIG, static mixers (if applicable), guide vanes etc.). The catalyst model shall consider number of active sites based on design data which has been field validated for high ash coals. The model shall predict dependencies of NH_3/NO ratio, temperature, residence time and flue gas composition. The Bidder shall provide the result of computer simulation for fluid dynamics of the SCR De-NOx system at 100% BMCR, 80% BMCR, 60% BMCR and turn down load for the SCR system. Bidder shall load the final CFD model alongwith all necessary files on Owner's Computer.

3) The Bidder shall also perform model study using physical scale model to validate the CFD model results. The physical model study shall confirm the suitability of the size/layout of the ducting, uniformity of the flue gas distribution, minimize mass/temperature stratification, maximize gas/ammonia mixing, minimizing draft loss, and minimum dust drop out and build up etc. The physical model study shall comply to the following minimum requirements:

a) The Bidder shall conduct physical model testing of the SCR system by fabricating a transparent scaled model. The model testing shall be in accordance with relevant ICAC publication. The Bidder shall fabricate a three dimensional model of one complete flue gas stream of the SCR System from economiser outlet to APH inlet consisting of one (01) cyclone separator , one (01) SCR reactor and associated ductwork & ash hoppers with a scale of not less than 1:10. As a minimum the study shall be conducted to simulate 100%, 80% and 60% BMCR gas flow equivalent to one (01) flue gas stream. The Bidder shall submit the detailed procedure for carrying out model study for the approval of the Owner.

b) Based on the model test studies, the Bidder shall finalize the geometry of the reactor, ductwork, flow modification devices, sampling points etc. The model study shall be carried out in the presence of the Owner/consultant. The physical model shall use

fan(s) to draw air through the model at a flow rate that provides similar fluid dynamic behaviour to the full scale system

c) Dust shall be injected into a model to simulate the behaviour of particulate in a system (to assess ash fall out, accumulation etc. for example). The complete model shall be constructed with clear walls so that flow patterns can be observed via smoke flow, strings, etc. Flow characteristics are measured over a grid of traverse points with an inserted probe. 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 Owner's representative during the test. Model results shall be presented as colour contours, histograms, and other plotting methods. A test report shall be submitted covering the complete model study including the details of the recommend geometries for the components of the complete SCR system.

d) The Bidder shall be required to maintain the SCR system model until the SCR systems have successfully met all the performance guarantees. In case the Bidder cannot maintain the SCR model till completion of SCR guarantee test, it 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 unit, SCR Bidder shall make the model ready byre-assembly for such repeat testing within four (4) weeks of notice by the Owner in this regard.

e) The model test shall be planned during the early stages of the contract so as to effectively engage with the engineering of the flue gas ducting. The bid proposal shall contain bar chart indicating milestones and completion date for the model test.

23.1.6 Ammonia Injection System

1) Ammonia injection system for putting ammonia into the flue gas shall be provided upstream of the static mixers (if required)/SCR inlet hood and shall consist of ammonia injection grid (AIG) complete with nozzle lances, control valves, headers/piping for the distribution of the ammonia/air mixture, connection to ammonia piping from ammonia supply, isolating valves, flow/temperature meters etc. Ammonia shall be injected into the flue gas duct as a dilute mixture (with air).

2) The Ammonia injection grid (AIG) shall uniformly distribute the ammonia/air mixture across the gas duct. It shall be structured to avoid unbalanced ammonia injection caused by ash deposition, clogging, abrasion etc. The AIG shall have zonal control to regulate ammonia/air mixture for distribution into the flue gas stream. It shall be possible to remotely regulate the zone injection in order to have uniform gas/ammonia mixture concentration across the duct area before the catalyst face. The AIG nozzles shall be connected through service air for nozzle blow-off.

3) The design offered by the Bidder for the AIG system having zonal control/metering feature shall be operating in at least two (2) power stations at the time of bid opening. In case the Bidder/ SCR system supplier has not used AIG with zonal control feature in its earlier references, the other AIG design based on their standard practice and

shall be operating in at least two (2) power stations at the time of bid opening shall also be considered. However, details of the same shall require to be submitted for specific approval of the Owner.

4) The nozzle density for the AIG grid (nozzles per square meter of gas duct area) shall be selected to reduce the mixing length. The selection shall be based on standard practice of the bidder which shall be brought out in the bid proposal for similar size of the SCR system supplied by the bidder or its AIG technology provider. The selection adequacy for the AIG nozzle density and duct mixing length and other provisions shall also be demonstrated through CFD analysis through sensitivity analysis for varying nozzle density.

5) The grid shall be divided into multiple branches consistent with the flue gas duct size and configuration and as per standard practice of the Bidder. The ammonia flow control shall be redundant (2 x 100 %) . The control station shall be installed in an easily accessible location and shall be weatherproof for inspection and maintenance work. Ammonia supply piping shall be able to be isolated safely during inspection.

6) The ammonia flow control unit (AFCU) shall be provided for SCR reactor located before ammonia injection grid. The AFCU shall control according to the signals of the NOx content of the untreated flue gas, the NOx content of the treated flue gas, the O2 content of the flue gas and the flue gas flow rate. The AFCU shall consist of two parallel stream. Each stream shall consist of one pneumatic flow control valves along with motorized isolation valve on upstream side and manual isolation valve on downstream. Further, a pneumatic emergency shutoff valve shall be installed upstream of ammonia flow control unit (AFCU) for isolating ammonia system from the flue gas system.

7) Ammonia air mixture density after dilution and mixing shall be controlled with appropriate dilution air quantity suitable for safe and efficient operation at all operating conditions.

8) Ammonia slip monitoring instruments shall be provided between SCR and the Air pre heater, in order to monitor and maintain the Ammonia Slippage. The catalyst layer cleaning can be carried out based on this.

9) Components of ammonia injection system exposed to flue gas stream shall be constructed from suitable grade of stainless steel. The common supply header and riser pipes outside the flue gas stream shall be of carbon steel (ASTM A106, Grade B) material. AIG system piping shall be provided with proper supports for the injection grid taking into consideration off thermal stresses and vibration caused by the flue gas flow.

10) Ammonia Injection Grid shall be properly designed to prevent the plugging of nozzles by dust. Devices which can detect the plugging condition and perform nozzle cleaning shall be provided.

11) An emergency shower/eye wash station shall be installed in the area of the ammonia flow control units. Ammonia leak detector and warning light shall be provided nearby Ammonia injection and control station area. In case of ammonia leakage, remote indication shall be provided in the unit control room. N_2 purge line shall be positioned in the Ammonia pipe line.

23.1.7 Dilution air system

1) The dilution air fans shall take suction from the atmosphere and its discharge shall be heated (if required) and mixed with gaseous ammonia. The ammonia/air mixture shall be injected upstream of static mixer (if required)/SCR inlet hood. The supply line of ammonia/air mixture shall be thermally insulated as per the system requirement to prevent condensation upstream of ammonia injection grid at any load.

2) One (01) dilution air station consisting of 2X100% capacity centrifugal dilution air fans and 2X100% capacity dilution air heaters (if required), shall be provided. One (01) set of fan and heater shall remain in operation while other set shall be in standby mode. The dilution air heater shall be electrical type. The dilution air fans shall be suitably located away from ash hopper evacuation systems and without effecting the maintenance space of other equipments.

3) Silencer and filter shall be provided on the suction side of each fan. Filter and motor operated damper shall be provided at discharge of each fan. The fans shall be complete with motors, base plate, foundation bolts, coupling and coupling guard, dampers, supports etc.

4) 1X100% capacity ammonia-air mixer shall be provided for SCR system to uniformly dilute the gaseous ammonia with the dilution air before being supplied to the ammonia injection grid, so that gas mixture is safe and non-flammable. Ammonia-air mixer chamber shall meet the NFPA requirements for handling of ammonia and air mixers.

5) Alternatively dilution air may be supplied from a suitable location in secondary air duct.

6) The maximum amount of ammonia in the diluted air shall be 5 % by volume. At an amount of 7.5 % and higher the entire system shall be shut down automatically and brought to a safe state.

7) The dilution air system shall be designed for entire ammonia required to reduce the flue gas NOx as per SCR design criteria and shall consider 25% margin on entire air flow and 30% margin on pressure head required considering ambient temperature of 47°C and relative humidity of 60%.

8) In the event of failed dilution air supply, the ammonia supply to AFCU shall be automatically disconnected. The flaps of the isolating damper shall be equipped with end position signaling.

23.1.8 Ammonia Unloading, Storage, Handling and Preparation System

Ammonia unloading, storage and supply system comprises of the unloading area facilities, storage tanks for anhydrous ammonia, ammonia unloading compressors from supply truck tanks, ammonia forwarding system , vaporization system, nitrogen supply system etc. The anhydrous ammonia storage tank, unloading compressors, forwarding pumps (if required) and vaporization system equipment shall be housed in shelter. Complete ammonia system shall be provided with all necessary safety system complying with applicable OSHA standards and local regulations.

The Bidder shall create scheme with all the necessary equipment and connections to achieve a fully safely, reliable and maintenance an easier repair with high availability.

Entire ammonia unloading, storage, and handling area shall be fenced with automated gated entry. Two (02) gates shall be provided for emergency escape.

1) **Ammonia Unloading area facilities**

a) The anhydrous ammonia is envisaged to be delivered by tank-trucks to the ammonia storage facility at the power station. The tank-truck decanting shall be carried out using unloading compressors. For the purpose, ammonia unloading station shall consist of flexible hoses with quick release coupling at the ends for connection with the tank truck for the liquid phase and for the gas phase connections.

b) Ammonia unloading station shall consist of a tank truck parking pad include a bulkhead to provide truck pull-away protection. The unloading safety system design shall include back-flow check valve, excess flow check valve, remote shut-off valves, dry-link couplings, water sprinkling and safety shower/eye wash station, local alarms with flashing beacons and horns.

c) The unloading process must be controlled and monitored via the remote operator control panels. The valve group shall be monitored by means of CCTV cameras.

d) The gas phase pipes between tank truck station, tanks and compressors shall be provided with electrical trace heating and thermal insulation as required.

e) Nitrogen shall be used for purging (and filling to obviate air and moisture) different parts of the decanting system including end-connecting pieces before and after the maintenance work. Nitrogen supply system shall be complete with cylinder rack, pressure reducing and relief valves, piping & valve, flexible hose, pressure gauge, switch for alarm for low supply etc.

f) The gas phase pipes between tank truck station, storage tanks and compressors shall be provided with electrical trace heating and thermal insulation (if required).

g) Following component arrangement requirements shall be followed:

- Tank truck unloading station: a free passage way shall be provided between enclosure and vertical column.

- Tanks and equipment items shall be identical in design (no mirror symmetry),

- Emptying of ammonia tanks into truck tank or an emptying tank must be possible with the compressors after manual switching of the valves in case of a system failure.

In the region of the unloading an illuminated wind direction

indicator shall be provided. Wind direction and speed are also display in the continuously manned area.

2) **Ammonia Unloading Compressors**

a) Two (02) oil free reciprocating type ammonia unloading compressors complete with motor drives and receivers shall be provided with all necessary fittings, monitoring and safety devices for unloading of ammonia from the tank truck to ammonia storage tank. The compressors shall be skid mounted. The compressor design shall have double and triple packing to obviate harmful gas leaks. Further, any leakage gas shall be returned to the suction line and no nitrogen purge and leak gas monitoring device with gland seal of the piston rod shall be required.

b) Same compressor shall be used for liquid ammonia transfer and ammonia vapour recovery. The compressor shall be designed with the consideration of ammonia vapour recovery which may result in excessive temperature rise.

c) Each compressor shall be provided with gas filter and liquid trap with level control on its suction side. Liquid trap shall be designed for pressurized and vacuum operating condition. 4-way valve ball valve shall be provided for each unloading compressor for switching the direction of gas conveyance.

d) Atleast One (1) pressure relief valve shall be installed in the discharge line of each compressor and its connecting pipe shall be routed back to the storage tanks.

e) The design of compressor shall ensure the compliance with the following operational requirements:

i) Facilities for emergency shutdown of compressor at low suction pressure, high discharge pressure and high differential pressure across suction & discharge of the compressor.

ii) Facilities for emergency shutdown of compressor at high discharge temperature.

f) Parallel operation and auto changeover of compressors shall not be envisaged. After completion of unloading of ammonia from the tank truck, the compressor must be switched off by means of a flow monitor and the unloading process completed.

g) Material of construction of compressor shall be suitable for handling anhydrous ammonia.

h) A clear space of 1 to 1.2 m shall be provided around the compressor for inspection purpose.

3) **Ammonia storage Tank**

a) Two (02) storage tanks shall be provided for the SCR System. One (01) storage tank shall be in service at a time i.e. shall supply the ammonia to SCR System while other tank(s) shall be in stand-by mode. Changeover from the tank in service to the standby tank

shall be possible automatically during operation without any restrictions. All the tanks shall be interconnected in such a way (like through compressor) so that transfer of liquid ammonia can be done whenever required.

b) The tank shall be designed, fabricated, and tested in accordance with ASME Boiler & Pressure Vessel Code Section VIII. Tank shall be made up of ASTM SA516-70 or equivalent material. All welds in the tank must be 100% radiographed and stress relieved. Each tank shall be provided with a corrosion protective coating according to the site conditions.

c) Storage tank should be mounted with proper support and suitably above ground level for easy maintenance & access. A clearance of 1.5m shall be provided as a working area for maintenance activities around the tank.

d) The storage tanks shall be single-wall pressure tanks and shall be arranged horizontally and above ground. All tank connections must be located within the gaseous phase at the top of each tank. Valves and measuring instruments shall be installed. Two manholes of minimum 800 mm diameter with rotary arms shall be installed which shall be properly accessible.

e) The storage tanks shall be equipped so that operationally no vacuum can occur inside. In order to ensure the pressure equalization necessary for proper functioning, all the tanks shall be connected on the gas side.

f) Ammonia storage capacity of the tank shall be calculated considering density of liquefied ammonia at maximum design fluid temperature while for load calculation density at lowest design temperature shall be considered.

g) The ammonia storage tank shall have self-supported platform i.e. its load must not be transferred to the tank. The inspection level is arranged about 300 mm to 350 mm above the upper edge of the tank. The tank connecting nozzles must end above the upper edge of the open floor grating.

h) The ammonia storage tank shall be designed taking thermal expansion into consideration.

i) Ammonia storage tank shall be transported to site in one piece. Bidder shall select the tank dimension accordingly.

j) Ammonia storage tanks shall be painted compulsorily in white colour to minimize heating due to solar radiation.

k) The blow off connections of the tank pressure relief valves shall preferably be routed into the nearest chimney constructed according to Indian standards and discharge to atmosphere.

l) Following minimum equipment shall be provided for each storage tank:

i) One (1) liquid level float gauge for local indication and remote indication glandless magnetic transmission of floater movement indicator, with alarm high and respectively indication of the permitted peak and low level, fill level limit switch with design licensing.

ii) One (1) pressure relief manifold connection on top with one three way valve.

iii) One (1) vacuum breaker including back pressure check-valve venting to the atmosphere (flame breakdown safety lock, suitable for zone.

iv) Two (2) manholes with rotating mechanisms, one manhole shall be located at the tank platform for easy access purposes.

v) One (1) spare nozzle on top with one (1) ball valve and temporary cover.

vi) One (1) pressure gauge and One pressure transmitter with isolating valve.

vii) One (1) temperature transmitter and One (1) temperature gauge.

m) Ammonia storage tank shall be equipped with a dual pressure relief valve system. It should consist of two pressure relief valves mounted on a three-way valve. Each pressure relief shall be capable of protecting of tank independently. The three-way valve permits shutting off either but not both, of the relief valves for replacement without emptying the tank. Pressure relief valve shall be made of stainless steel and shall be sized based on the worst case scenario as per codes/standards such as API, etc.

n) Excess flow valves shall be provided in all pipe and hose connected with the tank to prevent substantial leakage in the event of a catastrophic line failure.

o) The tank shall be equipped against overheating with a permanently installed sprinkler system. The sprinkler installations of the tanks shall preferably be arranged directly underneath the platforms (by means of suitable spray nozzle design/setting).

4) **Ammonia Forwarding pump (if required)**

a) Two (02) ammonia forwarding pumps (1 working and 1 standby)with recirculation line shall be provided for the steam generator to ensure steady supply of ammonia to the vaporizer and flow control units (located at the steam generator) irrespective of the ambient temperature and liquid level/pressure in the storage tanks.

b) The forwarding pumps shall be skid mounted constructed from stainless steel without mechanical seals with magnetic drive to obviate any ammonia leakage.

c) Pump shall be provided with strainer & manual isolating valve in its suction line and check valve & motor operated isolation valve in

the discharge line. Each pump shall be provided with a recirculation line along with a self-actuated PRV in the common line to storage tank. Any other valves required for changeover of pumps shall also be provided.

d) Pressure relief valve shall be installed for each pump to relieve the pressure to ammonia storage tank as backup protection.

e) Bypass line to the forwarding pump shall be provided to operate during periods when the storage tanks have sufficient pressure or during period when the pump is not available. Bypass line of each pump shall be adequately sized to meet the ammonia requirements of the SCR System.

f) Forwarding pump shall be complete in all features with respect to instrumentation (gauges, transmitters, etc.).

5) **Ammonia Vaporizer**

a) Two (2) (1W +1S) ammonia Vaporizer shall be provided for the steam generator. Vaporizer shall be designed to supply ammonia vapour to SCR reactor under all operating conditions. The vaporizer shall be shell and tube type heat exchangers. Auxiliary steam shall be used as heating source which will transfer heat to secondary Glycol/water cycle which in turn would supply heat to ammonia. Glycol/water mixture as intermediate heat transfer medium shall be circulated in closed cycle. Degree of super heat of ammonia has to be decided by the Bidder for efficient and safe working. Gas-liquid separator shall be provided to prepare pure ammonia gas.

b) The design of the vaporizer has to be done according to API 650/ASME VIII. DIV.1 or equivalent. It must contain at least the following facilities:

- Flood protection
- Thermostat with a temperature limit and a safety temperature limitation
- Pressure relief valves
- Pressure gauge
- Quick acting valve along with manual isolating valve at both side at inlet of vaporizer
- pressure control valve along with motorized isolating valve on upstream and manual isolation valve at downstream in ammonia outlet line
- Filter upstream of vaporizer in liquid ammonia supply line
- Drain Nozzles
- Measure to prevent un-vaporized ammonia entertainment accumulator

c) 2X100% capacity Glycol/water pump with 1X100% capacity glycol/water heater shall be provided for recirculation and heating of Glycol/water mixture for each ammonia vaporizer. Glycol/water will be heated through Auxiliary steam. Auxiliary steam shall be provided with 2X100% control station to ammonia/glycol heater. Further, condensate generated due to condensation of steam in the heat exchanger shall be routed to the nearest condensate tank in the Bidder's scope. A common glycol/water overhead make up tank shall be provided for providing make up at the suction of all

the glycol/water pumps. DM water make up line along with 2X100% control station shall be provided in glycol water make up tank to control the water level.

d) The discharge line of glycol/water from the each vaporizer shall be equipped with a pH-measurement to monitor the water quality and obtain an indication at ruptures in the vaporizers.

e) Changeover to standby glycol/water recirculation pump and standby vaporizer without interruption to service.

f) The super-heated ammonia vapour shall be maintained at a constant pressure by providing self-actuated pressure regulating valve keeping into consideration the variation in supply side pressure and demand side consumptions.

g) A self-actuated pressure regulating valve shall be provided downstream of the vaporizer for steam generator.

h) The gas phase pipes between the vaporizers, the pressure control loops and the dosing systems shall be covered throughout by electrical/steam trace heating and thermal insulation.

6) **Accumulator**

a) Accumulator shall be provided downstream of each vaporizer to ensure steady flow of ammonia at stable pressure and temperature to AFCU. It shall be designed to prevent condensation of ammonia vapour with the suitable thermal insulation and sufficient degree of super-heat of the ammonia vapour.

b) Pressure relief valve shall be mounted on the accumulator to prevent the excessive pressurization causing destruction of equipment.

c) Accumulator shall be designed in accordance with the relevant design codes/standard i.e. ASME Section VIII, Division 1. Further, ammonia-related stress corrosion cracking shall also be taken into consideration while accumulator design.

d) Accumulator outer shell shall be made of ASTM A516-70 or equivalent. A corrosion allowance of 3 mm shall be taken for accumulator.

e) Quick acting valve along with manual isolating valve at both side shall be provided at outlet of Accumulator.

23.1.9 Waste ammonia dilution tank

1) Waste ammonia dilution tank should be sized such that it can cater system requirement for all the drains and vent connected to it.

2) Waste ammonia dilution tank shall be used to collect the ammonia drained from various equipments. It shall consist of diffuser at the bottom of dilution tank immersed in water and shall be designed for effective diffusion of ammonia in water. Diffuser shall be properly designed to prevent clogging.

3) Velocity of gaseous ammonia through the pipeline and diffuser shall be selected to prevent erosion and to have the sufficient retention time within the water solution.

4) To prevent over-pressurization of the dilution tank, a vent line along with a rain-cap shall be provided considering the maximum entering flow-rate. The vent line shall be extended beyond the canopy of the dilution tank.

5) The dilution tank shall be provided with manhole of minimum 800 mm diameter, with rotary arms. One manhole shall be provided in the roof section and other on the side wall. To approach the roof section manhole, stair along with handrail shall be provided around the dilution tank.

6) Dilution tank shall be provided with a service water make-up line and a drain line along with control valve in each line. A motorized isolation valve shall be provided on the upstream of control valve and a manual isolation valve shall be provided on the downstream of control valve.

7) Dilution tank shall be constructed of corrosion resistant material such as A240-304 / 6 or equivalent.

23.1.10 Ammonia storage tank dyke, waste water retaining basin and sump pump

1) A dyke shall be provided around ammonia storage tank area with storage capacity equivalent to one storage tank. This dyke shall be used as collection basin for liquid ammonia leakage from storage tank, for the water coming from spray, safety showers, eyewash installations within the storage facilities, and for collection of liquid ammonia leakage/spillage etc. The dyke shall be connected to a waste water retaining basin. Sufficient numbers of ammonia resistance balls shall be supplied to cover the top surface of dyke to minimise ammonia evaporation from the dyke.

2) A waste water retaining basin of minimum 10 m^3 storage capacity shall be constructed to collect the water/ammonia coming from the storage tank dyke area and ammonia dilution tank. Further, water/ammonia coming from the spray/safety showers/eyewash installations, spills & leakages etc. in other areas of the ammonia unloading and vaporization system shall also be routed to the waste water retaining basin.

3) This ammonia storage tank dyke and the waste water retaining basin shall be made from chemical resistant material to handle anhydrous ammonia.

4) The sump shall be suitably fenced and with handrail etc.

5) Minimum two (2) steel stair cases shall be provided for assess to the diked area and waste water retaining basin.

6) For neutralization of waste ammonia in waste water retaining basin, chemical dosing system alongwith agitator(s) shall be provided. Two (02) sump pumps shall be provided in a 1.5 m deep pump well at the corner of the retaining basin. Sump pump shall be used to supply waste water at PH not more than 8 up to the Water Treatment Plant. The pump sump shall be monitored by pH- analyzer.

7) Sump pump shall be of material suitable for handling of ammonia contaminated water and service condition. Pump material shall be SSC13 or superior material.

23.1.11 **Not Used**

23.1.12 **Water Spray/ sprinkler System**

1) Water spray/sprinkler system along with annunciation system shall be provided to absorb the leakage ammonia vapour and to cool the equipments.

2) Spray/sprinkler system shall compulsorily be installed in following areas

   i. Tank truck parking area
   ii. Storage tank area
   iii. Unloading compressor area
   iv. Forwarding pump area
   v. Vapouriser area

   Further any other area needs to be provided with the spray system shall be decided during detailed engineering.

3) Deluge valve for the water spray/sprinkler system shall be arranged in a valve station for safe and easy access.

23.1.13 **Ammonia Storage and Unloding Station Arrangement**

1) Ammonia storage tanks and equipment provided for the ammonia handling and preparation system e.g. unloading compressors, forwarding pump, vaporizers, control/metering valves, control panels etc. shall be housed in permanent shelter.

2) Partition between storage tank and other ammonia handling and preparation equipment shall be provided.

3) The ammonia storage and unloading station shall meet all safety norms and local regulations.

4) Furthermore, ammonia storage and unloading station must comprise and accommodate the following:

   - Proper ventilation shall be provided in the storage and unloading station.
   - Battery of breathing air cylinders (3 nos.) and personal protective equipment including storage cabinet;

5) Switchgear room for accommodation of electrical switchgear and panel room for accommodation of C&I panels.

23.1.14 **Safety Arrangement System**

1) Bidder shall design the Ammonia unloading, storage and handling system complying to the requirements of IS:4544, CGA G 2.1—2014 6th Edition (formerly ANSI K61.1), OSHA etc.

2) Safety of limb and life shall be central consideration in the design of SCR system due to use of ammonia gas as the reagent. Every area covered by ammonia equipment or piping shall be reviewed by the Bidder w.r.t. safety considerations.

3) Ammonia leak detectors shall be installed in the unloading area, tank truck, storage tank, forwarding pump, vaporizer area and Ammonia flow control unit for SCR reactor area etc. Sirens for warning at site location and alarm in the main control room shall be provided.

4) The central unit control room shall be provided with an emergency-shut-off pushbutton for the system. Emergency shutoff push-buttons shall be provided at all required major locations. If one of the emergency-off functions is activated, the allocated quick acting valves shall be switched fail safe to closed position. The emergency shut-off circuits shall relate to the shutdown of tank truck unloading or of the overall system.
5) A wind direction indicator shall be installed in the area of the truck tank unloading station.

6) An eye wash and safety shower shall be provided in the area of the truck tank unloading station, forwarding pump, vaporizer and Ammonia flow control unit for SCR reactor etc. These devices shall be operated with potable water.

7) OSHA/NFPA or equivalent certified personal protective gear and respiratory equipment shall be provided as following.

    i) Self-contained breathing apparatus suitable for minimum 30 minutes – 4 Sets

    ii) Full Face Shield - 4 Sets

    iii) Chemical resistant body suit, boot, Gloves – 4 Sets

    iv) Ammonia gas respirator – 4 Sets

    (Ammonia gas respirator shall include face mask, chemical cartridges/canister, etc. Chemical cartridges/canister shall be capable for 30 minutes use at ammonia concentration up to 250ppm.)

23.1.15 Piping, Fittings and Valves

1) All integral piping/fittings required for proper, efficient and safe operation of Ammonia unloading, storage and handling system including headers, drains, vents and other integral piping. The piping shall be designed to meet the requirements of ASME B31.1 power piping and/or ASME B31.3 Process piping and local regulation. Any piping not specifically excluded and required for completion of system requirements shall be provided. The following specifications shall be read in conjunction with Pressure cycle piping system and Low pressure piping system of technical specification. In case of conflict between the two the better/stringent design specification shall prevail.

2) All ammonia, steam and condensate carrying pipelines shall be laid above ground. If necessary an electric/steam heat tracing and / or insulation as per standard practice of the Bidder shall be provided for the vapour recovery pipeline, pipes between storage tanks/compressors/pressure control loops/tank truck station; vaporizer outlets continuously up to the inlet of the dosing system of the SCR system, including all cross-links and dead-end branch pipes.

3) Suitable interconnection between all ammonia storage tank shall be provided.

4) All liquid phase charged piping sections which can be isolated while operation must be equipped with safety relief valves.

5) All pressure relief valves connected in the ammonia pipelines shall be connected to pressure relief valve manifolds which are led back to the storage tank.

6) All the ammonia drains shall be connected to the waste ammonia dilution tank.

7) The supply pipe to the SCR systems shall be monitored for unallowable pressure increase and pressure drop. The motorized isolation valves downstream of the forwarding pumps shall automatically close at an unallowable pressure drop.

8) The above mentioned pipe has to be installed above ground on a pipe trestle.

9) The water spray pipes shall be connected to the fire spray water network. These tubes shall be delivered in galvanized steel with an outer with bituminous coating. All piping should be routed so that they cannot be damaged by the operational medium.

10) Ammonia carrying pipes

   a) The blow-off pressure relief valves of ammonia storage tanks, blow-out of the loading arms, pressure relief valves installed on pipes and which are connected to storage tanks shall be led up to chimney for safe discharge.

   b) Flange connections shall be sealed with spiral wound gasket with centering ring that cannot be pressed. The number of flanged joints shall be kept as low as possible.

   c) The liquid ammonia pipes will have a system pressure test at 1.1 times the maximum working pressure allowed. Ammonia gas lines have to undergo a leak test.

   d) All ammonia - carrying pipes are to be fitted with a suitable anti-corrosive paint and labeled according to the transported medium.

11) All impulse pipelines shall be subjected to a leak test before commissioning.

12) **Valves and fittings**

All necessary isolating, control, regulating, check and relief valves

whether pneumatically operated, motor operated valves, hydraulic or manually operated including vent valves, drain valves, root valves, pressure relief valves, mountings etc., as required for the ammonia handling, storage, handling system and associated piping system. All power operated valves shall be complete with actuator assemblies and accessories like limit switch assemblies, position transmitters, air locks etc. Any valve/ mounting not specifically indicated but required for safe/efficient/reliable operation shall also be included. For ammonia application material of valves shall be stainless steel. The valves and accessories shall comply with the following requirements and shall include:

a) Ball valves shall be used as isolation valves for ammonia system. Ball valves with pneumatic actuators shall be used as emergency stop valves.

b) Isolation valves wherever required for system requirement and for maintenance of equipment/system shall be provided.

c) All instrument tapping with root valve.

d) Excess control valves shall be provided in all ammonia storage tank nozzles.

e) The position of the valves must be explicitly recognizable and distinctive.

f) All safety relief valves shall be equipped with bellows.

g) Ammonia ball valves and changeover valve sets shall be fire safe and equipped for the discharge of electrostatic charges.

h) Ammonia ball valves shall be designed for full passage and with standardized end plates/spindle ends for each nominal width (suitable for manual operation with/without spindle extension and for mounting of pneumatic rotary actuators); the full passage requirement shall also be applicable for ball valves in water-bearing pipes; for double shut-off valves (liquid ammonia), one valve shall be provided with "pressure relief for avoiding impermissible pressure rise between the two valves.

i) Ammonia pressure relief valve shall be designed as per relevant codes & standard such as API RP520/521, ASME B31.1/31.3, etc.

j) Ammonia pressure relief valves shall be designed with mono block body, bellows lagging and gas-tight hood without lifting device; the stainless steel bellows shall be designed for the maximum counter pressure (static).

k) Ammonia control valves (closed-control valves) shall be designed with bellows or, alternatively, with equivalent spindle sealing, pneumatic diaphragm drive, closing by spring force against 25 bar, position controller with lift pointer/indicator, if necessary with pressure reducer including indicator in compact design.

l) Gaskets for positive-fit ammonia flange connections (groove/ tongue, projection/ recess) shall be sized (thickness) such that

positive-fit is maintained. Spiral gaskets for ammonia flat-face flange connections shall be provided with interior and exterior ring.

m) Sealing faces for ammonia flanges with flat faces (also for valves) shall preferably be designed in accordance with DIN EN 1092, shape B1. Straightway valves (except for condensate drains etc.) shall, as a matter of principle, comply with the valve face-to-face dimension stipulated in DIN EN 558-1 Gr.1.

n) All other operational requirements specified elsewhere shall also be complied with.

NOTE:

i) Flexible tubes shall be designed with loose flanges on one side (no Van Stone flange design or the like),

ii) Protective hoods or similar shall be provided to protect ammonia leak detector in the tank truck station and the tank dome shafts against the impact of sprinkler water.

iii) All the drain, non-return valve & vent valves are not shown on the P&ID shall be provided based on layout and process requirement.

13) Pipe trace heating

Electric pipe trace heating shall be provided to maintain flowing media temperature and to prevent condensation, as per system requirement. The systems shall be divided into different heating circuit, equipped with suitable temperature controls and monitoring. The trace heating system shall be designed to meet the system requirement for the entire year ambient conditions.

23.1.16 **Access, Walkways and Platforms**

1) Access platforms, walkways, handrails, stairs, ladders and gratings etc. for proper approach during maintenance shall be provided for the entire SCR system i.e. reactor, cyclone separator, ducting system, dampers, expansion joints, ammonia injection grid, ammonia storage facility, ammonia vaporization/metering station etc. in the scope of this package. Properly designed stairs, walkways and platforms which are adequate in size, numbers, headroom etc. shall be provided for inspection, maintenance and sampling. Walkways, platforms, stairs & ladders shall be provided in accordance with specified elsewhere unless specified otherwise.

2) The arrangement of reactors and platforms shall be designed in such a way that external personnel (not specialized for catalyst exchange) is able to install and exchange catalyst layers including.

3) Platform shall be provided at each catalyst elevation all around the reactor. The width of the platform shall be atleast 3 m. The platform shall also be used as lay-down area/ temporary storage for the catalyst. The depth of such platform on certain sides shall be worked out based on such requirements. The platforms for the catalyst modules shall be designed for loads of 1.6 t/m2. On the sides where De-dusting system get retracted the depth shall be higher as required.

4) In case steam operated soot blowers are provided as catalyst de-dusting device, minimum 1500 mm wide platform shall be provided all around to the soot blowers to facilitate, maintenance, inspection.

5) The gas duct shall be provided with 1000 mm wide walkways at minimum three (3) elevations during the rise of the duct. Additionally platform shall be provided at the locations of AIG, turbulence enhancing vanes, static mixer (if applicable) and flow straightener.

6) Expansion joints, dampers, silencer, etc. shall be arranged accessible respectively platforms and stairs shall be provided which ensure a simple access.

7) All facilities such as SCR plant, cyclone separator, flue gas ducts, valves and other equipment, etc. which must be accessible for inspection and/or for cleaning shall be equipped with access and cleaning openings at suitable locations (manholes minimum diameter of DN 800). They must be accessible without auxiliary equipment and must open, close and seal comfortably and reliably. Access openings shall be equipped with handles and required ascending supports.

8) Manhole covers shall be attached to swivel arms. All openings shall be equipped with machined sealing faces.

23.1.17 Insulation and Cladding

Specification requirements for insulation and cladding indicated in the Thermal Insulation chapter elsewhere in specifications shall also be applicable for SCR system. Further, all the ammonia pipe lines shall be suitably insulated to prevent heat loss and condensation as per system requirement.

23.1.18 Painting and Material Protection

Specification requirements for painting and material protection specified elsewhere in the specification shall also be applicable for SCR system.

23.1.19 Civil Works

Refer Volume VI - Civil & Structural Works

23.1.20 Electrical

Refer Violume IV - Electrical Works.

23.1.21 Control & Instrumentation

Refer Volume V – Control & Instrumentation Works.

23.1.22 Laboratory Tests and Experimental Investigations

Bidder shall conduct laboratory/shop test for the catalyst to access its suitability for Indian coal/ ash, at least for the following:-

1) Catalytic activity (K and K/K_o) according to VGB R-302

2) SO_2 to SO_3 conversion rate according to VGB R-302

3) Surface area of catalyst and catalyst carriers according to ASTM D3663
4) XRF test for change in material composition

5) Loss of catalyst material due to erosion.

23.1.23 **SCR System Sizing Criteria**

The SCR System shall be designed to comply with the requirements stipulated in the table below:

A) SCR System Sizing shall comply the following:

S. No.	Description	Criteria
1)	No of SCR Reactor per Steam Generator	Two (02)
2)	Each Reactor shall be sized	a) For 50% BMCR flue gas flow and temperature at BMCR load for range of coal as specified corresponding to 47 deg.C ambient temperature and 60% RH b) 25% excess air c) Pressure withstand capability: ± 660 mmwc (Minimum) at 67% yield strength or Maximum conceivable head of fans, whichever is higher. d) Air in leakage in reactor- max 1% of flue gas flow
3)	SCR system operating range	40% TMCR to 100% BMCR load
4)	No. of catalyst layer	Three (3) layer + 1 layer for installation in future
5)	Flue Gas maximum velocity through SCR reactor (m/s)	Maximum 5 m/sec
6)	Minimum Chemical life of the catalyst (Hrs)	16,000
7)	Minimum Mechanical life of the catalyst (hrs)	60,000
8)	Minimum Plugging of the catalyst face surface to be considered for catalyst volume (%)	15
9)	SCR casing thickness	6mm (min)
10)	SCR Supporting Structure	
	Considering additional load of following	a) Ash accumulation of 150mm height above each catalyst layer including future layer b) Each layer plugged with 50% ash including future layer c) Ash hopper completely filled with Ash

B) The SCR System shall be designed to comply with the requirements stipulated under 'Guarantee point and design point' in the table below:

S. No.	Description	Guarantee Point	Design Point
1)	Type of Coal	Range of coal as specified in the specification	
2)	Ambient air	7°C to 47°C	
3)	Boiler Load	100% TMCR	40% TMCR to BMCR
4)	NOx at SCR Inlet (mg/NM^3 at 6% O_2 on dry basis, keeping ammonia slip within the maximum limit)	Actual but limited to 500	500
5)	SCR efficiency for control of Nox Emission (%) (keeping ammonia slip within the maximum limit)	85	85
6)	Inlet Dust Burden (g/NM^3)	35 OR Ash remaining after cyclone separator collection as per cl. no. 23.1.23, C, iii-3, whichever is higher.	35 OR Ash remaining after cyclone separator collection as per cl. no. 23.1.23, C, iii-3, whichever is higher.
7)	SO_2 to SO_3 oxidation (%)	<1	<1
8)	Maximum Flue Gas pressure drop across SCR System (mmwc)	To be guaranteed	150
9)	Ammonia Slip after last catalyst layer (ppm at 6% O_2 on dry basis)	< 2	< 2
10)	Minimum ammonia Consumption in Kg/Hr	To be guaranteed	1.05 Normalized Stoichiometric Ratio

Note:-In addition to above in guarantee test NO_x emission level at SCR outlet corresponding to inlet level of NO_x i.e. $500mg/Nm^3$ (to be achieved by adjustment of air staging) shall also be demonstrated.

C) **Components of the SCR System shall be designed to comply with the requirements stipulated in the table below**

S. No.	Description	Criteria
(i)	**Catalyst module**	
1)	Catalyst Type	Plate Type
2)	Catalyst pitch	Minimum 7mm
3)	Catalyst substrate thickness & material	Minimum 0.3 mm, Stainless steel
4)	Finished Catalyst plate thickness	Min 0.7 mm

S. No.	Description	Criteria
5)	No. of sublayers in each catalyst module	Maximum 2 sublayer is permitted
(ii)	**Flue Gas Duct inlet and outlet**	
1)	Flue gas velocity at BMCR with 25% excess air at economizer outlet	Max 13 m/sec with Design/Worst/Best coal whichever gives maximum flue gas flow and operating temperature corresponding to 47 deg.C ambient temperature and 60% RH
2)	Duct plate thickness	Min 6 mm
3)	Economiser bypass duct sizing	Adequate to maintain required flue gas temperature at SCR inlet corresponding to design point for the operation of SCR system in the load range of 40% TMCR to BMCR.
4)	SCR bypass duct capacity	Flue gas flow corresponding to BMCR load with 25% excess air
(iii)	**Cyclone Separator**	
1)	No. of separator modules	Two (02), one for SCR reactor
2)	Capacity of cyclone separator	a) For 50% BMCR flue gas flow and temperature at BMCR load for range of coal as specified corresponding to 47 deg.C ambient temperature and 60% RH b) 25% excess air c) Pressure withstand capability: ±660 mmwc (Minimum) at 67% yield strength or Maximum conceivable head of fans, whichever is higher. d) Air in leakage in reactor - max 2% of flue gas flow
3)	Ash Collection efficiency (minimum)	60

S. No.	Description	Criteria
	(%)	
4)	Flue gas pressure drop (maximum) (mmwc)	35
5)	Flue gas tangential velocity (maximum) (m/s)	11
6)	Cyclone Separator vane life (minimum) (years)	8
7)	Ash hoppers storage capacity (hours)	Eight (8) at 100% BMCR while firing worst coal.
8)	Cyclone Separator Supporting Structure	a) Considering additional load of following: b) Cyclone separator filled with 10% ash by volume. c) Ash hoppers completely filled with Ash

D) Ammonia Unloading, Storage & Handling System:

This system shall be designed for considering the condition indicated under design point of SCR system.

S. No.	Description	Criteria
(i)	**Ammonia Storage Tank**	
1)	No. of tanks	Two (02), Cylindrical, Horizontal
2)	Storage capacity of each tank	Catering the requirement of two (02) reactor SCR System for steam generator under design condition meeting 14 day requirement
3)	Fraction of vapor/Liquid	15%/85%
4)	Corrosion Allowance	Min 3 mm
5)	Design Pressure & temperature	Min 23 kg/cm^2 & -20 to 50 Deg.C
(ii)	**Ammonia Unloading system**	
1)	No of unloading Compressors	Two (02)
2)	Capacity of each compressor	Min 1100 LPM, Reciprocating, oil free type
3)	Discharge pressure	Min 20 bar or as per system requirement considering 44% margin, whichever is higher
(iii)	**Ammonia vaporizer system**	
1)	Total No. of vaporizer	Three (03)

S. No.	Description	Criteria
2)	Design capacity of each vaporizer	475 kg/Hr or the system requirement of SCR System for one (01) steam generator under design condition considering 20% margin, whichever is higher
3)	No. of warm water/glycol circulation pumps per vaporizer & capacity	Two (02). One pump capacity to take care of one vaporizer with margin 20% in flow and 44% in pressure
	Water/Glycol heater	
4)	Type	Tube and Shell type
5)	Heating media	Steam
6)	Heating capacity	Considering added margin of 20°C over the process requirement
(iv)	**Ammonia Forwarding system**	
a)	**Forwarding Pumps (If Applicable)**	
1)	Type of pump	Leak proof and without seal type
2)	No. of pumps	2 (1W+1SB)
3)	Capacity of each pump	Catering the requirement of SCR System for steam generator under design condition
b)	**Accumulators**	
1)	No. of accumulators	Two (2) (1W +1S)
2)	Capacity of each accumulator for handling ammonia	Min 3 m^3
(v)	**Waste Ammonia Collection, Dilution and Disposal System**	
a)	**Waste Ammonia Collection, Dilution**	
1)	No. of waste ammonia dilution tank	One (01)
2)	Storage capacity of dilution tank (minimum) (m^3)	10
3)	Service fluid	NH_3 contaminated water
4)	Temperature	80°C
b)	**Dyke for collection of ammonia**	
1)	No. of dyke	One(1) around storage tank
2)	Storage capacity of dyke (m^3)	Equivalent to one storage tank

S. No.	Description	Criteria
		capacity
c)	**Waste Water Collection System**	
1)	No. of waste water retaining basin	One (01)
2)	Storage capacity of retaining basin (m^3)	Ten (10)
3)	No. of waste water disposal pump	Two (02)
4)	Capacity of each waste water disposal pump (minimum) (m^3/hr)	30 or the system requirement considering 20% margin, whichever is higher
5)	Pressure	As per system requirement plus 44% margin

E) <u>Dilution Air System</u>

S. No.	Description	Criteria
(i)	**Dilution Air System**	
1)	No. of dilution air fans	Two (02)
2)	Type of fan	Centrifugal
3)	Capacity of each fan	Catering the requirement of two (02) reactor of SCR System for steam generator under design condition
4)	Fan inlet air temperature (°C)	40°C with 60% relative humidity
5)	Margin over rated flow (%)	25
6)	Margin over rated discharge pressure (%)	30
(ii)	**Dilution air heater (if applicable)**	
1)	No. & Type	Two (2) & Electrical
2)	Flow	Each heater flow equivalent to capacity of one dilution air fan/ inlet duct
3)	Heating capacity	Considering minimum inlet temperature 7°C to 47°C or process requirement whichever is higher

CONTENTS

SECTION – 3

1.00.00 ELECTROSTATIC PRECIPITATORS (ESP)

Bidder scope shall include supply of one (1) Electrostatic Precipitators complete in all respects with all components and accessories etc., The characteristics of the coal, ash and other relevant design data are specified in Volume II.

1.01.00 ESP for Steam Generator of 800 MW unit complete in all respects including all components and accessories stated in this Chapter.

1.01.01 Electrostatic Precipitator serving one steam generator, shall have atleast six (6) numbers of independently operated passes (gas streams) housed in six (6) independent casings including outside shell, structural steel supports and frame work (excluding foundation), access ladders, platforms, safety rails, stairways, walkways, access doors and weather proof pent house etc. Each gas stream/ casing shall be provided in twin compartments. ESP shall be designed to comply with the requirements stipulated under 'guarantee point' and 'design point' as detailed in Chapter 1, Section 3.1, Clause No. 11.00.00.

1.01.02 Flue gas inlet distribution system complete with perforated plates, turning vanes, deflector plates, flow splitters, guide vanes and all necessary gas flow control devices in the inlet and outlet cones and duct, warranted by the results of flow model test, complete duct stiffening devices, interior bracings, slide plates, access doors, brackets, supporting structures, hangers, sampling connections, etc.

1.01.03 Collecting and discharge electrode systems

1.01.04 Rapping system complete with structural supporting frame, drives, and automatic rapping control, etc.

1.01.05 Ash hoppers complete with panel type heater on trapezoidal / pyramidal face and wrap around pad heaters on conical portion of hopper or adapter, as applicable, level monitors and indicators, outlet flanges, jointing material, poke holes, access doors and walkways beneath the hoppers.

1.01.06 Foundation base plates, bolts along with templates, nuts, anchor materials, packing shims, inserts & embedments along with lugs etc.

1.01.07 For assessment and design of appropriate flue gas flow distribution in the ESP and the duct work connected on the upstream and downstream sides of the ESP, the Bidder shall conduct comprehensive model testing by developing physical model by fabricating a three dimensional physical model of the Electrostatic Precipitator and it's ducting with a scale not less than 1:10.

(b) Computer model based on Computational Fluid Dynamics (CFD) techniques, using "Star CD", or equivalent (User friendly) CFD modeling code .

The Bidder shall develop three dimensional CFD model for the ESP along with its upstream and downstream side duct-work (from air preheater outlet to ESP and from ESP outlet to ID fan (s) inlet and from ID fan(s) outlet to chimney inlet transition duct outlet) using the above CFD Modelling code / software. Owner's Engineers shall be fully associated at all stages of development of the above CFD model.

Configured model for "HPGCL" "1X800 MW EXPANSION UNIT at DEEBANDHU CHHOTU RAM THERMAL POWER PLANT, Yamuna nagar ESP and duct work along with the results recommendation of the Computer modeling shall be supplied to the Owner on completion of the model testing.

1.01.08 Opacity monitors complete with all accessories at the outlet of each pass (gas stream) of ESP but upstream of the ID Fan i.e. six (6) no's per ESP serving one steam generator.

1.01.09 Inspection and maintenance access doors, frames and safety locks.

1.01.10 Safety devices, safety barriers, etc.

1.01.11 Monorails with electrically operated hoists including monorail beams on the roof for handling transformer rectifiers.

1.01.12 Water washing system for the ESP and its hoppers along with all piping, valves and nozzles etc.

1.01.13 Thermal Insulation, Lagging, Cladding & Refractories

Thermal Insulation along with aluminum cladding, lagging, reinforcement wiremesh, cleats and supports, shall be provided for all the equipments surfaces having skin temperature more than 60 degree Celsius. The insulation thickness shall be designed as specified in the specification. For details of thermal insulation refer Volume III, Chapter 26.

1.01.14 Dressing of foundations, grouting of pockets and underpinning of base plates for structures equipment etc., civil works associated with directly buried cables.

1.01.15 Corrosion protection painting for structures as described in the specification.

1.01.16 Rain water drainage arrangement from Roof/penthouse of ESP.

1.01.17 Sheeting work for roof (pent house)/ canopy/ side cladding of ESP.

1.01.18 For assessment and design of ESP hopper for ash flowability, the Bidder shall conduct a comprehensive 'Ash Flowability Study' of ESP hopper.

CONTENTS

SECTION – 3.1

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 shall be drawn from air preheater outlets of the balanced draft, pulverized coal fired Steam Generator and guided through adequately sized duct work into the specified number of independent gas streams of ESP. Similarly, the flue gas after the Electrostatic Precipitators shall be led to the suction of the induced draft fans. The flue gas temperature may approach the economizer outlet temperature of about 300^0C in case the regenerative air preheaters fail to operate. The Bidder shall take this aspect into account while designing the precipitator.

1.02.00 SERVICE CONDITIONS

The Steam Generator are designed to burn pulverized coal having properties as indicated in technical specifications. Also LDO shall be used during startup and at low loads for warm up and flame stabilization. Further, the frequency and duration for startup and low loads operation may be quite long during the first year of unit commissioning and operation. The Bidder, shall take into account the entire characteristics of expected combination of fuels (if applicable) to be fired and shall clearly bring out in his proposal the recommendations on preventive measures or equipment to be provided by him to minimize 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 as specified. Representative coal and ash analysis for the expected coal and oil are given in Technical Specification. The precipitator parameters that are required to be satisfied are given in ESP sizing criteria, 11.00.00 of this section. The values indicated for ESP sizing shall be considered as minimum design criteria. These shall be modified to more conservative values if Bidder experience warrants the same. However, no credit shall be given to the Bidder for this during evaluation of the bids. Utilization of these values in no way relieves the Bidder of his responsibility to meet all the guarantee requirements. The Bidder shall also furnish along with his offer the detailed calculations and data along with his Bid to establish as to how he meets the efficiency requirements both at design point and guarantee point as specified in ESP sizing criteria.

1.03.02 The Electrostatic Precipitator shall be arranged in atleast six (6) independently operating gas streams viz. precipitator shall have six (6) independent casings per steam generator.

1.03.03 The Bidder shall also furnish along with his offer the detailed calculations for ESP efficiency, ESP power consumption and T-R set rating etc.

1.04.00 Justification of Proposed Design

1.04.01 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.

1.04.02 The Bidder shall submit with the Offer, comprehensive information on how the specific collection area, effective migration velocity or total migration velocity of the proposed design has been arrived at. The Bidder shall also submit along with the offer, a detailed write up on the proposed design features with recent design modifications, if any, and their specific advantages over the previous designs.

1.05.00 **Location & Layout Requirements**

1.05.01 The design of ESP shall permit the installation of the Ash Handling System. Ash extraction system will be installed at the bottom of the ESP hoppers. These equipment will take support from the ESP hoppers. Bidder to consider the above loads in the design of ESP. Exact loading details due to the above and details of ash handling equipment shall be finalized during detailed engineering stage.

1.05.02 Following minimum additional loads shall be considered in the design of ESP structure:

a) Cantilever loads of not less than 2000 kg/m at a distance of 1200 mm from the external face of columns on both sides of the ESP for owner's cable/ pipe trays and walkways.

b) Ash handling system piping loads.

1.05.03 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.

2.00.00 **MODEL STUDY**

2.01.01 The Bidder shall perform model study (Physical scale modeling) 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-entertainment from within the precipitator.

(a) The Bidder shall conduct physical model testing of ESP by fabricating a transparent scaled model of ESP. The model testing shall be in accordance with IGCl publication no. EP-7 (latest). 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 Bidder 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 Bidder shall submit the detailed procedure for carrying out model study for the approval of the Owner.

(b) The model study shall include the design of all connecting duct work from the air preheater gas outlets to the induced draft fans inlets, induced draft fan outlet to chimney flue inlet including the inlet duct transition piece, including all dampers, turning vanes and distribution devices. Based on the model test studies, the Bidder shall finalize the design of the ductwork, guide vanes, sampling points etc. The model

study shall be carried out in the presence of the Owner. 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 Owner'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 bidder shall be required to maintain the precipitator model until the Electrostatic Precipitators have successfully met all the performance guarantees.

2.01.02 In addition to the above physical model testing, the Bidder shall also conduct computer model based study using CFD modeling techniques. The CFD modeling shall configure ESP's and complete duct work as indicated above and shall recommend finalization of duct work design , guide vanes, flow splitters etc. so as to achieve minimum objectives as spelt out above. The computer model shall incorporate details of the gas distribution screen, the collecting plates and hopper baffles for accurate visualization of flow patterns & hopper re-entrainment.

In this process the modeling shall

(a) Investigate the flow characteristics and estimate accuracy.

(b) Improve accuracy based on observation on modification to achieve the desired flow pattern

The results of CFD modeling shall be validated by physical model testing and by the actual testing/measurements at site.

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 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 1.0 M 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. Clear head room of atleast 2.2 meters shall be maintained over platforms and walkways.

Five (5) no's of staircases (one each between the 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.

There shall be atleast one interconnection at the roof of ESP stream with the adjacent stream.

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 or 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 for 800 MW unit.

3.05.00 Each compartment of individual stream of ESP shall be provided with isolation dampers at inlet and outlet for carrying out maintenance work while the remaining streams of ESP are in service by completely isolating it electrically and grounding it. Suitable safety interlocks etc. shall be provided.

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 utilization of collection areas at the inlet and outlet. It shall be designed to minimize 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 Bidder 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 ESP Sizing Criteria, 11.00.00 of this section. The profile of the collecting plate shall be such as to minimize the 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 Bidder or his principals for the design offered, over a minimum period of two years of commercial operation in at least one plant, where the ESP are operating for a coal fired boiler in conjunction with oil firing. In support of the above, the Bidder shall furnish sufficient data, to the Owner's satisfaction, with reference to the operating experience as stipulated elsewhere.

6.00.00 **DISCHARGE ELECTRODES**

The high tension discharge electrodes shall be spiral type design. The discharge electrodes 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 Section. The rapping mechanism shall be tumbling hammer type. This shall be adjustable in frequency and duration 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 stop page 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 along with 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 Bidder'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.

8.00.00 **DUST HOPPERS**

8.01.00 Dust hoppers shall be of pyramidal type. 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 maximum ash collection rate of the field under which the hopper is being provided when two preceding fields are de-energized. The hopper capacity shall be based on the inlet dust burden, gas flow rate and gas temperature indicated in ESP sizing criteria (11.00.00 of this section) 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 750 kg/m3 (maximum) for calculating storage capacity and 1600 kg/m3 (minimum) for structural design. Further for hopper strength and ESP structural calculations the level of ash in ESP shall be considered at least upto 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 upto 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.

8.02.00 Hoppers shall be in welded steel plate construction with 5 mm minimum plate thickness. The lower 1.5 meters of each hopper 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 (60) degrees. A curve segment made of 6 mm thick SS-304 shall be used for pyramidal type or other type (except conical type) which will be welded in acute angle formed by the side walls, so that the collected ash encounter a smooth radius in lieu of sharp angle. Hopper outlet flanges shall be terminated at a height of 3.5 meters above the ground level to facilitate installation of fly ash removal system.

8.03.00 The dust hoppers shall be electrically heated upto a minimum of lower one third (1/3) of the dust hopper height but not less than 1.5 meter in height by thermostatically controlled panel type heating elements to prevent ash bridge formation. All heaters on each level shall have same wattage and be capable of maintaining internal hoppers temperature in excess of 140°C and capacity selection of these heaters shall be as per Owner's approval. This temperature must be maintained even when there is no flow of flue gases through the precipitator. Maximum excursion of flue gas temperature upto 300°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 per hopper where two nos. of hopper per TR set are provided and not less than 15 KW per hopper where one hopper per TR set is provided. The hopper heaters shall be complete with local junction box having, indicating lamps and test lamps. 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 burnout 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 Ni-chrome 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. 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 shall also be provided with suitably

designed and located rapping anvils for loosening the fly ash by striking with sledge hammer.

8.05.00 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.

8.06.00 Provision shall be made on the two sides each hopper for future installation of aeration block (if applicable).

8.07.00 Each dust hopper shall be provided with a high level and a low level dust level monitor operating on proven Radio frequency 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 signaling 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-energize 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.

8.08.00 Each hopper shall be provided with a quick opening access door of not less than 600 mm dia. (if round) and of 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.

8.08.00 The hopper outlet shall not be less than 350 mm x 350 mm. The hopper outlet flanges shall be terminated at a height of 3.5 m above ground level. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

9.00.00 **CASING**

9.01.00 Each of the ESP streams shall be housed in its own separate and independent casing.

9.02.00 The precipitator elements shall be enclosed in gas tight, weather proof, 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, 6 mm minimum thickness, carbon steel plates conforming to ASTM A36 / IS: 2062. 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 diameter 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 at such locations as may be required to limit precipitator, duct work or expansion joint forces or movement. 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 306 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 **PENT HOUSE COVERING**

ESP's shall be provided with weather proof pent house. The pent house shall be covered continuously with sheet. Further, in case TR set are kept above pent house then complete whether proof roof on the pent house shall also be provided which should cover entire ESP including stairs. The TR sets/ electrical equipments placed on ESP roof shall be adequately covered for weather protection with corrugated GI/Metapoly sheets.

11.00.00 **ESP SIZING CRITERIA:**

The Electrostatic Precipitator shall be designed to comply with the requirements stipulated under 'Guarantee point and design point' in the table below:

S.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
1.	Boiler Load		800 MW TMCR	800 MW TMCR	800 MW TMCR	BMCR	BMCR	BMCR
2.	Type of fuel		Design Coal	Best Coal	Worst Coal	Design Coal	Best Coal	Worst Coal
3.	Ambient air condition		27 degree Celsius Temperature and 60%RH.	Shall be sized for range of Ambient Temp. (as specified in the specification)	Shall be sized for range of Ambient Temp. (as specified in the specification)	Shall be sized for range of Ambient Temp. (as specified in the specification)	Shall be sized for range of Ambient Temp. (as specified in the specification)	Shall be sized for range of Ambient Temp. (as specified in the specification)
4.	Gas flow per ESP at the ESP inlet when firing respective fuel.	m^3/sec	To be worked out by the bidder when firing specified design coal at 100 % TMCR load considering 25 % excess air at economiser outlet, 15 % air heater in leakage and 2 % duct leakage as a minimum.	To be worked out by the bidder when firing specified best coal at 100 % TMCR load considering 25 % excess air at economiser outlet, 15 % air heater in leakage and 2 % duct leakage as a minimum.	To be worked out by the bidder when firing specified worst coal at 100 % TMCR load considering 25 % excess air at economiser outlet, 15 % air heater in leakage and 2 % duct leakage as a minimum.	To be worked out by the bidder when firing specified design coal at 100 % BMCR load considering 25 % excess air at economiser outlet, 15 % air heater in	To be worked out by the bidder when firing specified best coal at 100 % BMCR load considering 25 % excess air at economiser outlet, 15 % air heater in leakage and 2	To be worked out by the bidder when firing specified worst coal with maximum ash at 100 % BMCR load considering 25 % excess air at economiser outlet, 15 %

S.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
						leakage and 2 % duct leakage as a minimum.	% duct leakage as a minimum.	air heater in leakage and 2 % duct leakage as a minimum.
5.	Gas temperature at ESP inlet #	°C	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
5.1	Gas temperature at ESP exit considering air ingress in ESP	°C	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
5.2	ESP dust collection efficiency	%	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
5.3	Moisture in flue gas at ESP inlet % by weight	%	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
6.	Inlet Dust Burden (Considering maximum Fly Ash)	gms/ Nm^3	85 % of ash or actual predicted whichever is higher being carried forward to ESP while firing specified design coal.	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	90 % of ash or actual predicted whichever is higher being carried forward to ESP while firing specified

S.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
								worst (maximum ash) coal.
6.1	ESP Dust Collection loading at outlet, when all fields of each pass are in service	mg/N m^3	<17 mg/Nm^3 or as per MOEF requirement whichever is more stringent	Bidder to specify				
6.2	ESP Dust Collection loading at outlet, when first field of each pass out of service. (mechanical collection efficiency of first field not exceeding 20% or actual, whichever is lower)	mg/N m^3	Bidder to specify.					<30 mg/Nm^3 or as per MOEF requirement whichever is more stringent
6.3	Minimum specific collection area	m^2/m 3/ sec	260	260	260	260	260	260

S.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
7.	Maximum flue gas velocity through the ESP	m/sec	<1	<1	<1	<1	<1	<1
8.	Treatment time of the flue gases	Sec.	Minimum Twenty (20)	Minimum Twenty (20)	Minimum Twenty (20)	Minimum Twenty (20)	Minimum Twenty (20)	Minimum Twenty (20)
9.	(b) Other Design Parameters	(c)	(d)	(e)	(f)	(g)	(h)	(i)
a)	Minimum Aspect Ratio		2	2	2	2	2	2
b)	Design internal pressure at 67% yield strength	mmwc	±660	± 660	± 660	±660	± 660	± 660
c)	Precipitator mechanical design temperature	deg.C	200	200	200	200	200	200
d)	Short temp excursion temperature (for approx. thirty (30) minutes at a time)	deg. C	300	300	300	300	300	300

S.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
e)	Ambient Condition for ESP Design	deg. C	50	50	50	50	50	50
f)	Minimum no. of T/R sets per stream per series electrical field	Nos.	One (1)	One (1)	One (1)	One (1)	One (1)	One (1)
g)	Maximum collection area served by one T/R set	m^2	4000	Vender to specify	Vender to specify	Vender to specify	Vender to specify	Vender to specify
h)	Minimum no. of bus sections per T/R set		One (1)	One (1)	One (1)	One (1)	One (1)	One (1)
i)	Minimum dust hopper storage capacity each (upto the maximum trip level based on design point conditions (while firing range of coal (with	hours	Eight (8)	Eight (8)	Eight (8)	Eight (8)	Eight (8)	Eight (8)

S.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
	maximum ash)							
j)	Minimum hopper valley angle to the horizontal	degrees	Sixty (60)	Sixty (60)	Sixty (60)	Sixty (60)	Sixty (60)	Sixty (60)
k)	Spacing between the collecting electrodes (Centre line to centre line) transverse to the gas flow *	Mm	300	300	300	300	300	300
l)	Minimum installed corona power per unit effective collection area **	Watts/m^2	17	17	17	17	17	17
m)	Maximum nos. of ash hoppers	Nos.	Two (2) for one TR set.	Two (2) for one TR set.	Two (2) for one TR set.	Two (2) for one TR set.	Two (2) for one TR set.	Two (2) for one TR set.

Note:

i) * A spacing of 400 mm for the last two series fields is also acceptable in which case the collection area of these field shall be such that the total effective specific collection are (SCA) of the ESP is not less than the specified SCA for which the effective collection area will be worked out based on the following formula. (Corresponding to 400mm, SCA shall be 195 $m^2/m^3/$ sec)

Total effective specific collection area = (Collection area of fields with 300 mm collection area spacing + collection area of field with 400 mm spacing x 400/300) divided by gas flow.

ii) ** The corona power shall be defined as the product of, average bus voltage and mean current divided by the collection area served by one T/R set.

iii) Nm^3: calculated at NTP.

iv) Discharge side of ESP shall be suitable for either two (2) ID Fans or any one of the two.

v) ESP shall be suitable for Tri-sector / Bisector type Air preheater.

vi) ESP auxiliary power consumption shall be included in Liquidated Damages (L.D) for total auxiliary power consumption.

vii) Air tightness test for ESP shall be conducted before first light up.

viii) PG test instrument tapping requirements shall be provided at inlet and outlet

CONTENTS

SECTION – 4

1.0.0 PRE-COMMISSIONING ACTIVITIES, COMMISSIONING OF FACILITIES AND INITIAL OPERATIONS

2.0.0 General

2.1.0 The pre-commissioning and commissioning activities including Guarantee tests, checks and initial operations of the equipment furnished and installed by the Bidder shall be the responsibility of the Bidder as detailed in relevant clauses in Technical Specification. The Bidder shall provide, in addition, test instruments, calibrating devices, etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Bidder's workmen required for the above test shall always be present at Site during such operations.

2.2.0 It shall be the responsibility of the Bidder to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment systems which are installed by him. The Bidder shall also be responsible for flushing & initial filling of all oils & lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Bidder shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications & documents.

2.3.0 The Bidder upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the facilities ready for sustained safe, reliable and efficient operation. All pre-commissioning/commissioning activities considered essential for such readiness of the facilities including those mutually agreed and included in the Bidders quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Bidder.

3.0.0 Testing / Commissioning Schedule

The Bidder shall submit to the Owner, his testing/ commissioning schedules for various equipments/ systems covered under the contract, for approval, at least 18 months before the actual commissioning of the equipment/ systems.

The list of documents and commissioning checks to be submitted and their content details shall be agreed upon during preaward discussions.

The list of commissioning documents viz. standard checklists; testing / commissioning schedules and the details regarding contents of testing/ commissioning schedule shall be submitted by the bidder for owner's approval during detailed engineering.

4.0.0 Pre-commissioning Activities

4.1.0 General

The pre-commissioning activities including some of the important checks & tests for certain major equipment/ systems (as a minimum) are described

below, although it is the Bidder's responsibility to draw up a detailed sequential & systematic list of checks / tests and various activities / procedures connected with pre-commissioning of the complete facilities with all systems, sub-systems and equipment supplied and installed by him and get the same approved by the Owner.

4.1.1 Steam Generator

4.1.1.1 Hydraulic Testing of Pressure Parts

On completion of installation of each Steam Generator pressure parts, and the high pressure external piping a hydraulic test in accordance with the requirements of the Indian Boiler Regulations, shall be performed by the Bidder. The procedure adopted for hydraulic test and preservation shall have the prior approval of the Owner.

The water for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the Steam Generator and high pressure external piping shall be suitably drained and preserved.

All the valves, high pressure piping and interconnected pipes connecting the pressure parts, shall be subjected to hydraulic test along with the pressure parts. All blank flanges or any removable plugs required for openings not closed by the valves and pipings shall be furnished by the Bidder. The pressurisation equipments including water piping from the supply, and any chemicals for preservation, needed for the above test shall also be furnished by the Bidder. Any defect noticed during the testing shall be rectified and the unit shall be retested by the Bidder.

The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting authority as per the provision of the IBR and the Project Manager.

4.1.1.2 Air & Gas Tightness Test

After completion of installation of furnace tubes and/or inner skin casing wherever applicable ducts and airheaters, and before commencement of application of thermal insulation a test shall be performed on the Steam Generator & ESP by the bidder to prove or to establish the tightness of the erected equipments from the outlet of FD fan through Steam Generator to the stack. Such test shall be done, as far as possible, with all mountings like soot blowers etc. installed in position. The procedure adopted for such tests shall have the prior approval of the Owner. Normally the test shall be conducted by the Bidder using fog/smoke generator. Any defects noticed during such air and gas tightness test shall be corrected and the unit retested.

All equipments including any temporary blanking, if required, for the above test shall be provided by the Bidder.

4.1.1.3 **Chemical Cleaning of Pressure Parts**

The Bidder shall perform thorough and efficient cleaning operations of all the internal parts of the boiler, like economiser, water wall / evaporator, separator, feedwater line, piping, start-up recirculation lines and associated piping and all other pressure parts and associated high pressure piping covered under these specifications (except those portions which are to be steam blown).

The cleaning operation shall consist of De-mineralised (DM) water flushing, the chemical cleaning using acids like hydrofluoric acid or as recommended by the manufacturer, DM water rinsing, DM water flushing, nitrogen capping etc. Complete chemical cleaning procedure, the scheme and layout including parameters of the pumps, size of tanks, materials of construction, the rate of consumption and total requirements of steam and water for such cleaning process shall meet the approval of the Owner.

The Bidder shall furnish all labour, materials such as the required chemicals and other consumables, all equipment such as acid transfer and acid circulating pumps complete with drive motors, acid storage and acid mixing tanks, all temporary piping, valves and specialities and local instruments for pressure, temperature and flow measurements and any other items needed to carry out the process. All equipment required for chemical cleaning of Steam Generator shall be supplied by the bidder.

The Bidder shall take care to dispose off the used chemicals and the effluents from the cleaning operations, after neutralisation, meeting all the statutory regulations and in a manner acceptable to the Project Manager and which would comply with the norms of the State Pollution Control Board. This include construction of suitable neutralization pit, channels, disposal equipments etc.

The Bidder shall specifically make all necessary arrangements for prevention of any fire accidents, explosions etc. during the performance of the chemical cleaning operations.

The Bidder shall ensure that during the cleaning process the procedure adopted shall be such as to consume minimum demineralized water.

The cleaning procedure shall include final flushing and draining of the boiler under a nitrogen gas cap and/or filling the boiler with inhibited water or any other proven procedure recommended by the manufacturer for the preservation of the boiler which is acceptable to the Owner. The Bidder shall furnish a detailed procedure for boiler preservation during detailed engineering for Owner's approval. All equipment needed for such preservation including the nitrogen cylinders, interconnecting piping and any regulating equipment for N2 cap and other preservatives shall be provided by the Bidder for the each Steam Generator and the same shall also become the property of the Owner after completion of the chemical cleaning.

The Bidder shall provide adequate safety and protective equipment for all his employees and ensure that they are worn at all times of danger. Specialised treatment equipment (such as required for first aid when using hydrofluoric

acid) for once through steam generators must be provided at the place of handling acid. An acid cleaning report and log of each cleaning must be provided by the Bidder to the Owner, immediately after the cleaning operation.

4.1.1.4 **Steam Blowing**

Steam blowing of complete Superheaters, Reheaters and various external pipelines shall be carried out by the Bidder as per requirements/scope of work. In addition if any other piping, not specifically mentioned in the scope of the Bidder and is also required to be steam blown, the Bidder shall extend all cooperation for steam blowing of these additional piping during steam blowing operation.

The Bidder shall give recommended procedures, method of blowing and scheme for steam blowing indicating clearly additional system, if any, to be cleaned by steam blowing and furnish data/ write-up/ layouts/ drawings to that effect to the Owner's approval.

The Bidder shall furnish his recommendations regarding use of various test equipments and instruments and termination/acceptance criteria for steam blowing, which in any case shall meet the steam turbine-generator requirements.

The systems which should be ready and operational before steam blowing and are in the scope of the Bidder shall be made ready/operational by the Bidder by the scheduled date for starting of steam blowing.

For equipments/components installed on high pressure external piping, such as various thermowells, flow meter, control valves, HP/LP Bypass valves etc., the Bidder shall comply with guidelines to be followed during steam blowing, with respect to removal / blanking / replacement of such items their internals etc. by spool pieces as given by the respective manufacturer/sub-bidder.

Supply of all such spools (as above) and/or blanks, temporary piping and supports etc. as required, cutting / welding / edge preparation and rewelding required for blanking, temporary piping connection and/or for replacements by spool pieces shall be the responsibility of the Bidder. After steam blowing removal of spool pieces & temporary piping and reinstallation of various components, shall also be the responsibility of the Bidder.

It will be the responsibility of the Bidder to operate the each Steam Generator and its accessories equipment to generate adequate steam at the parameter and quality in line with the requirements of steam blowing procedure. The Bidder shall make adequate provisions for temporary enhancement of fuel oil firing capacity of the steam generators by changing oil gun tips etc. as may be required so as to be able to conduct complete steam blowing operation by oil firing alone. All necessary precautions to avoid fires and cold end corrosion of Air preheater, during such oil firing at enhanced SG loads, shall be taken by the Bidder.

The Bidder shall ensure successful and timely completion of steam blowing of all systems and will render all help/services as required including:

(i) Services of test/operating personnel/supervisors.

(ii) Extending all cooperation during erection, pre-commissioning of plant and equipment to be made ready and operational before starting steam blowing.

(iii) Extending all cooperation for interface engineering of equipments/components of temporary system required for steam blowing operation.

(iv) Bidder's engineers shall be available for all coordination meetings arranged by the Owner for finalising the details of temporary system for steam blowing.

For the steam blowing operation, steam conditions like pressure, temperature etc. at the Steam Generator outlet shall be so selected that a minimum cleaning ratio/ disturbance factor of 1.6 is achieved. A cycle of heating, cooling and blowing/ purging, is to be repeated to ensure thorough cleaning of the interior of the pipes/ tubes etc. The final indication of cleanliness shall be demonstrated by purging through target plates positioned at the discharge point.

4.1.1.5 **Balancing of Coal/Primary air flow**

Bidder shall balance the primary air as well as coal flows in the pulverised fuel pipes such that the minimum PF and PA flow imbalance in the PF pipes from each coal pulveriser does not exceed 5% of average flows.

The above balancing shall be checked by the Bidder by carrying out both clean air test and dirty air test (using dirty pitot tubes).

4.1.1.6 Any other pre-commissioning activity such as floating of safety valves etc. as considered essential for readiness of facilities for commencement of commissioning activities shall also be undertaken by the Bidder.

4.2.0 **Gas Distribution Test of ESPs**

4.3.0 **Balance of Plant equipment & systems**

All pre-commissioning tests & activities as indicated in the technical specification shall be performed by the Bidder.

5.0.0 **Commissioning of Facilities**

5.1.0 **General**

Upon completion of pre-commissioning activities/test the Bidder shall initiate commissioning of facilities. During commissioning the Bidder shall carryout system checking and reliability trials on various parts of the facilities.

Bidder shall carry out these checks/tests at site to prove to the Owner that each equipment of the supply complies with requirements stipulated and is

installed in accordance with requirements specified. Before the plant is put into initial operation the Bidder shall be required to conduct test to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.

5.1.2 The Commissioning tests/checks shall specifically include but will not be limited to following:

(a) Checks on the operation of all controls of isolating gas and air dampers.

(b) Checks on operation of all fans to ascertain level of noise and vibration.

(c) Test running of all pumps.

(d) Checks on operation of all air heaters and adjustment of seals, if necessary when each heater is upto its working temperature.

(e) Checks on operation of all soot blowers and retraction gear and the sequences control.

(f) Check run on the Pulverised Fuel (P.F.) Mills including clean air flow test.

(g) Standard commissioning tests and procedures as per Bidder's practice for Steam Generator, Electrostatic Precipitator and other equipment / auxiliaries within the Bidder's scope of work.

(h) Checks on operation of all individual control loops in the Steam Generator control loops in the Steam Generator control system.

(i) Checks on inter-relation between each control loop in the Steam Generator control system. Checks on inter-relation between each control loop in the turbine generator control system.

(j) Checks on correct functioning of the Burner Management System (BMS).

(k) Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.

(l) Tests on Control & Instrumentation (C&I) Equipments:

The Bidder shall finalise the protocol of check lists, after erection of the system and equipment, as per International Codes/Standard with the Owner.

The Bidder shall furnish requisite no. of copies of procedures and list of start up, pre-commissioning, commissioning and initial operation tests for Owner's approval.

The Bidder shall also demonstrate the performance of all C&I equipment, the tests on main equipment or prior to that as the case may be.

Other tests shall be conducted, if required by the Owner, to establish that the plant equipments are in accordance with requirements of the specifications.

6.0.0 **Initial Operation**

Upon completion of system checking/tests and as a part of commissioning of facilities, complete plant/facilities shall be put on initial operation.

7.0.0 **Cold Air Velocity Test (CAVT)**

The Bidder shall conduct a cold air velocity test.

8.0.0 **Thermal Performance Test (TPT)**

During commissioning, the Bidder shall conduct a comprehensive TPT to demonstrate the Furnace Exit Gas Temperature (FEGT) and various flue gas Multi-shield High Velocity Temperature (MHVT).

8.1.0 The Bidder shall conduct the comprehensive guarantee tests on the Steam Generator in co-ordination with the Steam Generator to establish the functional guarantee values at stipulated conditions as indicated in guarantee chapter.

8.2.0 The Bidder shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all Electrical & C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied & installed by the Bidder and follow the guidelines indicated above or elsewhere in these technical specifications.

9.0.0 **Commissioning Spares**

It will be the responsibility of the Bidder to provide all commissioning spares including consumable spares required for initial operation till the Completion of the project and successfully handed over to the Owner facilities. The Bidder shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Owner and mutually agreed to. However. such review and agreement will not absolve the Bidder of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Owner.

These spare will be received and stored by the Bidder atleast 3 months prior to the schedule date of commencement of initial operation of the respective equipment and utilised as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Bidder and he will be allowed to take these parts back at his own cost with the permission of Owner.

CHAPTER – 2

TURBINE GENERATOR & AUXILIARIES

CONTENTS

SECTION - 1

SCOPE OF WORK

1.0 GENERAL

The scope of work for the equipment and accessories to be furnished in accordance with this specification shall include design, manufacture, engineering, inspection and testing at Contractor's work(s), packing, forwarding to site, unloading, erection, supervision, pre-commissioning, testing, commissioning and performance testing of the equipment/systems indicated hereunder. Items though not specifically mentioned in the specification but required to complete the equipment and systems to meet the intent of specification, shall also be deemed to be included unless otherwise specifically mentioned under exclusions.

2.0 STEAM TURBINE & AUXILIARY SYSTEMS

The scope includes all equipment required for Steam Turbine Generator unit along with auxiliaries of the type specified to be installed at DCRTPP, Yamunanagar, Haryana, India.

The unit will include but not be limited to the following:

2.1. Steam Turbine

1. The steam turbine shall be of tandem compound construction, single reheat, regenerative, condensing with minimum eight (8) numbers of extractions with extraction for the top HP heater from the HP turbine for regenerative feed heating. HP turbine shall be of double casing design. Separate HP, separate IP and separate LP casing(s) OR combined HP-IP and separate LP casing(s) shall be provided. HP inner cylinder, IP cylinder and LP cylinder(s) shall be horizontally split as per standard practice of Turbine manufacturer.

2. Steam turbine shall be complete with casings, rotors, bearings, temperature detectors, couplings, steam gland seals, rotor turning gear preferably hydraulic type and having remote operation facility, hand barring gear, emergency stop and control valves and reheat stop and control valves with their servomotors, removable type steam strainers for start up and normal operation upstream of emergency stop and reheat stop valves, cross-over/cross around piping and electric motors for all its integral subsystems. Steam strainers integral with main steam emergency stop and reheat stop valves are also acceptable as per standard practice of Turbine manufacturer.

3. Bidder shall provide Pneumatic power operated / assisted quick closing type & ordinary NRVs for each steam extraction line (except for extrations from LP Turbine) including steam extraction line to BFP drive turbine. For each CRH line and extractions from LP Turbine (except for heaters in condenser neck) minimum one hydraulic/pneumatic power operated / assisted QCNRV shall be provided. However, if bidder wishes to provide hydraulic power actuator, then fire resistant fluid (FRF) should be used. The type of actuation i.e. hydraulic / pneumatic shall be as per then standared proven practice of the manufacturer.

4. Turbo generator set shall be suitable for installation on foundation as specified elsewhere in the specification.

2.2. Steam Turbine Auxiliary Systems

1. Turbine gland sealing steam system shall be provided with gland steam condenser, gland steam exhausters, all associated motors, associated piping, valves and fittings, specialties, hangers and supports, necessary insulation and complete with all instrumentation and control hardware including electro hydraulic/ electro pneumatic controller, actuator, electro hydraulic / electro pneumatic converter etc. so as to make the system complete in all respects.

2. Cross over/cross around piping between IP and LP casing(s) including necessary hangers and supports for piping and secondary structural steel shall be provided, if required.

3. Lubricating Oil System (common for Turbine Generator Set) shall be complete with oil tanks, oil purifying system, oil pumps and jacking oil pumps with drive motors, oil coolers, strainers, vapour extractors with drive motors, all interconnecting piping, valves and fittings, hangers and supports, necessary instrumentation and control hardware to make the system complete in all respects. Centralized oil storage and purification system shall be provided including clean oil tank, dirty oil tank, transfer pumps, purifying unit with interconnecting piping, necessary instrumentation and control hardware to make the system complete in all respects.

   Turbine lube oil system must have duplex filter with manual isolation valve.
   - 3 way temp DCS operated control valve should be provided for lube oil temperature control.
   - Turbine Lube oil purification System for MOT must have series of filters for maintain the NAS Value as defined by Turbine OEM along with Online NAS counter hooked to DCS with De-hydration System.

4. Steam turbine control fluid and its purification system along with its conditioning system shall be complete with control fluid tank, control fluid pumps with drive motors, strainers, accumulator, control fluid coolers, waste fluid tank, purification equipment including fluid circulation pumps with drive motors, associated piping, valves, fittings and specialties, hangers and supports, Instrumentation and control hardware to make the system complete in all respects for the 800 MW unit.

   Turbine Governing Control Fluid must be FRF. Turbine Governing oil purification System for Control Fluid Tank must have series of filters… NAS control filters, TAN Control filters with De-hydration System

5. Steam turbine governing and protection system shall be complete with electro hydraulic governor with suitable backup as per standard practice of manufacturer, electro hydraulic converter, hydraulic converter, tracking devices, hydraulic speed governor, electrical speed sensors, speed/load adjusting gear, motor drives, remote trip solenoids, overspeed, low condenser vacuum, low lube oil pressure, high axial shift and other trip/protection devices, electrical components associated with electro hydraulic system, test devices and test panel inserts etc. and hydraulic components like accumulator, strainers etc. alongwith associated piping, valves, fittings and specialties, hangers and supports.

6. Steam turbine exhaust hood spray cooling system shall be complete with spray arrangements, associated piping, instrumentation and control devices, valves and fittings, motor/solenoid operated valves and specialties, hangers, supports and insulation etc.

7. Steam turbine, associated piping & equipment drain & vent system shall be complete with turbine flash tanks, piping, valves and fittings, valve motor drives, specialties, hangers and supports, insulation, instrumentation and control etc. The drains are under the scope of the Bidder and the vents shall be led to atmosphere upto a safe height outside the main plant building.

   Turbine & Aux drain valves should be ball type valves with Zero passing & Zero bubble leakage as per rated class.

8. Potable type Turbine preservation system consisting of adequate numbers of air driers including fans, motors, filters, heater drying wheel, connecting pipings, valves, fittings etc. for preservation against corrosion of turbine during idle periods shall be provided.

9. Boroscopic inspection ports in turbine for in situ inspection of turbine internals shall be provided as per bidder's standard practice with one set of applicable tools.

10. HP/LP Bypass system shall be complete with steam and spray valves, spray control station, throttling devices, fittings, desuperheaters, hydraulic power pack, solenoid valves, quick acting devices, blanking devices for steam blowing, supports, associated piping including warm up arrangements, valves, instrumentation and control hardware, electrical devices and actuators/motors etc.

11. Clarified water cooled, divided water box, horizontal surface condensers shall be complete with all accessories such as hotwells, valves, drains, vents, strainers, associated CW piping to and from the condenser within terminal point, suitable handling arrangement(s) for water box & steam throw off devices for HP-LP bypass system, extraction steam piping routed through the condenser to low pressure feed water heaters and heater(s) within the condenser neck, shall be provided.

    Condenser Tube must be seamless Stainless Steel Tube (ASTM A-213-TP304). Condenser Water Box -- all well coated resins /ceramic coating to avoid erosion & corrosion.

12. Flash tanks / vessels for accepting all turbine and cycle recoverable drains including those from main steam, cold reheat, hot reheat lines, HP-LP bypass lines, heater drains, complete with all associated spray system, piping, valves and fittings, specialties, hangers and supports and insulation, instrumentation and controls etc. shall be provided. Manifolds on condenser shall not be acceptable. In addition one atmospheric flash tank will also be provided to accept the drains from feed water heater safety valves. Startup drain shall be led to atmospheric flash tank.

13. Condenser air evacuation system shall be complete with 2x100% vacuum pumps for each condenser, associated motors, all accessories, associated piping, valves & fittings, specialties, instrumentation and control etc.

14. The ingress of seepage steam into the turbine during standstill of the turbine and operation of the boiler shall be prevented. The turbine injection shall be provided with a control valve and a power operated NRV. In Addition to these valves in the injection lines, stop valves shall be provided in order to make possible repair and maintenance work on turbines during shut-down. For drainage system of turbine and its auxiliaires, requirements of ASME-TDP-I (latest) shall be duly met by the bidder.

15. The Pressure relief diaphragms shall be designed for the maximum possible steam flow.

2.3. Make up System

Normal cycle make-up to condenser hot well consisting of piping, valves, flow elements with flow transmitter and indicators, hot well makeup control station (normal and emergency) including control valves, drain, vents, etc. are in bidder scope within terminal point. Likewise, condensate spill pipe line consisting of piping, valves, control station etc. are in the bidder's scope. De-aerator and Hotwell make-up pipe shall be of SS304.

3.0. FEED WATER HEATING PLANT

Complete regenerative feed heating system including full capacity drain cooler, minimum four (4) low pressure heaters, one (1) deaerator and feed storage tank, minimum three (3) high pressure heaters (HP), all accessories, associated piping, valves, Nitrogen gas and filling arrangement, instrumentation and controls etc. shall be provided. However, bidder is free to optimize the number of heaters, maintaining the minimum number of heaters as specified here. One set of test kit for measuring oxygen content at deaerator outlet shall also be provided for the station. HP/LP Heaters & GSC Condensate / Feed Water Tube shall be seamless Stainless Steel (ASTM A-213-TP304).

4.0. CONDENSATE POLISHING UNIT (CPU)

For details refer Chapter 9.

5.0 CONDENSER ON LOAD TUBE CLEANING SYSTEM

Sponge rubber ball type condenser on load tube cleaning system separately for each condenser shall be provided. Each Condenser on load tube cleaning system shall be complete with one ball recirculation pump, one ball separator, one ball collecting vessel, differential pressure measuring system, ball monitoring system (comprising of ball recirculation monitor and ball oversize monitor), associated piping, valves and accessories, instrumentation and controls, all drives, power and control cables, motors and accessories etc.

6.0 Deaerator Level Control Station

Deaerator level control station for condensate water flow control, consisting of the following:

i. 2 x 100% capacity pneumatically operated condensate control valve.
ii. One motor operated gate valve on upstream and one manual operated gate valve on downstream of each condensate control valve.
iii. One motor operated inching valve in bypass line of above condensate control station.

7.0. CONDENSATE EXTRACTION PUMPS

2 x 100%/ 3x50% capacity motor driven condensate extraction pumps alongwith VFD, mechanical seal gland arrangemenmt and all accessories, drives, suction strainers, associated piping, and valves, instrumentation and control including one (1) no. canister drainage pump etc

8.0. BOILER FEED PUMPS

1. a) One, fifty percent capacity (1x50%) motor driven boiler feed pump for the unit complete with booster pump along with it's drives, mechanical seals, flexible couplings, hydraulic coupling, gear box, base plate(s), forced oil lubricating system (including oil pumps, oil tank, lube oil coolers, working oil coolers, duplex oil filters etc.), ON/OFF type low load recirculation flow control valve, mobile cradle, integral piping and valves, temporary and permanent strainers, local instrument racks / enclosures, instrumentation and control etc. shall be provided. One (1) portable centrifuge of adequate capacity shall also be provided.

   b) Two, fifty percent capacity (2x50%) steam turbine driven boiler feed pumps with required margin complete with booster pumps, step down gear boxes, flexible couplings, mechanical seals, foundation base plates, ON/OFF type low load recirculation flow control valve, mobile cradle, integral piping and valves, local gauge boards, instrumentation and control etc. shall be provided.

   c) Two (2) steam turbine drives for the turbine driven boiler feed pumps complete with ESV, control valves, non return valves for single admission drives, permanent & temporary steam strainers, hydraulic turning gear, hand barring device, atmospheric relief diaphragm and it's vent piping, all inter connecting piping, foundation base plates, integral gland seal system, complete lube oil and control oil system including oil tank, oil coolers, duplex oil filters, vapour exhausters, 100% capacity centrifuge for each steam turbine driven pump, jacking oil system (if required), Electro-hydraulic governing system, Turbine Supervisory system alongwith all control and accessories as specified in the specification shall be provided. The exhaust of these turbines will be connected to the main condenser. The design and sizing of these equipment shall be in line with the requirement for main turbine condenser. If bidder offers separate condenser for each drive turbine then separate 2 x 110% vacuum pumps. COLTCS system for condenser, 2x100% CEP for each drive turbine condenser (if required), associated piping fittings, instruments etc. shall be provided by the bidder. The design and sizing of these equipments shall be in line with the requirement of main turbine condenser.

   d) Boiler feed pump sets shall be suitable for installation on spring supported Reinforced Cement Concrete (RCC) foundation.

   e) BFP lube oil coolers & working oil coolers shall have standby also.

   f) BFP Turbine control oil shall be FRF and its oil coolers should have standby,100% capacity centrifuge, TAN Control, De Humidifier, NAS

Control filter with online NAS Monitor hooked to DCS for each steam turbine driven pump.

2. Feed regulating station (FRS) for feed water flow control during unit startup, consisting of the following:

a) 1 X 30% BMCR pneumatically operated Control valve capacity with upstream & downstream Motorized valve with motorized equalizing valve.

b) Two motor operated gate valves with motor operated integral bypass valve, one each on upstream and downstream of feed control valve.

c) Two motor operated gate valve (each 50% BMCR capacity) with motor operated integral bypass valve in parallel to the feed control valve to bypass the feed control valve in the unit operation range of 30 to 100% BMCR.

d) 2X100% BMCR capacity pneumatically operated control valves (1W+1S) with upstream& down-stream Motorized valve with motorized equalizing valve for each line.

9.0. TG INTEGRAL AND OTHER MISCELLANEOUS PIPING

The scope of work for TG integral and miscellaneous piping covered under this specification shall include but not be limited to the following systems:

a) Condenser air evacuation system

b) Condenser cooling water system within terminal points

c) Cycle make-up system within terminal points

d) Control fluid system

e) Gland steam sealing system

f) Lube Oil system

g) Central oil storage and purification system

h) Exhaust hood spray system

i) Gland sealing (of valves and pumps) system

j) Equipment cooling water system within terminal points

k) Compressed air system (Service Air and Instrument Air) within terminal points

l) Steam evacuation line (HPT exhaust) from CRH piping system.

Piping shall be complete with fittings / accessories and specialties, expansion joints, valves, insulation, hangers, supports, restraints / guides, snubbers and auxiliary steel etc. The design and engineering of the piping system shall include but not be limited to pipe sizing, hanger / snubber engineering, engineering of thermal insulation etc.

10.0. TURBINE HALL EOT CRANES

For details refer Chapter 28.

11.0. PERFORMANCE GUARANTEE TEST

Performance tests of all the equipment/systems in the contractor's test facilities and performance guarantee tests at Purchaser's site as specified elsewhere in the specification are included in the scope of this specification.

Performance guarantee/acceptance test for turbine-generator unit shall be carried out as per ASME-PTC-6 (Latest Edition).

12.0. OTHER MISCELLANEOUS ITEMS

The scope of work for the equipment covered under this specification shall include but not be limited to the following systems:

1. All weld neck counter flanges shall be supplied by bidder wherever nozzle ends on any equipment such as strainer, flow nozzles etc. are flanged.
2. All fixtures, embedded parts, steel embedments including fixing lugs and welding between them, foundation plates, nuts, bolts etc. for fixing all the equipment, piping on civil works shall be included in scope work of this package.
3. All structures which would be required by the Bidder for supporting the piping shall be included in scope of work of this package.
4. Initial charge of all the lubricants and fluids including one year topping up requirement.
5. Paints and painting of all equipment shall be as per approval.
6. Chemical cleaning of all equipment and systems after their erection shall be in Bidder's scope.
7. Thermal insulation and removable metal cladding shall be provided for all the equipment, piping and piping support frames as required. HP Turbine insulation must be Re-useable Blanket/Bag Type Insulation.
8. Necessary blanking arrangements required to protect the valves and turbine internals and other auxiliaries during steam blowing shall be provided.
9. Suitable EOT/Electric Monorail hoist cranes alongwith runway/ monorails beams and approach ladders and/ or platform of adequate capacity to meet the need for erection, operation and maintenance shall be arranged by the bidder. Further, Jacking facilities required for stator lifting shall also be arranged by the contractor. Wrenches for erection & commissioning of TG & Generator to be arranged by the bidder
10. Operating platform around the deaerator, GSC, flash tanks, lube oil/ control oil tanks, HP/LP bypass valves, Emergency Stop Valves / Intercept valves, local platforms for various inaccessible valves and equipment etc. shall be in contractor's scope.
11. The oil drains from the lube oil system in TG area which are collected in a common collection tank, will be transferred to container for further disposal/reuse.

12. All the environmentally clear waste shall be suitably routed to the storm water drainage system through drains. All the vents to atmosphere shall be suitably led to outside the main plant building.

13. All oils, chemicals etc.,to waste shall be routed to common collection tank (to be supplied by the bidder) individually identified by the owner for oil or any such obnoxious material which cannot be put into the plant drainage.

14. Similar arrangement will be provided for the oil drains in controlfluid system also.

13.0 Equipment Cooling Water System.

Refer Chapter 16.

14.0 Roof Top Solar System

Refer Volume IV.

15.0 Central Lube Oil Storage & Purification system;

System shall be complete in every respect with lube oil tanks, clean, dirty & unloading tanks, centrifuge, pumps, interconnecting piping, valves, fittings, instruments etc. Central Lube oil purification System shall have series of filters for maintaining the NAS Value as defined by Turbine OEM along with Online NAS counter.

16.0 Design of TG foundation.

For detail refer Volume VI.

17.0 Tools and Tackles

1. One set of all special tools and tackles required for the maintenance of equipment/system have to be supplied. These tools and tackles shall be separately packed and brought to site. These shall not be used for erection/commissioning purposes and shall be in an unused and new condition, when they are handed over to the Owner. A list of all such special tools and tackles shall be submitted alongwith the offer.
2. One set of maintenance and repair tools including all special tools and tackles required for the installation and maintenance of equipment/ system for commissioning, testing, calibration, modification and maintenance.

18.0 Erection Materials

All the erection materials and consumables like shims, welding rods, soldering and brazing alloys, insulating tapes, compounds, chemicals etc. required for the erection and commissioning work shall be included in the Bidder's scope of work.

19.0. Spares

The offer shall cover all the mandatory spares, start-up spares, commissioning spares, consumable spares and others as specified in the specification. The list of mandatory spares is attached in the specification.

SECTION – 2

DESIGN BASIS

1.0 STEAM TURBINE AND AUXILIARY SYSTEMS

1.1 STEAM TURBINE

1.1.1 Type

Each steam turbine shall be tandem compound, single reheat, regenerative, condensing, multi-cylinder design with separate HP, separate IP and separate LP casing(s) OR combined HP, IP and separate LP casing(s), directly coupled with generator suitable for indoor installation.

1.1.2 Rating

Each steam turbine generator unit shall conform to the following design and duty conditions:

(i)	Output under economic maximum continuous rating (EMCR) (guaranteed output load) at generator terminals	800 MW
(ii)	Maximum turbine cycle heat rate at 100% TMCR, design Condenser pressure 0% make up with TD- BFPs	By bidder (Kcal/Kwhr)
(iii)	Turbine throttle steam pressure	270 Kg/cm^2 (abs)
(iv)	Turbine throttle main steam temp.	600 °C *
(v)	Reheat steam temp. at turbine inlet	600 °C *
(vi)	Design & operational requirement including variations in rated steam	Generally as per IEC 45 or otherwise specified elsewhere in the temp. & pressure specification
(vii)	Pressure drop in reheat circuit i.e. between H.P turbine exhaust & IP turbine inlet.	As Optimized by the bidder, not exceeding 10% of H.P turbine exhaust Pressure.
(viii)	Condenser design pressure	As optimized by bidder at 1% make-up and 32.5^{0}C CW temperature for VWO condition but not exceeding 70 mmHg (abs)
(ix)	Turbine speed	3000 rpm
(x)	Frequency variation range around rated frequency of 50 Hz	+3% to -5% (47.5 Hz to 51.5 Hz)
(xi)	DM water make up to thermal cycle under EMCR condition	1% of throtal steam flow
(xii)	Final feed water temp. for Heat Rate guarantee point & EMCR condition	As optimized by bidder but not less than 293^0 C.
(xiii)	Turbine protection against water induction	As per ASME-TDP-I (latest)
(xiv)	Turbine Heat Rate	As minimized by bidder

Note: - * Maximum Operating Main Steam & Hot reheat temperature at Turbine inlet shall be 605°C. $\pm 5^0$C is operating margin. Turbine shall be designed for 605^0C temperature.

1.1.3 EMCR (Economic Maximum Continuous Rating)

Economic maximum continuous rating (EMCR) output achieved at generator terminals shall be 800 MW after deducting all electrical power used for excitation, turbine generator control, lubrication, generator cooling and sealing, turbine gland steam exhauster, turbine generator main oil tank vapour extractor and any other such integral auxiliary of turbine generator under rated steam conditions with heat cycle makeup of 1% of throttle steam flow, all extractions in operation and design condenser pressure.. In case of static excitation system, the EMCR output at generator terminals shall be 800 MW plus excitation power requirement. (including transformer losses) Power consumption by following auxiliaries shall also be added:

a) Ventilation fans of oil and control fluid tanks, (If separate driven)
b) Lubricating pumps (If separate driven)
c) Control fluid pumps (If separate driven)
d) Auxiliaries for seal oil and Hydrogen System (If separate driven)
e) Stator water cooling pumps (If separate driven)

1.1.4 TMCR (Turbine Maximum Continuous Rating)

This means 800 MW electric power output at generator terminal under 0% cycle make up at 33°C design cooling water inlet temperature.

Note:

i) "Throttle/Main Steam Conditions" means initial/main steam conditions (i.e. pressure, temperature and flow) at inlet to Main Steam Strainer.

ii) "Reheat Steam Conditions" means reheat steam conditions (i.e. pressure, temperature and flow) at inlet to Reheat Steam Strainer.

iii) Wherever in the specification "Main Steam/Throttle Steam/Reheat Steam/Rated Steam conditions" have been mentioned, in connection with turbine/turbine cycle rating and performance guarantees, the same shall be interpreted as per above two clauses of this note.

iv) Wherever in the specification words or combination of words have been used to describe Output of the turbine generator set (such as Power at generator terminals, Output at generator terminals, Unit load, TG load, TG Output, Unit Output etc.), it shall mean electrical power output at generator terminals after deducting the power consumption by auxiliaries as described elesewhere in the specification.

v) "Condenser pressure", "Design condenser pressure" is indicated the same shall mean average of HP & LP the condenser pressure.

1.1.5 Other Features

a) Turbine shall be capable of operating continuously with valves wide open (V.W.O) to swallow at least 105% of EMCR steam flow to the turbine at rated main steam and reheat steam parameters and also the corresponding output

shall not be less than 105% of rated load with 1% make up and design condenser pressure.

Bidder can offer overload valve (HP stage bypass) to meet the above specified VWO requirement, if it is a proven practice of the Turbine manufacturer. In such case VWO shall mean wide open condition of both, the turbine main control valves and the overload valves. However, if bidder offers overload valves, then bidder to ensure sufficient margin in the main turbine control valves so as to generate at least 102% of rated load at rated main steam & reheat steam parameters at design condenser pressure with 1% makeup. Load requirement beyond 102% of rated load can be met with overload valve.

b) The steam turbine generator unit shall be suitable for direct connection to steam generator having no inter connection with other units either on the boiler feed water side or main steam side.

c) The steam turbine shall have minimum eight (8) uncontrolled extractions for regenerative feed heating based on optimized cycle and shall be suitable for satisfactory operation under tropical conditions.

d) The cycle will consist of minimum 3 HP heaters with extraction for top HP heater from HP turbine, one deaerator and minimum 4 LP heaters.

e) Auxiliary steam supply will normally be fed from CRH steam. During unit startup auxiliary steam system will be fed from Main Steam line. The auxiliary steam system will consist of a low temperature & high temperature header as per parameters specified elsewhere in the specification.

However, when the auxiliary steam system is being fed with steam from CRH (Load range of 50%-100%), the temperature in the high temperature aux. steam header will be floating, and shall vary approximately in the range 300^0C to 400^0C depending on the unit load and the CRH steam Parameters. When auxiliary is sourced from HC PRDS during low load and startup temp. will be maintained at 310^0 C. Bidder to take note of this and design the systems accordingly, wherever, auxiliary steam is being used for equipment. Bidder to further note that when auxiliary steam is being tapped from auxiliary boiler, auxiliary steam will be available only at low temperature of 210^0C.

f) The turbine- generator set shall be capable of continuous TMCR output under rated steam conditions, 70 mm Hg (abs) condenser pressure, 1% make-up and 47.5 Hz grid frequency.

1.1.6 Operational Capabilities

1.	H.P. heaters out of service	Turbine Generator set shall be capable of continuous operation with HP heaters out of service with maximum output not less than 800 MW
2.	Overpressure Operations	a) Bidder shall indicate the turbine over pressurization (under VWO) possible and ensure corresponding contiuous output of TG set (if applicable). b) Turbine shall be capable of accepting variation in steam temperature &

		pressure as per IEC-45 in casde continuous over pressure operation is possible.
3.	Two shift & cyclic load	Turbine shall be suitable for continuous base load operation. In addition Turbine shall be suitable for two-shift operation & cyclic load variations.
4.	Part load & start up	a) Turbine shall be capable of operation on variable pressure modes during part load & start up operation. b) TG set shall be capable of being started from cold condition to full load operating conditions in as short time as possible.
5.	House load operation	TG set shall be capable of operating on house load during sudden total export load throw off using HP- LP bypass system. Unit shall not trip on overspeed in the event of total export load throw off.

1.1.6.1 FAST START UP AND LOADING/UNLOADING RATE

1.1.6.1 The TG set shall be capable of being started from cold condition to full load operating conditions in as short time as possible. The TG sets shall be designed for minimum rate of loading/ unloading mentioned below without compromising on design life of the machine:

Step load change	Minimum ±10% per minute to facilitate fast loading/ unloading of the unit
Ramp Rate	Minimum ± 3% per minute above 30 % load (under sliding pressure operation)
	Minimum ± 5% per minute (50% to 100% load) (under Constant pressure operation)

1.1.7 NUMBER OF START UPS

1.1.7.1 Expected number of turbine generator start-ups during design life of minimum 25 years shall be as under. The design of turbine generator and the associated systems shall take care of these start ups without affecting the life of equipment adversely. No component shall be stressed beyond acceptable safe stress and fatigue levels when operating under the stated duty conditions.

Cold Start (after shut down period exceeding 72 hours)	455
Warm Start (after shut down period between 10 hours and 72 hours)	1000
Hot Start (after shut down period less 10 than hours)	4500

1.2 MATERIAL REQUIREMENTS

Bidder's proposal shall include the schedule of materials used in turbine construction indicating chemical composition and designation of materials for following components:

	Description
i.	**Turbine Casing**
a)	HP outer casing
b)	HP blade carrier
c)	IP casing
d)	LP casing
ii.	**Turbine Shaft and Shaft Coupling**
a)	HP shaft
b)	IP shaft
c)	LP shaft
iii.	**Moving Blades**
a)	HP turbine first stage
b)	HP turbine other stages
c)	IP turbine first stage
d)	IP turbine other stages
e)	LP turbine stages
iv.	**Fixed Blades**
a)	HP turbine first stage
b)	Other stages
c)	IP turbine first stage
d)	Other stages
e)	LP turbine first stage
f)	Other stages
v.	**Casing Joint Bolts**
a)	HP cylinder
b)	IP cylinder
c)	LP cylinder
vi.	**IP/LP crossover/cross around piping**
vii.	**Turbine steam admission valves**
a)	Valve Body
b)	Valve Spindle
c)	Valve seat

The steam turbine shall be built up using materials which are proven for rated turbine inlet steam parameters.

1.3 MAINTENANCE REQUIREMENTS

i.	Wet Steam Washing (if applicable)	a) Turbine shall be suitable for Wet Steam washing. Necessary stubs/ connections on turbine/piping shall be provided for future connection to wet steam washing system b) Recommended washing procedures to be furnished.
ii.	Forced Cooling of turbine	Necessary equipment shall be provided for forced cooling of turbine during emergency condition for quick access.
iii.	Turbine Preservation	a) Provide Turbine preservation system to protect against corrosion during idle periods. b) Write-up on the recommended system to be furnished.
iv.	Boroscopic Inspection	a) Provide Boroscopic Inspection ports in turbine for in situ inspection of turbine internals as per their standard practice. The inspection ports shall cover turbine internals as maximum as possible as per Bidder's Standard practice. b) The inspection port should be designed for ease of accessibility with leakage proof features while in operation. c) One set of applicable tool and plants for the inspection port will be supplied.

1.4 TURBINE CASING

1) The turbine casing design shall have following features:

a) Separate casings for HP, IP and LP or combined casing for HP-IP and separate casing(s) for LP turbine.

b) Symmetrical in design to minimise effects of thermal stress and creep.

c) Turbine casing design: Maximum pressure & temperature to be encountered during service including as specified under operational capabilities.

d) Steam tight horizontal joints with metal to metal contact or as per proven practice of bidder

e) Provide proven steam chest support arrangement, capable of accepting piping forces during operation without transmitting these to the casings.

f) All extractions shall preferably be from the lower half of casing and extraction branches shall be welded to casings except for LP casing(s) extractions which can be with either welded type or bolted type connection as per turbine manufacturer's standard practice.

g) Adequate drainage facility with temp. sensing devices (in pair) in casings, strainers housings, stop and control valves, extraction lines etc and drain lines for water detection and proper removal during start-up.

h) Provide pressure relief bursting diaphragm for LP casing(s) to limit the exhaust hood pressure within a safe margin from design pressure.

i) Provide a completely self contained exhaust hood spray system for L.P casing(s) to protect the turbine against excessive temperature due to windage at no load / low load and HP/LP bypass operations.

j) Dismantling of casing should be possible with minimum removal of insulation.

k) Provide guide rods to prevent damage to blades during erection and maintenance.

l) Bearing inspection should be possible without necessity of dismantling the turbine casing.

m) The turbine casings shall be designed for a hydro-static test pressure of at least 50% in excess of the working pressure. Hydrostatic test for HP turbine outer casing is not envisaged as per OEM practice. However other quality tests as required will be performed. Hydraulic test will be done for IP turbine outer casing.

n) There shall be no sudden cross section changes and sharp corners leading to stress concentrations.

o) The differential expansions if any between rotors and casings shall be kept to the minimum.

p) Steam tightness of LP turbine shall be ensured by providing suitable seals.

q) In order to make rapid assembly and dismantling of the turbine possible, the turbine casings shall be horizontally split and supplied with guides to permit safe lifting of the casing.

r) To check the condition of the turbine blading without opening the casings, openings are to be provided at suitable points on the LP casings.

s) The design and surface preparation of the supports are to be such that thermal expansion is not prevented.

t) Suitable lifting gear and slings shall be provided for raising and lowering the upper portions of the turbine casings and rotors, blading or remainder of the machines.

u) Inspection holes shall be provided for field balancing of rotor without dismantling the casings.

1.5 STEAM TURBINE ROTORS

a) Provide forged alloy steel rotor.

b) Ensure uniformity of material composition and strength by examining adequate number of test specimen.

c) Ensure static & dynamic balancing of composite rotor and blade assembly.

d) Maximum permissible shaft vibration measured at bearing housing will be as per zone A of ISO 7919 and maximum permissible bearing vibration measured at bearing housing will be as per zone A of ISO 10816-2.

e) Critical speed of composite rotor and blade assembly shall not be within (-) 10% & (+) 15% of rated speed.

f) Turbine assembly radial seal clearances at rotor blade tip and interstage area shall not be less than 0.8 mm.

g) Complete rotor including coupling shall be capable of withstanding the shock loading and excess torque resulting from a generator short circuit without damage.

h) The procedures proposed for inspection of the rotors in order to ensure their soundness and homogeneity shall be stated in the specification, together with particulars of the thermal treatment proposed in order to minimize the possibility of distortion occurring in service. The HP and IP rotors shall be given thermal stability test. The Bidder shall state in his intentions with regard to thermal stability tests for the LP rotors.

1.6 NOZZLES AND BLADES

a) Ensure material is hard, corrosion & erosion resistant alloy steel.

b) Ensure quick & easy site replacement of blading.

c) L.P blades design without lacing wires is preferred.

d) Ensure LP stage design for effective removal of moisture.

e) Hardening of LP last stage blades upto 1/3rd (minimum) of blade length & width 25mm (minimum) or stelliting or design of LP last stage blades with provision of moisture removal as per the proven standard practice of OEM shall be provided.

f) Ensure that there is no resonance of LP blading in the continuous operating frequency range of 47.5 Hz. to 51.5 Hz. Furnish Campbell diagrams for all free standing blade stages offered for LP blading.

g) Ensure independent tuning of at least 3 stages of LPT blades to avoid resonance frequency in the operating frequency range of 47.5 Hz. to 51.5 Hz.

h) Ensure stress induced in LPT blading due to back end steam loading under V.W.O. conditions not to exceed 90% of design stress value.

i) The design of turbine blading will have to ensure high efficiency of energy conversion with low loading, stressing and vibration considerations to insure long-term reliability.

j) The turbine blading shall be designed to withstand the centrifugal stresses that arise due to rotation and bending stresses due to flow of steam. In Addition HP blading shall withstand high temperature and LP blading shall resist corrosion and erosion in fast flowing wet steam.

k) LP stage shall be provided with blade hardening or stelliting as per the proven standard practice of turbine manufacturer.

l) Material of nozzles and blades shall be hard, corrosion and erosion resistant alloy steel. m. Fatigue strength, vibration damping shall also be provided in the design of blades.

1.7 BEARINGS

Provide adequate number of Journal and thrust Bearings with:

(i) Tin base babbit lining properly secured to the bearing shell.

(ii) Pressure lubrication.

(iii) Independent supporting arrangement outside the turbine casings and easy access.

(iv) Horizontally split with the ability to dismantle and replace lower half with minimum shaft lift.

(v) Measurement of bearing temperature as near the point of heat generation as possible and measurement of the oil temperature leaving the bearing.

(vi) To reduce maintenance difficulties, all bearing shall be accessible without having to remove cylinder cover, cross over piping etc.

(vii) Local temperature indicators in each bearing lube oil drains; embedded redundant duplex resistance elements/ thermocouples for monitoring temperature of bearing; necessary pick-ups and accessories for remote monitoring of bearing metal temperature & vibrations (Horizontal & Vertical)

1.8 SHAFT COUPLINGS

(a) Ensure ready disconnection preferably through bolts.

(b) Provide sufficient allowance for taking up reaming / honning of bore holes
during entire life of the machine.

(c) Shearing type rigid couplings shall be used. Couplings shall be designed to allow for removal of any rotor without opening adjacent turbine casings. Couplings with axially fitted bolts may be offered. Hydraulic bolt tensioning equipment is also preferred. Coupling shall be suitably lubricated, if required. Couplings shall be designed to take care of short circuit shock.

1.9 TURNING GEAR

(a) Provide suitable turning gear device, either High-speed hydraulic type or motorised turning gear as per standard proven practice of the Bidder.

(b) Ensure automatic engagement / disengagement with shaft speed decrease/ increase at preset value.

(c) Provide manual hand barring facility also for manually cranking the turbine in case of emergency including A-C power failure. Ensure availability of lube oil to the bearings during manual barring operation.

(d) Provide instrumentation & control for local & remote operation (from unit control room).

(b) Ensure proper interlocks of lubrication system with operation of turning gear.

(f) Ensure all other necessary interlocks and protections.

(g) Suitable protection shall be provided to prevent the turning gear device from being started unless the jacking oil pump is in operation and an adequate jacking oil pressure has been established.

1.10 GLAND SEALING SYSTEM FOR STEAM TURBINE AND TDBFP

1.10.1 Design Requirement

(a) Gland sealing system for the T.G set and TDBFP shall comprise of:

(1) Spring back Labyrinth seal or seals as per manufacturer's standard practice.
(2) Turbine shaft glands sealed with steam.

(b) Fully automatic gland sealing steam supply system including necessary piping, valves, fittings and control and Instrumentation as required.

(1) Gland Steam condenser to condense and return to cycle all gland leak off steam along with 2x100% capacity exhausters (AC motor drive) to remove air and non-condensable gases. The exhaust gases shall be left outside the TG hall roof level.

(2) Bypass arrangements of Gland steam condenser. If required as per standard practice of turbine manufacturer may be provided.

(3) Seal material shall be proven.

(c) Design pressure of Gland steam condenser shall not be less than 3 kg/cm^2 (g) and full vacuum. Design temperature of gland steam condenser shall not be less than maximum expected temperature under all operating conditions.

(d) Effective drain system shall be provided alongwith instrumentation to monitor and maintain the required temperature to avoid thermal shock to the rotor during changeover from self sealing to alternate source of sealing steam.

(e) System shall be designed to ensure the required minimum condensate flow through gland steam condenser during start-up and other normal/abnormal operating modes. Gland Steam condenser tubes shall be made of Stainless steel only.

1.10.2 Operation and maintenance requirement:

(a) During normal operation, turbine shall be self-sealing.

(b) During start up and low load operation, sealing steam shall be supplied from alternate source of steam i.e. Gland steam header, alongwith a facility to automatically switchover arrangement from alternative source to the main source and vice-versa.

(c) Two nos. modulating type control valves shall be provided, one discharging surplus steam to condenser and other one for supplying extra steam to gland sealing header from steam source to maintain sealing steam header pressure at a preset value.

(d) Control valves to be stay put during power failure & sealing steam header pressure maintained by manual control of these valves.

(e) During changeover of steam supply source from turbine/auxiliary steam header, there shall be no rubbing at glands and no undue increase in vibration and the system shall be capable of withstanding thermal shock.

(f) The gland sealing arrangement for steam turbine shall permit easy examination and replacement of glands without lifting the upper half of turbine casing. Effective drain system for maintaining the required temperature shall be provided

1.11 STEAM ADMISSION VALVES (EMERGENCY STOP, REHEAT STOP, INTERCEPTOR STOP VALVES AND CONTROL VALVES)

1.11.1 Design, constructional and operational requirement:

(a) Designed to allow blowing out of Steam leads prior to startup.

(b) Designed to avoid seizure under operating condition.

(c) Withstand high Erosion by stelliting or other superior methods as per standard proven practice of the bidder for internal components of valves. Ensure that valves are stable and shall not vibrate at high steam velocities.

(d) Locate the steam admission valve close to the turbine casing for limiting turbine over speeding to safe limits because of entrapped steam volumes.

(e) Lagged with insulation and provided with lifting eyebolts.

(f) Provide Temporary & Permanent steam strainers for Emergency stop and Reheat Stop valves. In case there is no provision for temporary strainer, one set of strainers shall be provided in addition to the permanent strainer. The strainers shall be arranged to permit easy inspection and cleaning.

(g) Provide hydraulically operated valves, fail safe type & equipped with test device to permit complete closing of one valve at a time while the Unit is carrying load.

(h) Valves to close simultaneously & automatically when the over-speed governor trips and upon the action of other protective devices.

(i) The emergency and reheat stop valves, if not mounted on the steam turbine casing, shall be connected to the steam turbine by piping flexible enough to avoid transmission of excessive forces and moments to the steam turbine casing.

(j) The hydraulically operated control valves shall have removable seats to facilitate any repair work required. Valves stem shall be made of wear resistant and oxidation resistant materials to provide reliable operation with a minimum of maintenance work.

(k) In order to facilitate the safe and reliable shut-down of the machine, the emergency stop valves and governor valves must be arranged with easy access

(l) The emergency stop and reheat stop valves shall allow for removal of stop valve internals for blowing out the main steam pipes. Suitable provisions shall be supplied to protect valve seats and other internals surfaces, and to deflect the blowout steam where inlet and outlet are not in a straight line. Suitable provision shall be made by the Contractor to perform on load testing of main steam stop valve and reheat steam stop valve with out tripping the unit.

(m) Turbine operation with single emergency stop & Interceptor valve during emergency of site and due to failure of one emergency stop / Interceptor valve.

(n) Equipped with auxiliary contacts and limit switches for control interlocks and signaling. Additionally position transmitter shall be provided on control valves for remote indication and control.

(o) Each valve to be provided with two additional normally open (NO) potential free direct limit switch contacts in the valve closed position for use by the Owner.

1.12. NON – RETURN VALVES

1.12.1 Design and Constructional requirement:

(a) Bidder shall provide Pneumatic power operated / assisted quick closing type & ordinary NRVs for each steam extraction line (except for extrations from LP Turbine) including steam extraction line to BFP drive turbine. However, if bidder wishes to provide hydraulic power actuator then fire resistant fluid (FRF) shall be used. For each CRH line and extractions from LP Turbine (except for heaters in condenser neck) minimum one hydraulic/pneumatic power operated / assisted QCNRV shall be provided.

(b) NRV shall be suitable for on load testing individually and shall be provided with fail safe design and shall close on loss of power.

(c) The valves shall be full-bore type designed for minimum pressure drop.

(d) Ensure valves closure during unit trip.

(e) Provide two sets of Limit Switches for both open & close position with two changeover contacts.

(f) Requirements indicated in the Tender drawings are minimum. However, based on TSR analysis to be carried out by the successful Bidder, any additional requirements shall be met by him.

(g) Valves shall be of proven design w.r.t. type, size and rating offered (Furnish sufficient experience data for the same).

(h) The NRVs shall meet the requirements of turbine protection as per ASME TDP-1 and shall be located as close to the turbine as possible so as to reduce quantity of entrapped steam

1.12.2 The material of the NRV's shall be compatible to the material of piping on which they are mounted. However, it shall not be inferior to the following:

(a) Alloy steel (WC9) or equivalent compatible for NRVs on CRH line & extractions to H.P. heaters with the connected piping.

(b) Other NRVs: Carbon steel (WCB) or equivalent compatible with the connected piping.

1.13 INSULATION (STEAM TURBINE AND BFP)

(a) Bidder shall provide insulation & cladding for all equipment & piping with surface temperature more than 60^0 C.

(b) Bidder to ensure temp. of Cold face of finished insulation not greater than 60^0C with ambient temperature of 40^0 C.

(c) The HP cylinder, IP cylinder, steam chest, Turbine Valves, ESV & IV and interconnection piping, crossover / cross-around piping, such parts of LP cylinder as considered necessary, and all associated piping and valves shall be efficiently insulated with inner thermal insulating materials. The insulated portion of the steam turbines shall be covered with fabricated steel cover, provided with suitable anti-drumming and sound pressure attenuating material inside. The insulation and steel covering should be so designed and erected as to provide easy accessibility to parts requiring frequent inspection. HP/IP Turbine insulation must be Re-useable Blanket/Bag Type Insulation.

(d) The thermal insulation for the turbine casing shall preferably be insulated by preformed ceramic mattress blankets conforming to IS15402 or equivalent. These mattresses are fixed over the casing and held in position by metallic washers fastened to the MS rod welded to the casing. To meet the thickness requirements, multiple layers of mattresses may be applied.

Alternatively, bidder may apply turbine insulation as per their standard practice i.e. sprayed insulation produced by projecting specially prepared mineral wool along with a fine liquid spray. This should be covered with prefabricated 'blanket' type insulation. The bidder may apply complete spray type or complete blanket type or combination of both of above as per their standard practice. These blankets shall consist of high temperature felted mineral insulation fully enclosed in wire inserted asbestos free cloth for temperature exposure to 445^0C to 595^0C. A single layer of blanket shall not be more than 75 mm thick. Voids around the blankets should be avoided. However, unavoidable voids shall be filled with loose mineral wool.

(e) Nuts and other exposed portions of the casing and valve flanges shall be suitably insulated for minimum heat loss.

(f) Suitable stainless steel lugs shall be tack welded on turbine casing to support the insulation. In places where welding is not permitted, suitable alternative arrangement shall be provided by the Contractor. The design of the support shall be so as to involve minimum number of lugs.

(g) The thermal insulation designed, furnished and installed by the Contractor shall be such that the following items of performance shall be guaranteed, and the specific design and application features adopted shall be so as not to exceed the stipulated limits in temperature differentials. The Employer shall have the option to have any random check of specimen as per his choice, to establish conformity to guaranteed particulars:

(1) The difference in temperature between upper and lower metallic parts of HP and IP casings in the zone of governing stage/ steam admission shall not be more the 40^0 C during cooling of the casing.

(2) The difference in metallic temperatures of upper and lower halves of both H.P. and I.P. casings, during normal operating conditions shall not be more than 15^0 C.

(h) Applicable Standards:

1. IS – 9742: Sprayed mineral wool thermal insulation.
2. IS – 5696: Loose mineral wool.
3. IS – 3677: Unbonded rock and slag wool for thermal insulation.
4. IS – 8183: Lightly bonded mineral wool for thermal insulation.
5. IS - 7413, IS - 3144, IS – 9482

(i) The use of asbestos in any form for insulation and elsewhere is not permitted.

1.14. TURBINE GOVERNING SYSTEM, PROTECTIVE DEVICES & UNLOADING GEARS

1.14.1 Governing System

The Steam turbine generator unit shall be equipped with an electro-hydraulic governing system which shall meet the following requirements:

i) The governing system shall be capable of controlling with stability the turbine speed between zero to maximum power output when the unit is operating isolated or in parallel with other units.

ii) Over speed during full load loss shall be limited to turbine over speed trip value.

iii) Adjustable steady state speed regulation shall be provided between +3% to +8% of rated speed.

iv) Dead band at rated speed and at any power output within rated output shall not exceed 0.06% of rated speed.

v) Speed/load changer to control the speed or power output of the steam turbine within the limits and shall be capable of adjusting the speed of the turbo set to any value in the range of 94% to 106% or rated speed for manual/auto synchronization of the generator with the bus. It shall be capable of varying the load on the machine from no load to full load.

For remote control, suitable motor drive shall be provided. Indication of the speed/load changer position shall be provided on the Operator's work station and console panel insert.

vi) Load limiting device capable of being operated both locally as well as remotely from unit control room for the purpose of limiting the amount of opening of the governor controlled valves to set the load at a pre-determined limit, while the turbine is in operation A remote position indicator shall be provided on the console panel insert for indication of the setting of the load limit. Contacts shall also be provided on the load limiter for signaling load limited operation in Unit Control Room.

1.15. TURBINE PROTECTIVE DEVICES

(a) Emergency Governor

(1) Bidder shall provide over speed trip of the unit at 110% of rated speed in case speed governor fails to limit the turbine over speed.

(2) The emergency governor resetting shall be as per manufacturer's standard practice. However, it shall meet the IEC-45 requirements for overspeed trip.

(3) Bidder shall provide means for testing the operation of emergency governor when the machine is on load without exceeding the rated speed of the unit.

(b) Emergency Hand Trip

Bidder shall provide emergency local hand trip device to facilitate manual tripping of the unit along with facility to trip turbine from UCB.

1.16 UNLOADING GEAR

(a) Initial Pressure Regulator

(1) It shall ensure turbine unloading to a preset point to run on house load in case main steam pressure falls below a predetermined value.

(2) It shall be possible to adjust or bypass the initial pressure regulator from UCB at start up condition to facilitate starting with low steam pressure and during sliding pressure operation.

(3) Contact to be provided for signaling the device in, "Operation" and "Reset".

(b) Low Vacuum Unloading Gear

(1) Bidder shall provide a low vacuum unloading gear if applicable, based on his standard proven practice for the unit size in consideration, which shall ensure progressive decrease of Steam flow to turbine below a preset value of condenser vacuum, thus restoring the condenser vacuum.

(2) Contact to be provided for signaling the devices in "Operation" and "Reset".

1.17 VACUUM BREAKER

Bidder shall provide D.C operated device for rapid reduction of vacuum in condenser for turbine rotor to be brought to rest as quickly as possible. Provision shall be made for remote operation and manual (both) of vacuum breaker.

Vacuum breaker should preferably be with silencer as per the standard & proven practice of bidder.

1.18 TURBINE LUBRICATION OIL SYSTEM

(a) A self contained LUBRICATION oil system for TG Unit consists of:

(1). Centrifugal / gear type, Main oil pump (MOP) directly driven by turbine as per Bidder's standard practice with capacity to cater lube oil for bearings & emergency seal oil requirement. In addition of above 2x100% AC Motor driven Aux. oil pumps for start up, shut down of TG unit and as standby to M.O.P. for automatic operation shall be provided. Each pump shall also be capable of start up, shut down of TG unit and stand by to each other for automatic operation to cater lube oil & turning gear oil requirement.

Or

2 x 100% AC Oil Pumps as per Bidder standard practice with capacity to cater lube oil for bearing & seal oil requirement (if required for bidder design). Each pump shall also be capable of start up, shut down of TG unit and stand by to each other for automatic operation to cater lube oil & turning gear oil requirement

In case of complete power failure including DC supply, Turbine Generator set shall be capable of safe coasting down.

(2) One DC motor driven emergency oil pump with sufficient capacity for meeting lube oil requirement of bearings during emergency with automatic starting on low lube oil pressure preset value.

(3) 1x100% each AC & DC jacking oil pumps with an interlocking not to start till lube oil pressure is established. Jacking oil suction should be directly from tank along with Turbine Lube pump discharge

(4) Each unit of Lube Oil tank to have capacity to allow 8 oil charges per hour (at normal operating level), fitted with non-corrodable strainers, level transmitter & local indicators and necessary manholes, 2x100% duty vapour extraction fans, platforms, railings, necessary piping, supports and accessories etc.

(5) 2x100% DM water cooled lube oil coolers with 15% excess tube Surface area, designed as per TEMA having oil pressure greater than water pressure fitted with Dial type Thermometer and Manual 3-way valve on oil side for change over of coolers. Oil temperature at outlet of coolers will be maintained within

permissible limits at the inlet to the bearings. 3 way temp DCS operated control valve should be provided for lube oil temperature control.

(6) All vents shall be taken outside the building above the roof level. Horizontal vent pipe shall have a natural drainage back to the tank and suitable drainage arrangement for any oil build up shall be provided in the discharge piping of the extractors.

(7) The base of the tank shall slope to a common point to facilitate complete draining and an accessible lockable valve shall be provided in the drain line. Piping shall be provided from the drain valve to a suitable point from where the oil can be drained into the transfer or drain tank.

(8) The changeover arrangement shall be such that one cooler cannot be isolated before the second is in service. The oil side pressure of the oil coolers shall be higher than the water side pressure. The cooler shell shall be constructed of carbon steel and shall be fitted with an air vent at the highest point and a drain valve at the lowest point.The cooler water boxes shall be of fabricated steel. The highest point of each water box shall be supplied with a vent connection. The relief valve and all drain and air release valves shall be provided with pipe work leading to the nearest convenient drain trench.The coolers shall be supported such that the water boxes can be removed without difficulty and adequate access to the tube plates is possible.The arrangement of water box connections shall be such that tubes can be cleaned without dismantling any oil or water pipe joints. In case of tube type cooler provided by bidder SS Seamless tubes must be used.

(9) One AC motor driven emergency oil pump with sufficient capacity for meeting lube oil requirement of bearings during emergency with automatic starting on low lube oil pressure preset value.

(10) In addition to local pressure gauge, pressure transducers shall be provided for monitoring jacking oil pressure in each bearing.

(b) Purification System

Bidder will provide permanently Connected, Continuous Oil Purification having following major equipments fro each TG Unit.

(1) Oil centrifuge having capacity to purify 20% of total oil charge in system per hour. Purified oil shall have moisture not more than 500 PPM & maximum particle size confirming to code 15/12 as per ISO 4406 or requirement of turbine manufacturer whichever is better. The above particle size and moisture content shall be demonstrated with inlet oil quality confirming to 21/18 as per ISO: 4406 and 1500 PPM moisture respectively in one pass.

(2) Carbon steel antiflood tank for each purifier or as per standard practice of manufacturer.

(3) Positive displacement feed & discharge pumps (if required), each having capacity 10% higher than purifying unit. Necessary

interlocks for preventing centrifuge operation in case these feed and discharge pumps are not operating shall be provided.

(4) Electric oil heater to heat oil to temperature not more than 65°C with possibility to cut heater elements in steps.

(5) Entire purification equipment to be mounted upon a substantial metal base having a raised lip around the outside with a drain connection.

(6) Alternatively, Bidder may offer oil purification system as per their standard practice. The purified oil shall have quality as specified above.

(7) All the piping, valves & fittings of the purification system shall be of stainless steel.

(8) **Type test(s) to be conducted:**

Particle size impurity test as detailed out in the technical specification is to be carried out on purification system on main Turbine.

(9) Turbine Lube oil purification System for MOT must have series of filters for maintaining the NAS Value as defined by Turbine OEM along with Online NAS counter hooked to DCS with De-hydration System.

(c) Filters & Strainers

Provide duplex type filters/strainers with stainless steel element, with differential pressure switches with alarm at common oil supply line. The filter elements size shall be of five (5) microns or a size suited to manufacturer's requirements. In addition to above, the Bidder may provide filter/strainers at oil supply line to /oil return lines from bearing and generator seals as per his standard practice. Turbine lube oil system must have duplex filter with manual isolation valve.

Changeover from one filter to the other shall be possible without a reduction in flow or a momentary drop in pressure. The changeover valves shall be interlocked or arranged so that it is not possible to inadvertently cut off the supply of oil to the plant. A differential pressure gauge and differential pressure switches with alarm shall be provided on both filters. Adequate provision shall be made for draining and venting the section of filter undergoing maintenance.

(d) Oil Piping & fittings

(1) Provide double oil piping or equivalent shielding arrangement for all high pressure lines and all pipes close to hot pipes and parts to protect against fire hazards.

(2) Ensure oil return lines from bearings fitted with illuminated sight fittings, or any other device to see the flow of oil depending upon the standard proven practice of the bidder.

(3) Oil supply and return lines to / from each bearing should have oil flushing filters as per standard practice of manufacturer.

(4) All the piping, fittings, valves, Main Oil Tank and complete strainer including body & element shall be of stainless steel. Further all the parts of lube oil coolers (tubular or plate type) which are coming in contact with lube oil shall be of stainless steel.

(5) Standard Tees & bends shall be used in lube oil piping.

(e) Central Turbine Lubricating Oil Storage & Purification System

(1) Provide identical Dirty & Pure Oil tanks with capacity 1.5 times capacity of unit oil tank.

(2) Ensure Capability to add new oil to the unit oil tank

(3) Provide purification system identical to Unit purification system as specified at clause no 1.18 (b) of this section.

(4) Central Lube oil purification System must have series of filters for maintaining the NAS Value as defined by Turbine OEM along with Online NAS counter.

1.19 TURBINE CONTROL FLUID SYSTEM

(a) Provide control fluid system consisting of:

(1) Fire resistant fluid for control fluid system for all hydraulically operated valves & QCNRV, servo motor for turbine stop and control valves. The Fire resistance control fluid shall be field proven and detail of the same shall be provided.

(2) 2x100% AC driven pumps connected to fluid reservoir alongwith hydraulic accumulators.

(3) Fluid reservoir of adequate capacity fitted with non-corrodable strainers, level indicators, level alarm switches & overflow devices alongwith draining and sampling connection. NAS counter shall be hooked to DCS.

(4) Ensure surfaces of reservoir in contact with fluid to be stainless steel, with 2x100% vapour extraction fans (if required) alongwith access ladders, platforms railings and manholes with covers on reservoir etc.

(5) 2x100% control fluid coolers designed as specified at clause no 1.18.00 of this section above and ensure all surfaces coming in contact with control fluid to be of stainless steel. 2x100% air cooled coolers are also acceptable depending upon standard practice of the manufacturer. Cooler tube shall be SS seamless material (ASTM A-213-TP304).

(6) Control fluid purifying unit to purify atleast 2% of the total fluid charge in the system per hour on a continuous by pass basis alongwith 2x100% capacity A.C. driven purification pumps. (For fluid circulation through purification system). Turbine governing oil purification System for Control Fluid Tank must have series of filters NAS control filters, TAN Control filters, Depth filter with De-hydration System.

(7) Filters at downstream of all pumps having mesh size as per Bidder's standard practice alongwith differential pressure switches for alarm. 3 micron Filters before solenoid valve of each Turbine Steam Control valves.

(b) **Piping and other equipment/components**

All the piping of the system coming in contact with control fluid shall be of stainless steel and any other component of the system to be preferably of Stainless steel or of material compatible to control fluid depending on the standard practice of the bidder.

1.20 HP-LP STEAM TURBINE BY PASS SYSTEM

(a) Ensure HP bypass aggregate capacity not less than 65% of the main steam flow at BMCR condition considering rated main steam parameters at the upstream of valves & CRH steam parameters (pressure and temperature) corresponding to 60% TMCR condition on the downstream. The HP bypass system shall have minimum 2x50% capacity valves. In addition the aggregate capacity of HP Bypass valve shall be adequate to evacuate the required minimum steam flow from the boiler under various start up conditions (viz. Cold/warm/hot start up) as per combined boiler turbine start up curve.

(b) LP bypass shall be designed to condition the incoming steam from re-heater corresponding to parameters resulting from operation as specified at clause no 1.20 (a) of this chapter above to parameters matching with those of LP Turbine exhaust steam. For LP bypass valve sizing, no steam will be extracted for regenerative feed heating except for deaerator pegging at 3.5 ata with only MDBFP in service, the capacity shall commensurate with that of HP bypass system plus the spray water used in HP bypass. Number of LP Bypass valves shall be as per bidder's standard practice subjected to a minimum of 2 numbers.

(c) Seat tightness of the HP and LP bypass valves shall be equivalent to block valve tightness conforming to MSS SP61.

(d) Provide complete HP & LP bypass system with necessary control & instrumentation. For HP & LP bypass, the positioning electronics between the respective process controller and the actuator control shall have all necessary positioners for continuously controlled actuators, power modules, various converters, power supply & other fault monitoring & alarming modules, position transmitters etc.

(e) Provide HP bypass station spray water requirement from Boiler feed pumps discharge & LP bypass spray water requirement from condensate

extraction pump discharge. Spray system to include spray water control valves, NRVs and isolating valves.

(f) Ensure HP bypass designed to accept continuous spray water at temp. corresponding to all HP heaters out of service and deaerator pegged at 1.5 ata. Spray water shall be sprayed at the most turbulent zone inside the valve having steam velocity in the order of 350 to 400 m/sec. The entire atomization and evaporation of spray water shall be complete within shortest possible distance but not exceeding 1.0m from the spray point. The HP bypass spray controller shall have state controller with observer to achieve accurate control over outlet steam temperature under different operating conditions including the transients.

(g) For LP bypass system the de-superheating may be done outside the valve body with spray water tapped from condensate pump discharge.

(h) Ensure all valves (both in steam & spray water service) to be electrohydralucially operated.

(i) Provide separate oil system with 100% redundant pumps, motors, accumulators and control cubicles etc. for both HP and LP bypass systems. Accumulators shall be sized to take sufficient number of stroking operations of all actuators under a condition of loss of oil supply from the pumps.

(j) Alternatively for LP bypass system, the control fluid supply can be taken from steam turbine control fluid system based on Bidder's standard practice.

(k) Provide HP-LP bypass valves with gland cooling arrangement, preferably using spray water, as per standard practice of manufacturer. Further grafoil packing rings or equivalent arrangement shall be provided for valve glands.

(l) Provide warming up arrangement of HP/LP bypass valves and associated piping.

(m) Ensure Suitability for operations under sliding pressure mode to enable short start-up time.

(n) Capable of operation in parallel with turbine with all feed water heaters in service.

(o) Facilitate hot/warm restarting following a trip from full/part loads, controlled shutdown and cold start-up following a long shut down.

(p) Ensure that boiler operation is not affected in the event of loss of load on the turbine, by disposing off the steam produced in the boiler automatically by providing a quick opening device. The full stroking time of valve under quick action shall be within 2 to 3 seconds.

(q) HP-LP bypass valve body shall be designed to withstand thermal cycling. Body shall be protected from damage due to water injection by means of multi-function contoured cage. Contoured cages shall be used as they have higher mechanical strength and no tendency to resonate. Cage

shall be designed as free-floating element with streamlined shape to prevent vibration due to resonant frequency.

Contoured plug designs are not allowed because of poor acoustic performance.

HP spray water valve being a high pressure drop and severe service application, the valve trim should have sufficient number of discrete flow paths to limit the trim exit velocity, which is the root cause of most of the control valve problems. While deciding the size of valves, bidder shall ensure that valve trim exit velocity does not exceed 23 m/sec for cavitating liquid services and 30 m/sec for non-cavitating liquids. Body gallery area or valve run diameter should not be considered for calculating exit trim velocity. Valve characteristics profiling shall be provided on the cage and not on the plug. The valves should conform to MSS SP –61.

FRF oil shall be used in HP-LP bypass hydraulic system. Separate oil tank shall be used for HP & LP bypass valve.

Separate filtration circuit shall be available with pump and motor for continuous filtration of the oil. Filter change possible without switching off main pumps to avoid shutting down bypass for filter change. Oil filling shall be done through the circuit arrangement.

(h) Hydraulic Actuators

Energy for safe opening or closing (e.g. condenser protection) shall be independent of the oil pressure from the HSU, either through steam force or a separate hydraulic accumulator.

Position control cabinet to perform the modulating function and Quick close/open operation of the valves. DCS shall be the master equipment to communicate with the supplier supplied PCS cabinet.

PCS cabinet shall be supplied with the PASO software for initial commissioning/calibration purpose of the connected actuator.

Actuators are to be supplied with the position feedback transmitter cum limit switches for open and close measurements.

Hydraulic positioner shall be of digital smart type featuring simple adjustment through digital interface. For easy commissioning and maintenance positioners are located close to the valve/actuator and must be suitable for the harsh environment. Connections to the actuator shall be prefabricated and pluggable.

1.21 TURBINE DRAIN SYSTEM

Contractor shall provide warming-up and drainage system for the steam turbine system to drain away the condensate which may be formed due to steam coming into contact with cooler metal during start-up and stagnant steam sections. The drains shall be provided for every low point with automatic disposal of collected condensate. The drains shall be connected to the flash tanks via headers. The connections on the header shall be graded according to

the pressure. The drains from main steam piping, HRH, CRH, BFP turbine system and auxiliary steam headers etc. shall also be connected to the unit flash tanks/atmospheric flash tanks. The steam turbine drain system shall be designed in accordance with the recommendations outlined in ASME TDP-1(latest addition) for protection against water induction to the steam turbine. Drains shall be tapped off from main line through a drip pot with provision for removal of entrapped dirt. **Turbine drain valve/ HP Turbine dump valve** ball type valves with Zero passing & Zero bubble leakage as per rated class with pneumatic actuator along manual hand wheel. Turbine drain valves upstream & downstream temp. shall be provided in DCS. For sections having drain formation during normal plant operation such as auxiliary steam header lines and alternate steam lines to BFP turbines and deaerator, steam trap assembly shall be provided in parallel to the motorized/pneumatic drain valve. Drain valves shall be located in accessible areas to facilitate their maintenance.

(i) Flash tanks shall be designed as per the requirement of ASME boiler and pressure vessels (B&PV) codes, and ANSI standard. The design pressure and temperature for the pressure vessels (except bellows) to be designed shall be 3.5 kg/cm2 and 215°C respectively. Flash tanks shall also be designed for full vacuum condition.

(ii) Corrosion allowance of 3 mm shall be added to the design thickness of the shell and head of the vessels. The minimum thickness of the vessels including corrosion allowance shall not be less than 8 mm.

(iii) The Shell, head, wear plate/ baffles shall be made of ASTM 285 Gr. C or equivalent material. The material of nozzle neck shall be ASTM A 106 Gr. B or equivalent.

1.22 PERFORMANCE REQUIREMENTS

(a) The steam turbine Generator set apart from being capable of operation on base load shall also be suitable for two shift operation and cyclic load variations as the unit is expected to operate in automatic load frequency control system.

(b) Bidder to provide adequate temperature measurement and other instrumentation etc. for adequately guiding the operator to regulate loading of unit to keep the thermal stresses and fatigue levels within safe limit. Ensure TG Set capability of operating on variable pressure mode.

The logic loop developed by C&I sub-system supplier including set point i.e. turbine protection, turbine stress control system etc. shall be reviewed and vetted by turbine manufacturer.

(c) Ensure during sliding pressure mode, throttle pressure slides from rated pressure down to 40% of rated pressure.

(d) Provide adjustable throttling reserve from sliding pressure to modified sliding pressure.

(e) Ensure TG set capable of operating continuously with any one string of HP heaters out of service, with worst condenser pressure, 1% make-up & Aux. Steam requirement tapped from CRH, generating not less than the rated output without overstressing turbine components.

(f) Use of drip pump, if envisaged, by the bidder shall be restricted to one LP Heater only.

(g) Only 15 T/hr. steam is expected to be tapped off from CRH during normal operation for auxiliary steam consumption. Auxiliary steam tap off from CRH during other special conditions can be higher.

(h) Ensure normal make-up to cycle in the condenser hot well at 1% which at times may go upto 1.5%.

(i) Ensure during HP-LP bypass operation deaerating feed water heaters & accessories shall heat feed water from 45 deg. C to 140 deg. C.

(j) Ensure all cycle drains to condenser through flash tanks. Start-up drains to be led to a separate atmospheric flash tank.

(k) The steam generators have been provided with the start up recirculation & drain system with startup drain re-circulation pump. However in such situation when steam generators start up drain re-circulation pump is not available, the steam generator start up drains shall be routed to a boiler atmospheric flash tank. Condensate transfer pumps shall be provided for pumping the condensate from this atmospheric flash tank to turbine condenser. Bidder may route this condensate to turbine condenser either directly or through a flash tank

In such a case bidder shall ensure the temperature of condensate leaving the condenser does not increase beyond 55 deg C, so that performance and life of condensate polishing unit, is not affected adversely.

(l) Under all conditions of operation, the steam turbine generator set shall perform continuously without the noise levels of its components and auxiliaries (individually or collectively) exceeding the limits as specified Technical specification.

(m) Maximum permissible vibration measured at bearing housing will be as per zone A of ISO 10816-2. For auxiliaries, the vibration levels shall conform to 'GOOD' range as per VDI-2056 (criteria for assessing mechanical vibration of machines).

1.23 Heat Balance Diagrams:

1.23.1 Following Heat balances complete in all respects to be computed & furnished for the conditions stipulated with units indicated in MKS system & IAPWS-IF 97 steam tables. Pressure (in ata), temperature (in deg C), enthalpy (in kcal/kg) and flow (in tones /hr) will be indicated at all required locations to facilitate manual checking by the Employer. Other conditions for computing heat-balances are given elsewhere in the specification.

a) 840 MW VWO output (i.e. 105% TMCR) under rated steam condition at design condenser pressure with zero make up (GUARANTEED POWER OUTPUT).

b) 840 MW VWO output (i.e. 105% TMCR) under rated steam condition at design condenser pressure with zero make up (GUARANTEED HEAT RATE).

c) 800 MW output under rated steam conditions at design condenser pressure with zero make-up (GUARANTEED HEAT RATE).

d) 640 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure operation and rated steam temperature at design condenser pressure with 0% & 1% make-up.

e) 560 MW output under sliding pressure operation at design condenser pressure with 0% and 1% makeup

f) 480 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure at design condenser pressure with 0% & 1% make-up.

g) 400 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure operation at design condenser pressure 0% & 1% make-up.

h) 800 MW output under rated steam conditions at design condenser pressure with 1% make-up.

i) VWO output under rated steam conditions at design condenser pressure with 1% makeup.

j) VWO output under rated steam conditions at worst condenser pressure with 1% make-up

k) 800 MW output under rated steam conditions at worst condenser pressure with 1% make-up.

l) VWO with over pressurization corresponding to boiler capability at design condenser pressure with 1% make-up (If applicable).

m) 240 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure operation at design condenser pressure with 0% & 1% make-up.

n) HP heaters out of service (One string and both strings) under rated steam conditions at design & worst condenser pressure with 0% & 1% make up with maximum continuous output.

o) All HP heaters out of service under rated steam conditions at design & worst condenser pressure with 0% and 1% make-up with rated output.

p) 800 MW output under sliding pressure conditions at design condenser pressure with 0% & 1 % make-up.

q) HP-LP bypass operation under rated steam conditions with bypass valves open to full capacity and turbine on house load operation.

r) HP-LP bypass operation under rated steam conditions with steam generator output of 60% of BMCR.

s) 60% unit load with one condenser(s) in isolated condition.

t) Steam generator output corresponding to BMCR flow under rated steam conditions, turbine in parallel operation with HP-LP bypass with bypass open to full capacity.

u) Steam Generator output corresponding to BMCR flow under rated steam condition, turbine under VWO operation, worst condenser pressure with 0% and 1% make up. Difference of BMCR flow and VWO steam flow through turbine shall be assumed to be drawn off from Main steam line.

Same quantity of flow is to be added to condenser as additional make up.(GUARANTEED STEAM GENERATOR CAPACITY)

v) Turbine operation at 40% rated pressure at design condenser pressure with 0% and 1% make up, under sliding pressure operation.

w) 65% unit rated output under sliding pressure operation at design condenser pressure with 0% and 1% make up.

x) 816 MW(102% of rated load) under turbine throttle inlet steam condition corresponding to pure sliding pressure operation and rated steam temperature at design condenser pressure with 1 % make-up(if overload valve is offered).

y) 840 MW output at 1 % make-up design CW temperature and CW flow.(CONDNESER PRESSURE GUARANTEE CONDITION)

Note:

- Any additional heat balance deemed necessary by the owner shall be furnished. All the heat balances shall show turbine output mechanical & electrical losses in turbine and generator and input to shaft driven auxiliaries (if any).
- Steam supply to deaerator shall be from IP-LP cross-over / cross around pipe or from a point as per optimised cycle of the bidder and the minimum deaerator pressure shall be 3.5 ata during low-load operation and HP-LP Bypass operation.
- Drive turbines of BFP shall get steam from IP/LP crossover/cross around pipe or from a point as per optimised cycle of the Bidder during operation of turbine from full load to 60% EMCR load or below, if possible. At low loads, Drive turbines of BFP shall get steam from an alternate source from the same unit.
- It may be noted that for the purpose of HBD, quantity of desuperheating water to boiler superheater and reheater shall be considered as zero.
- Bidder to submit the HMBD on 800 MW output at 38°C cooling water inlet temperature also.
- Design pressure for duel pressure condenser shall be average of all the condenser pressures.

1.23.2 HEAT RATE

The turbine cycle heat rate shall be calculated as per formula indicated in section for Functional Guarantees and Liquidated Damages of the technical specification.

1.23.3 Correction Curves

Correction curves, if applicable, due to change in superheater & reheater quantities with respect to coal properties. (Note: Bidder shall necessarily include the correction curves for variation in super heater & reheater spray quantities with coal properties in his bid proposal, failing which no correction shall be permitted).

In Condenser Pressure variation Curves, the Change in net heat load to be furnished.

Combined (Boiler + TG) Start-up Curves for Hot start, Warm Start, Cold Start & any other shall be furnished.

Based on cycle condition & covering entire range of operation for Turbine & Condenser following correction curves for variation in Turbine Heat Rate & output to be furnished:

(a) Variation in main steam pressure and temperature.
(b) Variation in reheater steam temperature.
(c) Variation in RH sprays flow due to varying coal properties.
(d) Variation in condenser pressure for main condenser.
(e) Variation in power factor, frequency, generator hydrogen pressure and voltage.
(f) Change in system water storage.

Following condenser pressure variation curves for main condenser for change in CW inlet temperature, Heat load & quantity in condenser to be furnished

(i) Change in CW inlet temperature
(ii) Change in CW- quantity.

The above list of correction curves is conclusive & curves in addition to above shall not be applied.

1.23.4 Furnish turbine expansion line diagrams for guaranteed load point along with group efficiencies.

1.23.5 Furnish thermal kit data for plant performance by DDCMIS and true copies of Performance Guarantee test reports for sets rated for 800 MW or above.

1.23.6 Furnish turbine clearance diagram indicating values for radial & axial clearances and leakage rate at EMCR & under worst operating conditions.

1.24 Type test(s) to be conducted:

Following type tests as detailed in QA portion of the technical specification are to be carried out:

a) Life cycle test, meridional yield rupture test and squirm test on one metallic expansion joints of each type and size.

2.0 CONDENSING PLANT

(a) Design, manufacturing and testing as per Heat Exchange Institute, USA (latest) with proven design. Bidder to furnish thermal, hydraulic and mechanical design calculation for checking equipment capability.

(b) Suitable for condenser cooling water as specified. The Condenser on Load Tube Cleaning System (COLTCS) metallurgy and system design has to be suitable for cooling water quality specified. As such all material of condensing plant have to be suitable for intended service.

(c) Suitable for CW system of closed type with cooling Towers.

(d) Design for installation of LP heater(s) in condenser neck.

(e) Condenser to be designed for minimum air leakage and under normal operating conditions, the air leakage in condenser not to exceed more than 50% of design value taken for sizing of vacuum pumps. The same shall be demonstrated at site under actual operating condition failing which Bidder shall carryout necessary modifications.

(f) Separate sponge ball type condenser on-load tube cleaning system for each condenser including ball circulation pumps, strainer and ball monitoring system.

(g) Maximum oxygen content of condensate leaving the condenser shall be 0.015 CC per litre over the entire load range.

2.1 CONDENSER

(a) Horizontal surface type condenser of proven design with integral air cooling section and divided water box construction.

(b) Large box type screening structure with anti-vortex baffling at each hot well connection to suction of condensate pumps.

(c) Condenser shall be spring supported or rigid supported as per standard practice of manufacturers

(d) Provide suitable impingement guards or baffles on top row tubes. Similar guards for any steam or water connection to condenser. Other alternate arrangements to the satisfactory protection of top row of tubes shall also be considered.

(e) Easily removable/hinged type and refittable type water boxes alongwith suitable handling arrangement and provision of hinged manholes (of 460mm size) in shell, each water box and each hot well suction.

(f) Adequate cathodic protection shall be made for the water box and other water components in the condenser. COLTCS and other components of CW system to protect against corrosion. Water box interiors to be resin coated with suitable corrosion resistant primer of 0.25 mm minimum thickness.

(g) Tubes shall be welded type stainless steel as per ASTMA-249-TP304 and meeting the ASME specification for general requirements for carbon ferritic alloy and austenitic alloy steel tubes SA-450 and continuous without any circumferential joint suitable for intended duty with average wall thickness 22 BWG (minimum). Top rows of tubes shall be extra thick. Provision for taking care of thermal expansion of tube bundle and proper drainage of tubes during shut down shall be ensured.

(h) Water box, tube plates and support plates material carbon steel as per ASTMA-285 Gr.C or equivalent and suitable for intended duty. Adequate cathodic protection of water box side shall be provided and Titanium cladding of required thickness (5 mm minimum) shall be provided on water side of tube sheet plate.

(i) Corrosion allowance of minimum 3.2 mm for water boxes, tube plates and 1.6 mm for shell, hotwell and condenser neck.

(j) Stand pipes with necessary connections for instruments, with water level gauges and isolation valves.

(k) Ensure efficient steam distribution in the condenser when one half of the condenser is isolated and ensure atleast 60% of rated output under this condition.

(l) Suitable provision (like sliding and fixed base plate of condenser support feet etc.) for expansion of condenser shell to be made.

(m) Shell material shall be carbon steel conforming to ASTMA-285 Gr.C or equivalent and suitable for intended service, welded construction and 16 mm minimum wall thickness. Hotwell material shall be same as that of shell material and with proper drainage provisions.

(o) 2X100% capacity, fully automatic debris filter shall be installed on each condenser inlet line of suitable mesh size for clarified water application shall be provided with covered shed above ground level at the outside of the TG building at the upstream of COLTS for each CW inlet line. Debris filter shall be supplied with automatic self wash system. The debris filter design has to be suitable for clarified water quality. Debris filter flushing line outlet shall be routed to ash dyke by suitable arrangement.

(p) If condenser spring loaded deck than bidder must provide the condenser supports for carrying out flood test upto tip of last stage blade.

(q) The condenser tube must be SS seamless tubes (ASTM A-213-TP304).

(h) Water box interiors shall be painted with two coats of corrosion resistant primer and coated with coal tar epoxy paint or shall be rubber lined as per duty requirements involved. Tube plate on water side may alternatively be provided with suitable cladding as per standard practice of OEM.

(i) Air release valves and vacuum priming pumps (if applicable) shall be provided in water box of the condenser.

(j) All extraction pipes routed through the condenser shall be provided with stain less steel shroud to prevent erosion.

(k) All bolts, nuts and stays etc. inside the steam space shall be of approved material and where such parts project through tube plates they shall be fitted with stainless steel or approved cap nuts and protective sleeves. For deaerating zone, trays, fittings etc. made of stainless steel shall be provided.

2.2 DESIGN REQUIREMENT

(a) The duel pressure condenser shall be designed for heat load corresponding to unit operation for VWO, 1% make-up and design condenser pressure and conditions given at elsewhere in the specification. Condensate temperature at all loads shall not be less than the saturation temperature corresponding to condenser pressure.

(b) Design for full vacuum and min. internal pressure 1.08 Kg/cm^2 (g). Minimum shell side design temperature 120 deg. C.

(c) The Condenser hotwell shall be sized for three (3) minute storage capacity (between normal & low-low level) of total design flow with the turbine operating at VWO condition, 1% make-up & design condenser pressure. The low-low level of hotwell shall be atleast 200 mm above the bottom of hotwell.

(d) Sizing of steam dumping device to accept the steam from HP-LP bypass with necessary spray water including abnormal conditions like HP heaters out of service etc.

(e) Design of air removal section to cool the air and vapour mixture to atleast 4.17 deg. C below saturation temperature corresponding to 25.4 mm Hg (abs). Connections to air evacuation pumps shall be made at this section.

(f) Design for exhaust steam from steam turbine, BFP drive turbine, HP-LP bypass system, heater drains and vents, boiler separator drains during start up, low load and abnormal conditions and other miscellaneous drains.

(g) Designed to carry flooded weight (up to 1 m above of top row of condenser tube) for hydraulic and hydrostatic testing of condenser without installation of temporary supports or bracing.

(h) The condenser pit and CEP pit shall be partitioned and separate so that clarified water and DM water do not get mixed.

(i) C.W. butterfly valves with actuators shall be designed as per AWWA C-504 or approved equivalent standards.

(j) C.W. expansion joints shall be made from high quality natural/ synthetic rubber with carbon steel reinforcement rings and with flanges as per Class D of AWWA C 207. The expansion joints shall be designed as per expected deflections and fluid pressure during all plant operating conditions and shall be suitable to withstand full vacuum without collapse.

1.	Condenser Design Parameters	
a)	Number of Passes	Single pass/double pass.
b)	Design cold water temp.	32.5°C
c)	Min. size (O.D) of the tube	22.225
d)	Minimum thickness of the tube	22 BWG or Min. 0.71mm
e)	Tube velocity	1.6 to 2.2 m/sec
f)	Design condenser pressure	As optimized by the bidder at 1 % make-up and 32.5^0C CW temperature at VWO Condition but not exceeding 70 mmHg (abs).
g)	Max. tube length between tube plates	15 meters (Indicative)
h)	Temperature rise in circulation water across the condenser	Not more than 8.5 Deg C
i)	Tube material	SS Seamless tubes (ASTM A-213-TP304)

j)	Cleanliness factor	0.9
k)	Tube plugging Margin	5%
l)	Maximum CW side pressure drop in condenser and its associated systems under design CW flow and CW inlet temperature with tube cleaning system in operation.	As optimized by bidder but not exceeding 8.5 MWC
m)	Maximum circulating water temperature deg.C (min.)	38°C (max.)
n)	Condenser arrangement	Perpendicular to T.G. axis
2.	Water box design pressure	0.1 kg/cm² (abs) and 5 kg/cm²(g)
3.	Water box test pressure	1.5 times the design pressure
4.	Water box design temperature	60°C
5.	Shell side design pressure	Full vacuum and 1.08 Kg/cm^2 (g)
6.	Shell side design temperature	120°C
7.	Design parameters for expansion joints:	
a)	Design pressure	0.1 kg/cm² (abs) and 5 kg/cm²(g)
b)	Design temperature	60°C
c)	Test pressure	1.5 times the design pressure
8.	Design parameters of isolating butterfly valves with actuator	
a)	Design pressure	0.1 kg/cm² (abs) and 5 kg/cm²(g)
b)	Design temperature	60°C
c)	Test pressure	1.5 times the design pressure
9.	Condenser air evacuation system design parameters	
a)	Source of vacuum pump heat exchanger cooling water	Condenser cooling water as per analysis given else where in the specification
b)	Source of sealing water	Condensate
c)	Source of make-up water	Condensate
d)	Design pressure (cooling water side for vacuum pump heat exchanger	0.1 kg/cm² (abs)
e)	Pressure of make-up water	CEP discharge pressure
f)	Maximum temperature of condenser cooling water	38°C
g)	Duty code	HEI (Latest)
h)	Design condenser pressure	25.4mm (1 inch) of Hg (abs)

10.	Design pressure for CW piping, valves fittings, COLTCS equipment on the CW line etc	0.1 kg/cm² (abs) & 5 kg/cm² (g) CW line etc

2.3 ERECTION AND CONSTRUCTION REQUIREMENT

(a) If the condenser shells call for site assembly, care shall be taken in the assembly of shells, and the correctness of alignment shall be checked in a manner acceptable to the Owner prior to stitch welding. With stitch welding over, and on clearance of final alignment by the Owner, final welding shall be done by 'seam method' so as to ensure a minimum deformation of the welded parts. Only approved welders shall perform such welding operation. All the weld seams shall be properly ground and subjected to non-destructive examination. At least 10% of butt welded seams shall be subjected to radiographic examination.

(b) If the superstructure portion or the upper portions of the condenser are not welded to the condenser shell in the Contractor 'works, then they shall be properly aligned with the Condenser shells at site. Any special fixtures required for such alignment shall be furnished alongwith the equipment and made use of by the Contractor. All welding shall be done as prescribed under in this volume above and the weld seams shall be properly ground and subjected to dye-penetrant test.

(c) The Contractor shall be governed by the following conditions during condenser tubes insertion and expansion.

(1) The condenser shall be installed in its position prior to tube insertion. Tube insertion and expansion shall not be carried out in the open.

(2) The tubes shall be free from any dents, mechanical damages or any other defects caused during the storage.

(3) Both ends of the tube where tube expansion has to be carried out shall be thoroughly cleaned to a length of 100 mm to remove oil grease etc. The cleaning shall be done with a fine emery paper.

(4) The surfaces of the holes in the tube plates and the tube support plates shall be thoroughly cleaned and shall be free from paint, corrosion spots, oxide scales etc. The method adopted by the Contractor for such cleaning of the holes shall meet the approval of the Owner. Final cleaning shall be performed by a chemical cleaning agent like Carbon Tetra Chloride.

(5) The cleaned surfaces of the tubes and the reamed tube plate holes shall be free from any longitudinal scratches.

(6) Tubes shall be inserted such that their ends shall project out 2 to 3 mm beyond the tube plate outer surface. The tube shall then be expanded using an electronic automatic torque control tube expanding unit or pneumatic tube expander so as to get thinning of the tube walls as per bidder's standard design practice and the elongation of the tube ends shall be 0.40 to 0.60 mm. Tube expansion shall be so controlled that neither over expansion nor under expansion of the tubes takes place. Tube expansion shall be checked with a dial bore gauge indicator. Tube expansion shall be carried out to a length of 70% to 80% of the tube plate

thickness. In no case, the expansion shall go beyond the tube plate thickness. The tube insertion shall be such that the excess length of all tubes shall be at the same tube plate and they shall be cut off by a cutting tool followed by expansion. Both ends of tubes after expansion shall be flanged properly. Finally, proper chamfering shall be carried out. Expansion of condenser tubes shall start from the peripheral holes of the tube plate and shall proceed towards the centre of the tube plate in such a sequence as to avoid any deformation of the tube plate.

(d) In case the condenser is supported on springs and the condenser neck is directly welded to the L.P. cylinder exhaust hood, then the final lifting and installation of the condenser on permanent support shall be carried out only after final installation of the L.P. casing. It shall be ensured that all spring supports are evenly loaded and the gap between the condenser and the spring supports is within +/- 1.0mm. Suitable adjusting bolts shall be used to further lift the condenser till the clearance between condenser neck and L.P. exhaust hood is suitable for welding and such clearances shall not exceed 3.0mm. The welding of the above connection shall be performed as called for as prescribed in this volume above. Suitable machined permanent spacers shall be provided and the condenser load shall gradually be transferred on to these spacers from temporary bolts.

2.4 HYDROSTATIC AND HYDRAULIC TESTS

(a) The hydrostatic testing of condenser steam space shall be carried out after connecting all the pipes with the condenser alongwith the condenser vacuum system by filling the steam space with water 300 mm above final joint of condenser exhaust neck to turbine. Any leakage detected shall be rectified immediately. The level of hydraulic test shall be selected such that all the field welding joint shall be covered.

(b) The water space shall be tested hydraulically alongwith the circulating water lines, after assembly of the water box doors.

(c) After the hydraulic testing, the water boxes tube plates and covers shall be given suitable coatings of anti-corrosive paints. The paints and painting shall meet the approval of the Employer.

2.5. OPERATIONAL REQUIREMENT:

(a) Steam dumping device for dumping of desuperheated steam from LP bypass alongwith all accessories and instrumentation.

(b) No damaging due to vibration during normal, abnormal and transient conditions and during turbine trip from full load to HP-LP bypass operation, feed heaters out of operation, VWO condition, 100% load and start-up condition etc. Bidder to ensure satisfactory operation under above operating conditions.

(c) Natural frequency well above the frequencies induced by other associated equipments under all operating conditions including abnormal.

(d) For maximum deaeration and removal of non-condensable gases from steam and make-up water, air removal section to be suitably baffled to prevent water carryover.

(e) Air release valve and drain valve in water box and condenser shell and also for complete drainage of water from hot well.

(f) Water box, adequate size nozzle and valve for priming of condenser.

(g) Provide catch trough below tube sheet in hot well for detection of water leakage into steam side.

(h) Provide of motorized butterfly valve in each exhaust duct of BFP turbine for isolation of BFPT, when not in use.

2.6 CONDENSER AIR EVACUATION PUMPS

(a) Provide 2x100% air evacuation pumps for each condenser along with all accessories and instrumentation.

(b) Single/two stage liquid ring type with both stages (if two stage pumps provided) mounted on a common shaft.

(c) Suitable for indoor installation and for continuous duty The cooler used in vacuum pumps shall be with SS seamless tubes (ASTM A-213-TP304).

(d) Each pump and its accessories shall be mounted on common steel base plate. Pump shall be connected to motor by flexible coupling.

(e) Heat Exchangers shall be shell and tube type. For U-tube type: Removable tube bundle provision shall be provided. Alternatively-plate type heat exchangers with SS 316 plates and 20% area margin on plates also acceptable.

(f) Material of tube is SS 304. Material of shell and tube plates as M. S. type ASTM-A285 Gr. C properly coated.

(g) For U-tube type: Removable tube bundle provision.

(h) Pumps shall be sized as per latest HEI requirements holding capacity of each pump in free dry air at standard condition i.e. 760 mm Hg (abs) and 21.1^{0}C and capacity during hogging operation shall not be less than as specified in table. Vacuum pump impeller/ shaft should be of SS material.

2x100 % vacuum pump per condenser	Holding operation(with condenser operating at design pressure of 1 inch(25.4 mm) of Hg(abs) and sub cooled to 4.17^{0}C below temperature corresponding to absolute suction pressure)	20 SCFM (34 m^3/hr.)
	Hogging operation(at 10 inch(254 mm) of Hg(abs) condenser pressure	500 SCFM(850 m^3/hr) under standard conditions i.e. 760 mmHg(abs and 21.1^{0}C)

The above holding capacity of vacuum pump shall corresponds to the vacuum pump ITD (initial temperature difference) calculated separately for each condenser as mentioned below.

Vacuum Pump ITD = Saturation temperature corresponding to optimized condenser pressure for the respective condenser shell (which is considered for guaranteed condenser pressure)-specified cooling water inlet temperature to vacuum pump seal water cooler.

The hogging capacity of vacuum pump shall corresponds to specified cooling water inlet temperature to vacuum pump seal water cooler.

(i) Selection of materials for vacuum pumps and seal water recirculation pumps as below:-

(1) Casing - Nickel cast iron
(2) Shaft – Stainless Steel
(3) Impeller - stainless steel
(4) Shaft sleeves-Nodular iron/stainless steel

(j) Flexibility shall be provided for operating all the vacuum pumps during hogging and must be able to evacuate the condenser(s) in specified time as per HEI. Capacity of each pump during hogging operation shall as per criterion given in latest version of HEI plus 20% margin.

(k) Provision of Air Ejector(of required) for abnormal operation and selection of suitable compression ratio for air ejector

(l) The stand-by pump shall cut in automatically in case running pump fails or when condenser pressure falls back to a preset value.

(m) No cavitation under all operating conditions without air ejector.

(n) Noise levels should not exceed limitations as specified in Section of General Vibration limits shall be as per zone A of ISO 10816

2.7 TYPE TEST(S) TO BE CONDUCTED

Following type tests as detailed in QA portion of the Technical specification are to be carried out on one vacuum pump.

(a) Cavitation test
(b) Wet air test

3.0 CONDENSER ON LOAD TUBE CLEANING SYSTEM

(a) Sponge rubber ball type tube cleaning system designed for continuous & trouble free operation with abrasive coated balls cleaning in case of hard deposits inside tubes. Rubber ball pump housing & internal should be of SS material along with mechanical seal.

(b) Suitably sized non clog type ball recirculation pump to inject the cleaning balls into respective CW inlet pipe.

(c) Suitable ball injection nozzles.

(d) Suitable ball collecting strainer to be provided at CW discharge pipe to collect the cleaning ball and the same will be drawn off to the suction of ball recirculation pump.

(e) Sufficient capacity ball collecting vessel to hold the full charge of balls

(f) Necessary piping, fittings and accessories for complete installation of the system.

(g) Automatic / manual ball sorter to sort out under size balls.

(h) The system should be complete with necessary instruments, protection and interlocks.

(i) Provide manual and automatic back washing system with automatic collection of balls prior to back washing.

(j) Provision of ball monitoring system, which should at least consist of separate ball circulation monitor and ball oversize monitor.

(k) The ball collecting strainer should have redundant differential pressure transmitter, switch and gauge with remote seal type connection.

(l) The no. of balls in circulation should be at least 10% of nos. of condenser tubes.

(m) Bidder should indicate the number of ball losses in 1000 hrs. of normal operation.

(n) Enough provision for homogeneous ball injection and even distribution of balls throughout the condenser tubes.

(o) Avoid any dead zone inside the water box.

(p) Bidder should ensure that there should not be crowding of balls at the inlet of ball collecting strainer at discharge pipe.

(q) Provision to prevent losses of ball during normal and abnormal condition including tripping of CW pump.

(r) The ball re-circulating pumps, collector, monitor etc. shall be skid mounted.

4.0 Condensate Polishing Unit (CPU)

Refer Chapter 9.

5.0 CONDENSATE EXTRACTION PUMP

(a) **Configuration:**

2 x 100% or 3 X 50 % Condensate extraction pumps with mechanical seal gland arrangement..

(b) **Drive**

Constant speed squirrel cage induction motor with speed of 1500 rpm (Synchronous) with VFD.

(c) **Constructional Requirements**

Vertical, Multistage, Canister type, Centrifugal, diffuser type with double suction first stage impeller.

(d) **Shaft sealing**

Mechanical seals designed to prevent air ingress to condenser even when the pump is under shut down and exposed to condenser.

(e) **End Connections**

Discharge and suction connection of weld neck type, raised steel flange as per ANSI B. 16.5 and to be located above floor mounting flange.

(f) **Thrust Bearing**

Thrust bearing for the combined thrust load of pump and motor with a rigid coupling between pump and motor or individual thrust bearings for pump and motor with a flexible coupling between motor and pump.

(g) **Impeller/Casing design**

Closed and nonover-loading type impeller with wear rings on pump bowls.

(h) **Pump Sizing**

(i) **Design Capacity**

Combined flow of 2 x 50 % CEP to be based on 10% margin over highest condensate flow envisaged during unit operation (excluding HP/LP bypass operation).

Design Head

Corresponding to above considering 10% margin over deaerator pressure

(ii) **Best Efficiency Point**

Combined flow of 2x50% CEPs shall be based on TG unit EMCR and corresponding head.

(iii) **Maximum Capacity**

One pump shall be capable of handling the flow and head corresponding to 65% unit load.

(iv) **Other Capabilities**:

(i) 2 pumps shall be capable of handling the flow corresponding to Unit EMCR, all HP heaters out, 1% make up and worst condenser pressure at 47.5 HZ.

(ii) 2 pumps shall be capable of handling the flow corresponding to HP -LP by pass operation with turbine under tripped condition as well as turbine on house load.

(i) **Motor Rating**

Motor rating at 50 deg. C ambient temperature shall not be less than the maximum load demand of its driven equipment in its entire operation at frequency variations from 47.5 Hz to 51.5 Hz and motor shall not be over loaded during any mode of operation of driven equipment. The selection of the motor KW rating will be based on the selection criterion of motors mentioned in the electrical specification.

(j) **NPSH Margin**

NPSH (R) at 3% head drop shall not be more than half the NPSH (A) at design flow with low low hotwell level and NPSH(R) at 3% head break shall be well below NPSH (A) under all conditions.

(k) **Motor Bottom Level**

Bottom of motor to be above zero meter by suitably considering the pit level and motor stool dimensions.

(l) **Minimum Recirculation Flow**

Individual recirculation line for each CEP shall be provided. Minimum recirculation flow requirements of the pump shall be not less than 25% of design flow or on set recirculation (discharge/suction) whichever is higher.

(m) **Performance Curve**

Characteristic curve of pumps should be continuously rising type with decrease in flow and shut off head shall be between 115% to 130% of TDH at design point.

(n) **Critical Speed**

First critical speed in water shall not be within 20% of design speed.

(o) **First Stage Impeller Life**

Life due to wear due to Cavitation of first stage Impeller not less than 40,000 running hours

(p) **Peripheral speed at the eye of the impeller**

Not to exceed 20 m/sec.

(q) **Suction Specific Speed**

Suction specific speed of first stage impeller not to exceed 11,000 U.S. units based on 3% head break of that impeller at design point.

(r) **Interchangeability**

Complete interchangeability in all respects of the pumps and their components.

(s) **Design Pressure**

(i) Bowls and discharge components design pressure shall correspond to shut off head at 51.5 Hz and operating specific gravity and maximum suction condition.

(ii) Suction components shall be designed for 8 ata and full vacuum.

(t) The pump internals to be capable of being lifted out of casing after removal of motor and disconnecting discharge flange but not disturbing the discharge piping.

(u) **Material**

The material adopted shall not be inferior to those mentioned below:

(i) Suction bell/Pump casing - cast iron
(ii) Impeller/Wearings/Shaft/ Shaft sleeves - 12% Cr. stainless steel.
(iii) Cannister - Fabricated mild steel.

(v) **Applicable Code**

HIS (Latest edition)

(w) **Strainers at Condenser Extraction Pump Suction**

(1) Strainer body simplex and cylindrical type

(2) The clear area of strainer to be Five times the inlet cross sectional area of the connecting piping.

(3) Strainer to be constructed of 16 gauge perforated stainless steel (304 grade) and lined with stainless steel (316 grade) screen.

(4) At design flow and clean condition, Pressure drop not to exceed 0.1 Kg/cm2.

(5) At design flow and 50% clogged condition, Pressure drop not to exceed 0.15 kg/cm2.

(6) Strainer design to permit ease of inspection and cleanliness.

5.1 TYPE TEST(S) TO BE CONDUCTED

Following type tests as detailed in QA portion of the Technical Specification to be carried out:

a) NPSH (R) test on one CEP.
b) Pressure drop test on one CEP suction strainer
c) Strip down test of CEP which has undergone NPSH(R) test.

5.2 DRIP PUMP (IF OFFERED)

If the bidder optimizes the Cycle with drip pump at any one location for forward cascading of LP heater drain, then 2x100% Drip pumps shall be provided.

(a) **Configuration:**

2 X 100 % drip pumps.

(b) **Drive**

Constant speed squirrel cage induction motor with speed of 1500 rpm (synchronous).

(c) **Constructional Requirements**

Vertical, Multistage, Cannister type, Centrifugal, diffuser type

(d) **Shaft sealing**

Mechanical seals designed to prevent air ingress to heater even when the pump under shut down and exposed to heater.

(e) **End Connections**

Discharge and suction connection of weld neck type, raised steel flange as per ANSI B. 16.5 and to be located above floor mounting flange.

(f) **Thrust Bearing**

Thrust bearing for the combined thrust load of pump and motor with a rigid coupling between pump and motor or individual thrust bearings for pump and motor with a flexible coupling between motor and pump.

(g) **Impeller/Casing design**

Closed and nonover-loading type impeller with wear rings on pump bowls.

(h) **Pump Sizing**

(i) **Design Capacity**

Each drip pump flow to be based on 15% margin over highest drip flow envisaged during unit operation.

Design Head

Corresponding to above considering 10% margin over deaerator pressure.

(ii) **Other Capabilities**

1 pump shall be capable of handling the flow corresponding to Unit EMCR, all HP heaters out, 1% m.u. and worst condenser pressure at 47.5 Hz.

(i) **Motor Rating**

Motor rating at 50 deg. C ambient temperature shall not be less than the maximum load demand of its driven equipment in its entire operation at frequency variations from 47.5 Hz to 51.5 Hz and motor shall not be over loaded during any mode of operation of driven equipment. The selection of the motor KW rating will be based on the selection criterion of motors mentioned in the electrical specification.

(j) **NPSH Margin**

NPSH (R) at 3% head drop shall not be more than half the NPSH (A) at design flow with low low heater level and NPSH(R) at 3% head break shall be well below NPSH (A) under all conditions.

(k) **Motor bottom level**

Bottom of motor to be above zero meter by suitably considering the pit level and motor stool dimensions.

(l) **Performance curve**

Characteristic curve of pumps should be continuously rising type with decrease in flow and shut off head shall be between 115% to 130% of TDH at design point.

(m) **Critical Speed**

First critical speed in water shall not be within 20% of design speed.

(n) **First stage impeller life**

Life due to wear due to Cavitation of first stage Impeller not less than 40,000 running hours

(o) **Peripheral speed at the eye of the impeller**

Not to exceed 20m/sec.

(p) **Suction specific speed**

Suction specific speed of first stage impeller not to exceed 11,000 U.S. units based on 3% head break of that impeller at design point.

(q) **Interchangeability**

Complete interchangeability in all respects of the pumps and their components.

(r) **Design Pressure**

(i) Bowls and discharge components design pressure shall correspond to shut off head at 51.5 Hz and operating specific gravity and maximum suction condition.

(ii) Suction components shall be designed for 8 ata and full vacuum.

(s) The pump internals to be capable of being lifted out of casing after removal of motor and disconnecting discharge flange but not disturbing the discharge piping.

(t) **Material**

The material adopted shall not be inferior to those mentioned below:

(a) Suction bell/Pump casing - cast iron

(b) Impeller/Wearings/Shaft/ Shaft sleeves - 12% Cr. stainless steel.

(c) Cannister - Fabricated mild steel.

(u) **Applicable Code**

HIS (Latest edition)

(v) **Strainers at drip Pump Suction**

(i) Strainer body simplex and cylindrical type

(ii) The clear area of strainer to be Five times the inlet cross sectional area of the connecting piping.

(iii) Strainer to be constructed of 16 gauge perforated stainless steel (304 grade) and lined with stainless steel (316 grade) screen.

(iv) At design flow and clean condition, Pressure drop not to exceed 0.1 Kg/cm^2.

(v) At design flow and 50% clogged condition, Pressure drop not to exceed 0.15 kg/cm^2.

(vi) Strainer design to permit ease of inspection and cleanliness.

5.3.1 TYPE TEST(S) TO BE CONDUCTED

Following type test as detailed in QA portion for CEP of the Technical Specification to be carried at:

NPSH (R) test on one Drip Pump.

6.0 FEED WATER HEATING PLANT

(a) The plant shall be designed as per ASME Boiler and pressure vessel code, section VIII, Division-I (Latest) Heat Exchange Institute Standards (USA). In addition the requirements of ASME-TDP-1 latest code for turbine water damage prevention shall also be taken care of. Plant shall be designed for all operating conditions including transients like sudden load throw-off, HP-LP bypass coming into operation, preceding one or two heaters going out of service etc.

(b) The plant shall be suitable for operation in conjunction with the turbine. It shall be designed for raising the temperature of feed water from that in the condenser to a final feed water temperature of not less than 293^{0}C / or (as optimized by bidder) at the outlet of top heater at rated output with zero percent make-up and design back pressure. TTDs and DCAs of heaters shall correspond to the 100% TMCR heat rate guarantee conditions.

(c) Each heater shall be designed for removal from service individually without shutdown of unit, using hydraulically operated or motorised bypass and isolating valves except HP heaters which can be isolated as a string and not individually. In addition, 2 x 50% capacity spring loaded relief valves shall be provided in the bypass arrangement of HP Heaters with each spring loaded valve capable of passing feed flow equal to 50% BMCR capacity.

(d) Design with Minimum pressure drop on tube side. Velocity of water through the tubes shall be restricted to 3.05 m/sec under all operating conditions.

(e) Design for handling drains from preceding heaters for all operating conditions and emergency drains to condenser bypassing the drain cooling zone.

(f) Easy for floor mounting and shell removal dismantling except for LP heaters in condenser neck.

(g) Complete drainage both shell side and tube (water box) side.

(h) Provide start-up and operating vents with orifices and relief valves for removing non-condensable gases collecting on shell side individually to condenser. Vent orifice shall be sized to pass one half percent of TMCR extraction steam flow to respective heater under TMCR conditions.

(i) Tube material stainless steel as per ASTMA 688 Gr.TP304 for welded tubes. Maximum content of carbon shall be limited to 0.05%.

(j) Tube sheet material shall be carbon steel as per ASTM. A516 Grade 70 or SA 350 LF-2 and shall be welded to shell and water box. Tube support plates of common quality steel of 16mm (min) thickness.

(k) Prevention of super heated steam contact with tube plate and joint at entry to heaters.

(l) Water box channels to have access openings of minimum 450 mm dia or off elliptical shape with minimum size 450 mmX 350 mm. These shall be self sealing type and bolted design is not acceptable.

(m) Preservation by nitrogen blanketing during shut down.

(n) Minimum tube size shall be 15.875 mm OD and minimum wall thickness after bending shall be as per HEI. HP heater tubes shall be SS seamless (ASTM A-213-TP304).

(o) Minimum fouling resistance tube side 0.00004098 hr-m^2-deg.C/kcal and an additional 0.000061475 hr-m2-deg.C/Kcal on outer tube as per HEI.

(p) Corrosion allowance of 3.2 mm for each heater shell and water box.

(q) Stand pipes with necessary connections for instruments with water level gauges and isolation valves.

(r) Proper drainage of bled steam lines to be ensured. Each bled steam line to have ordinary and power assisted NRVs and motorised isolation valves except for heater mounted in condenser neck.

(s) Adequate baffling to prevent vibration, ensure uniform steam distribution and free drainage of condensate.

(t) Provide pass partition plates to facilitate easy removal and access to tube sheet.

(u) Design to minimise space requirements for tube nest/shell withdrawal as the case may be.

(v) Provide sentinel relief valve on tube side. Relief valve on shell side sized to pass flow from two ruptured tubes (four open ends) or 10% of water flow corresponding to VWO condition with 1% make up and design condenser pressure at 10% accumulation, whichever is higher and set to open at heater shell design pressure.

(w) No copper or brass shall be used in the internal construction of heaters to avoid copper pick up through condensate/ drips.

(x) Time of operation of motor operated isolating valve in extraction lines/other critical lines shall be as under :-

1. HP Extraction: Not more than 30 seconds.
2. LP & Dearator Extraction: Not more than 45 seconds.
3. HP heater isolation & bypass lines on feed Water side : Not more than 30 seconds

(y) HP heater isolating & bypass MO valves shall have integral bypass valves, motor operated.

6.1 LOW PRESSURE HEATERS AND DRAIN COOLER

(a) Horizontal and U-tube type with integral drain cooler. Duplex type LP heater (two heaters in single casing) installed in condenser neck is also acceptable. LP heater tubes shall be SS seamless (ASTM A-213-TP304).

(b) Shell of rolled steel as per ASTM A-516 Gr. 70 with SS-304 bands at cut points on shell to prevent damage against flame impingement during torch cutting.

(c) Water box channel of carbon steel as per ASTM A-516 Gr. 70 and welded to tube sheet.

(d) Rolled expansion of tubes to tube sheets. Tube shall be cold bent for fabrication.

(e) Roller support for shell removal of all heaters except for LP heater in condenser neck and for LP heater in condenser neck roller support for heater channel during the tube bundle removal.

(f) Requirement of drain cooler for heaters, installed in condenser neck and heater with drip pump for forward cascading of drains shall be as per standard practice of the bidder and cycle optimization. If separate drain cooler is offered is shall be straight or U-Tube type.

(g) Provide shell attachments for supports of LPH in condenser neck and anti flash baffles to protect the turbine from water ingress.

(h) Each of LP heaters and drain cooler shall be capable of handling 110% of design condensate flow from 2x50% condensate extraction pumps without undue vibration and deleterious effects.

(i) Provision for differential expansion between shell and tube.

(j) Details of tube sheets, tube to tube sheet joint, and tube support plates to be given. Drain cooler Material of construction shall be identical to other LP Heaters.

(k) Design pressure :

- Tube side – 105% CEP shut off head at 51.5 Hz.

- Shell side - Not less than maximum extraction steam pressure and full vacuum having extraction from LP turbine(s) with minimum design pressure of 3 kg/cm^2(g).

6.2 DEAERATOR

(a) Horizontal spray-cum-tray with integral direct contact vent condenser mounted on horizontal storage tank.

(b) Alternatively, Spray type or Equivalent with minimum two (2) spray control valves of disc type or equivalent, in order to ensure fine atomisation of incoming condensate and rapid heating up by the steam.

(c) Design and construction as per Indian Boiler Regulations (if applicable), ASME code for unfired pressure vessels, Section-VIII or any other equivalent code.

(d) Reinforced wide mesh strainer and antivortex baffles at discharge connections from deaerator.

(e) Fixed and Saddles support on storage tank.

(f) All pressure parts like shell, heads and nozzles shall be of carbon steel as per ASTM A-516 Gr. 70. Shell plate min. thickness 15.8mm of welded construction.

(g) Hardened 400 series stainless steel impingement plates for flashed drain inlet from HP heaters, BFP recirculation, boiler startup drains etc.

(h) All water spray valves, splash plates, trays, vent condenser and other elements in contact with undeaerated water or non-condensable gases shall be of stainless steel SS-304 or SS410.

(i) Deaerator safety valves of adequate relieving capacity shall be made of 13% Cr. stainless steel disc and spindle.

(j) Design for efficient steam distribution and deaeration of condensate under all operating conditions including VWO, 1% m.u., HP-LP bypass, one string/both strings of HPH out of service.

(k) Deaerator operation will be floating pressure type. Pegging pressure at 3.5 ata during HP-LP bypass operation, major load rejection, turbine trip and low loads when extraction steam pressure is less than 3.5 ata. During cold start-up the deaerator pressure shall be maintained at 1.5 ata with steam from auxiliary steam header. During hot and warm startup, if boiler startup drain circulation pumps are in service, deaerator pressure shall be maintained at 3.5 ata. In case startup drain circulation pumps are not in

service and startup drains are routed through condenser, deaerator pressure shall be maintained 1.5 ata. Steam supply shall be from auxiliary steam header. Deaerator pressure shall vary with load when it gets steam from turbine extraction. Design pressure & temp. shall not be less than extraction pressure or worst operating condition with sufficient margins above the same.

(l) Sources for heating:

(1) Extraction steam from turbine IP-LP cross over / cross-around pipe (normal operation) or as optimized by the bidder.

(2) Steam from CRH till extraction steam (normal source) pressure is available.

(3) Steam from Auxiliary steam header till CRH steam pressure is available.

(m) Minimum feed water storage tank capacity shall be based on 6 (six) minutes of BMCR flow (approx.) between normal operating level and low-low level with a filling factor of 0.66. This capacity shall be exclusive of the volume of internal piping, baffles and volume of the dished end. It shall be designed for maximum incoming steam flow when none of the LP heaters are working under HP/LP bypass condition.

For calculating deaerator capacity below low-low level(BFP tripping point) bidder shall carryout the transient analysis of BFP suction system considering the following conditions:-

i) Sudden load throw off i.e. turbine trip from VWO operating condition.
ii) No-pegging steam is available for deaerator.
iii) Deaerator at low-low level.
iv) All LPHs in service i.e. condensate enthalpy as per operating HBD with all LPHs in service.
v) Condensate and feed water flow maintaining same level just before the start of transient.
vi) The calculation shall be carried out with above conditions till deaerator is depressurized to 3.5 Kg/cm2 (abs).

(n) Design to withstand full vacuum and pressure decay.

(o) Maximum oxygen content shall be 0.005 cc/litre at deaerator outlet measured as per ASTM-D-888 reference method-A or Indigo carmine method at all operating conditions.

(p) Free carbon dioxide as measured by APH method shall be non traceable at all loads.

(q) Shell thickness corrosion allowance 3.2 mm.

(r) Sparger pipe and nozzle for feed water heating.

(s) Size of vent orifice for one & half percent of TMCR extraction steam flow to deaerator.

(r) Provision of distribution pipe for accepting drains as applicable for once through type boiler. Bidder to indicate his standard practice for accepting such drains in the deaerator.

(t) Provision to prevent deaerator coming under vacuum at any point of operation shall be provided.

6.2.1 Sizing for handling all incoming condensate, HP heater drains etc.

6.2.2 Provide access platforms and ladders alongwith hand rails on deaerator and storage tank. Manholes of 450 mm dia (min) on deaerator and storage tank for access to and removal of internals including trays

6.3 HIGH PRESSURE HEATERS

6.3.1 Design Requirement

(a) 2X50% capacity HP heaters horizontal and U-tube type with integral desuperheating, condensing and drain cooling sections.

(b) Shell of carbon steel as per ASTM-516 Gr. 70 and water box channel as per ASTM-A-266 Class-II and shall be welded to tube sheet.

(c) Roller supports for shell removal.

(d) Tubes to be welded to tube sheets and then roller expanded.

(e) Provision for differential expansion between shell and tube.

(f) Tube material stainless steel as per ASTM. A 213 Gr. TP 304 for seamless tubes.

6.3.2 Design Pressure

(a) Tube side:
The design pressure of HP-Heaters tube side shall not be less than maximum of the followings:-

i) 1.05 times the maximum operating pressure (including BMCR condition) at BFP discharge.

ii) Pressure required at BFP discharge under lowest spring loaded safety valve on boiler separator blowing condition.

iii) Design Pressure as required by IBR/ASME.

Pressure relief valve/3-way valve across HPHs shall be provided so that HPHs are not subjected to shut off condition. The HPHs shall be designed for full vacuum also.

(b) Shell side: not less than maximum extraction steam pressure and full vacuum. Design pressure of HP heaters taking extraction from CRH line shall be CRH extraction pipe design pressure and full vacuum.

6.3.3 Each of HP heaters shall be capable of handling 110% of the design flow from BFP without undue vibration and other deleterious effects.

7.0 BOILER FEED PUMP

7.1 (a) **Configuration:**

2x50% Turbine driven feed pumps (normally working) and 1x50% Motor driven feed pump (stand by) with required margin.

(b) Drives will be Constant speed squirrel cage induction motor with hydraulic coupling between motor and main pump and booster pump at other end of motor for MDBFP and variable speed turbine drive with suitable coupling between turbine and main pump and booster pump at other end of turbine with a gear box for each TDBFP.

BFP lube oil coolers & working oil coolers should have standby BFP Turbine control oil should be FRF and its oil coolers should have standby ,100% capacity centrifuge,TAN Control,De Humudifier,NAS Control filter with online NAS Monitor hooked to DCS for each steam turbine driven pump.

(c) **Construction Requirements**

(i) Main Pump

Horizontal, centrifugal type, multistage, outer casing barrel type with end rotor removal.

(ii) Booster pump

Single stage, two bearing design and double suction impeller type. Overhung impeller not acceptable.

(d) **Suction and discharge connections**

(i) Main pump

Location of suction and discharge connections of TDBFPs on the bottom of barrel (if located on operating floor). Butt welding type discharge connections and either butt welding or flanged connection type suction connection.

(ii) Booster pump

Side suction and discharge connections of flanged, weld neck raised face as per ANSI B16.5.

(e) **Shaft Sealing**

Mechanical seals for booster pump and main pump.

(f) **Pump sizing**

(i) **TDBFP**

(1) Design capacity and design head. Combined flow of 2x50% Turbine driven Boiler feed pumps to be based on 10% margin over feed flow corresponding to turbine V.W.O. condition, 1% makeup, design condenser pressure and corresponding head.

In case continuous over pressure operation of unit is envisaged then the capability of pump for such an operation shall be verified.

(2) Best efficiency point

Combined flow of 2x50% TDBFPs shall be based on TG unit EMCR and corresponding head.

(3) Runout point: One TDBFP shall be capable of handling flow and head corresponding to 65% of unit rated load.

(4) Emergency point: Two Turbine driven feed pumps to be capable of generating the discharge pressure not less than steam generator highest safety valve set pressure corresponding to 105% of boiler maximum continuous rating.

(5) Other Capabilities

Combined flow of 2X50% TDBFP shall meet the following:

(a) BMCR flow and head corresponding to rated steam pressure.
(b) V.W.O. output, 1% makeup, worst condenser pressure.

(ii) **MDBFP**

(1) 1x50% MDBFP shall meet all the above conditions (i.e. (i) (1) to (5) above). The head developed by MDBFP shall be calculated in the same way as done for TDBFPs for all the above conditions so that TDBFPs and MDBFP can be operated in parallel**.** The MDBFP to be located either on Zero (+0.00M) meter floor or on any intermediate TG floor **(not on operating floor).**

(2) One TDBFP and one MDBFP operating in parallel shall be able to generate flow -and head corresponding to minimum 100% of unit load.

(3) The conditions corresponding to (i) (5) for one TDBFP shall be met by MDBFP.

(4) Interstage bleed connection from boiler feed pump to supply water to reheat steam desuperheater and kicker stage tap-off from boiler feed pump to supply water to superheater attemperation (if applicable).

(5) The condition corresponding to i(5) shall shall be met by MDBFP at 47.5 Hz.

Note: Discharge flow of main pump not to include any seal flow, warm-up flow and balance drum leakage flow.

(g) **Motor Rating**

The maximum continuous motor rating corresponding to maximum cooling water temperature at cooler inlet not less than the maximum

load demand of driven equipment at its entire range of operation at frequency variations from 47.5 Hz to 51.5 Hz and motor should not be overloaded during any mode of operation of driven equipment. The selection of the motor KW rating will be based on the selection criterion of motors mentioned in the electrical specification.

(h) **NPSH Margin**

The ratio between NPSH (A) and NPSH (R) at 3% head drop for booster pump and main pump shall be not less than 2.5 at design point corresponding to Low-Low level of deaerator.

(i) **Interstage bleed**

Interstage bleed tap off for boiler reheater desuperheating preferably from the lowest available intermediate stage pressure of main pump. Rated discharge flow through interstage bleed off for reheater attemperation shall be 8% of maximum reheat steam flow for the unit as a minimum.

(j) **Trip speed of TDBFP**

10% above the design speed of the feed pump.

(k) **Performance curve**

The characteristic curves of booster pump and main pump should be continuously rising type with decrease in flow and shut off head shall be in the range of 115% to 130% of TDH at design point.

(l) **Minimum recirculation**

(1) The minimum flow of the booster pump and main pump shall not be less than 25% of design flow.

(2) ON-OFF type minimum recirculation valve with valve body designed for 40% of design flow.

(m) **Inter-changeability**

Identical design of boiler feed pumps, booster pumps, drive turbines, motors, hydraulic coupling and major equipment in order to provide complete interchangeability.

(n) **Motor drive start up time**

Motor shall be able to accelerate the pumps from standby conditions to rated pumping conditions in less than 15 seconds after receipt of starting signal while operating either singly or in parallel with other operating pump and MDBFP and associated auxiliaries to be designed for auto startup on failure of running equipment/auxiliaries.

(o) **MDBFP lube oil system**

Common lubricating oil system for BFP, booster pump, motor and hydraulic coupling complete with shaft driven lube oil pump, 2 x100%

AC motor driven auxiliary oil pump, two full capacity each of working oil cooler / lube oil cooler / oil filters / strainers, valves, fittings, instruments etc.

(p) **Shaft design**

Stiff shaft design and minimum internal clearances more than maximum static shaft deflection

(q) **Critical speed**

The first critical speed in water above the speed corresponding to turbine overspeed trip condition and internal clearances being 150% of new clearance or 130% of design speed whichever is higher.

(r) **First Stage Impeller life**

Life due to wear due to cavitation of first stage impeller not less than 40000 running hours

(s) **Dry running**

Preferably pump shall be capable of accepting complete loss of water due to incidents such as inadvertent complete closure of suction valve and brought down to rest in controlled manner from design condition with simultaneous closure of suction valve.

(t) **Clearances between periphery of impeller and casing of boiler feed pump:**

Not less than 4% and 6% of impeller outer diameter for diffuser and volute type pumps respectively.

(u) **Efficiency**

Not less than 83% (hot).

(v) **First stage suction specific speed**

Not in excess of 8000 (US units) and 9500 US units based on 3% head break down of that impeller of main pump and booster pump respectively at their respective design point.

(w) **TDH per stage**

Not to exceed 670 m at design point.

(x) **Casing design pressure**

TDH at minimum flow and operating at trip speed for TDBFP and TDH at minimum flow and maximum pump speed at 51.5 Hz for MDBFP under lowest operating density plus maximum suction pressure at booster pump.

(y) **Brinnel Hardness**

Casing wear rings Brinnel Hardness 50 points different from that of impeller wearing surfaces.

(z) **Axial thrust**

Balancing drum designed to balance 95% of total pump axial thrust. Balancing disc not acceptable

(i) **Thermal shock withstand capabilities**

The pump should be design to with stand thermal shock encountourted during the entire operating regime (normal & abnormal) of the unit. Bidder to substantiate with appropriate document

(ii) **Thrust bearing of booster pump and main pump**

Two times the worst thrust under turbine on trip speed for TDBFP and maximum speed of MDBFP, pump at shut off head and internal clearances 200% of new clearance. Thrust bearing should be suitable for reverse rotation.

(iii) **Base Plate**

Fabricated steel base plates shall be as per standard practice of bidder. The bed plate shall extend under all parts of the equipment from which oil or water may drip and shall have a raised lip with tapped drain connection with suitable grout holes.

(iv) **Materials:**

(a) Main pumps

i.	Barrel	:	Forged carbon steel with austenitic stainless steel inlay in high velocity zones and sealing surface.
ii.	Inner casing, Impellers, stage pieces.	:	13% chromium steel casting.
iii.	Wear rings, balancing drum bush	:	13% chromium steel with antigalling properties.
iv.	Balancing drum	:	Stainless steel
v.	Pump shaft	:	13% chromium steel forging.
vi.	Shaft sleeves	:	High alloy chromium or chromium nickel alloy steel.

(b) Booster pumps

i.	Casing	:	Cast steel.
ii.	Impeller	:	13% chromium steel casting.
iii.	Shaft, shaft sleeves and wearing rings	:	13% chromium steel forging.

(v) Applicable Code: HIS (latest edition)

7.2 Operational and maintenance requirement:

(a) Availability/Reliability

The pumps to be designed for the highest practicable degree of availability and reliability under all conditions of operation such as operation on turning gear during startup, maximum and minimum temperature of feed water encountered during operation, abnormal pressure decay in deaerator, sudden generator load throw off, frequency variations (47.5 Hz to 51.5 Hz), HP-LP bypass operation etc.

(b) Warm up arrangement

Suitable warm up arrangement (if required) to start the pump rapidly. However, pump should be capable of starting from any conditions without having any warm up in emergency.

(c) Parallel Operation

Response and Performance characteristics of BFP (MD and TD) shall be such that while operating in parallel the difference in flow handled by them and the flow proportionate to their rating corresponding to the load shall not be more than 5% of flow through any one pump.

(d) Emergency Lubrication of MDBFP

Pressure lubrication (if necessary) of MDBFP at the time of coasting down of the motor driven boiler feed pump set in the event of AC power failure shall be arranged by Bidder.

(e) Maximum Flow handling

If Bidder foresees any possibility of the feed pump operating at flow beyond its maximum flow handling capability due to low system resistance, then Bidder shall make necessary arrangements to protect the pump from such high flow condition without any necessity of reducing the plant load.

(f) Cartridge Concept

The inner pump element comprising shaft, impellers, stage casings capable of being removed and replaced as a unit without disturbing feed piping in not more than 12 hours and shall be demonstrated by Bidder. Suction, discharge and interstage bleed connections need not be broken to dismantle the pumps.

(g) Handling arrangement

MDBFPs and TDBFPs to be accessible to turbine hall EOT cranes for their erection and maintenance

7.3 Mechanical Seals

(a)	Type	Fully cartridgised design.
(b)	Seal face Materials	Not inferior to rotating silicon Carbide and stationary Carbon seal face combination.
(c)	Life	Not less than 20,000 running hours between Overhauls and having dry running withstand Capability as specified
(d)	Supporting system	Each seal to be provided with 2x100% magnetic filters, 2x100% tubular coolers, Piping, Valves, Control and instrumentation etc. Each cooler to be designed with margin of 20% over worst condition of heat generated in seals. Further in case of AC power failure, seal should be able to withstand without cooling water.

7.4 GEAR BOXES

(a) **Type**

Double helical gear by hobbing process, dynamically balance. The high speed pinion of heat treated forged steel with integral shaft and low speed gear of forged steel keyed to the input shaft. The gear casing shall be horizontally split and accurately machined to provide oil tight joints. The gears shall be enclosed in an oil and dust proof gear casing made of grained cast iron or fabricated steel. Oil used to be same as for the pump, motor and turbine and supplied from pump lubrication system. Gear to be designed for continuous service

(b) **Service Factor**

MDBFP (combined gearing/Hydraulic coupling)	1.4
Between turbine drive and booster pump	2.0

(c) **Bearings**

Gear box with separate thrust bearing or combined journal cum thrust bearing as per their standard practice shall be provided to meet the worst duty conditions.

(e) **Applicable Code**: **AGMA 420 and 421 (Latest)**

(f) Instrumentation - Two oil level gauges, drain fill vent thermometer dipstick with approved mounting valves, fitting etc. on gear casing.

(g) Design and manufacturing of gear boxes shall be as per AGMA 6011.

7.5 HYDRAULIC COUPLING

(a) Type

Combined fluid Coupling/Gear box type, Electric actuator and linkages alongwith necessary amplifier units.

(b) Rating

Adequately rated to meet the requirement of pump characteristics while operating in the range of capacities specified.

(c) Material and other accessories

Complete with stainless steel impellers and casing, self supported double duty roller bearings, pillow blocks and Kingsbury or Mitchell thrust bearing or proven thrust bearing as per bidder's standard practice for input/output with removable Covers, oil sump, duplex filters to remove all particles upto 25 microns, oil temperature and pressure gauges, Control pump for oil regulation if provided, regulating Valves, stainless steel scoop tube, 2x100% lube oil cooler, 2x100% Working oil cooler, one portable type oil purifier per station of adequate capacity to be included to form the centralized lubrication system for MDBFP set. The specification and capacity of portable type oil purifier shall be as specified in drive turbine section.

7.6 OTHER COUPLINGS

Either flexible Metal diaphragm type coupling designed to limit the rotor end play with spacer or flexible gear coupling as per standard practice of the manufacturer shall be provided.

7.7 OIL COOLERS

(a) **Type**

Tube bundle of removable type and tubes to be roller expanded and flared at the ends.

(b) **Material**

Tubes of type 304 seamless stainless steel and shell of mild steel construction. Suitable Corrosion allowance shall be added to all carbon steel and iron parts including shell, flanges etc.

(c) **Rating**

Adequately rated with suitable fouling allowance in accordance with TEMA wit necessary arrangements for changing over the cooler without interrupting the oil flow.

(d) **Cooling Arrangement**

Cooling medium shall be demineralized water taken from closed loop cooling system. Cooling medium shall flow in tube side.

(e) Instrumentation

Connections alongwith temperature and pressure indicators on inlet and outlet branches of the water side and also on the shell side of each Coolers. Adequate draining and venting of all parts of cooler.

7.8 DRIVE TURBINE:

7.8.1 Type

Dual admission type or Single admission type with an external control valve, single cylinder, condensing type

7.8.2 Casing

(a) To withstand the maximum pressure and temperature like to be subjected during normal operation and 25% over rated pressure for short term duration.

(b) Symmetrical to maintain thermal balance.

(c) Uniform shape and thickness and free from sharp corners.

(d) Provision to be made to take care of the effects of temperature changes on the alignment of the rotating parts relative to the casing and glands and free movement of casing due to expansion, both longitudinal and transverse.

(e) To permit inspection of the main bearings without dismantling the casing.

(f) Horizontally split at the centre line for raising and lowering the upper halves and rotor to clear off remainder of machine.

(g) Horizontal casing joint to be made tight with metal to metal contact. Gasket or grooves not acceptable.

(h) Horizontal joint bolts to be heat tightened and necessary bolt heating equipment and accessories (if required) to be made available by Bidder.

(i) Control valve chest to be an integral part of the drive turbine.

7.8.3 Drive Turbine Rotor

(a) Forged steel, heat treated, accurately machined and proportioned in order to keep critical speed away from operating speed.

(b) Statically & dynamically balanced rotor.

(c) Turbine blading designed to have a high efficiency of energy conversion, consistent with low loading, stressing and vibration consideration to ensure high degree of availability.

(d) All nozzles and blading in steam path to be of corrosion and erosion resisting alloy steel suitable for temperature encountered.

(e) Rotor blading shall be securely fixed and readily renewable type.

(f) Blading to be designed to minimise the blade end leakages.

(g) Turbine blading to operate smoothly over the operating speed range and natural and harmonic frequency of vibration of last few rows of blades shall be such that they are well outside the operating range so as to avoid resonant vibrations.

7.8.4 Drive turbine stop control valve

(a) Valves to be arranged to close through a trip device actuated either by over speed governor or by action of other protective devices.

(b) Stop Valves to be provided with removable stainless steel steam strainer for normal operation one additional strainer shall be provided for initial operation.

(c) Valves to be provided with removable internals to allow for steam blowing.

(d) Valves to be designed to resist erosion due to steam flow and to be stable and not to vibrate over entire operating range.

(e) Control valves to be designed to provide the required steam flow control when operating in conjunction with turbine governing system as specified elsewhere.

(f) Control valves and their seats to have stellite inlays with their stem hardened. Alternatively, bidder may offer nitriding for seats and stems, if it is suitable for maximum encountered temperature.

(g) Stop valves to have provision for on load testing.

(h) Inlet to control/stop valve to be flanged.

7.8.5 Bearings

(a) The bearing to be designed to avoid oil whip. Bearings to be spherically seated, horizontally divided type, with provision of adjustment and alignment of rotor, forced feed lubricated type, lined with babbit or suitable antifriction alloy. Thrust bearing of the Kingsbury or equivalent with pad type.

(b) Bearings to be arranged so that these are outside drive turbine for readily accessibility. Lower half of bearing to be capable of being removed and replaced by minimum lifting of Shaft.

7.8.6 Turning gear

(a) Drive turbine to be provided with an adequately sized AC motor driven or hydraulically operated turning gear for rotation of complete TDBFP train i.e. booster pump, gear box, drive turbine and main pump while unit being started or taken out of service.

(b) Turning gear shall be so arranged that drive gear is engaged manually by means of external lever while turbine is at rest. When steam is admitted to the turbine drive and its speed reaches beyond turning speed, its gear shall automatically disengage and latch in a disengaged position.

(c) Necessary interlock shall be provided to prevent the starting of turning gearmotor and shall trip on loss of lube pressure and should have provision of starting from the control room.

(d) Hand barring gear shall be provided for manually rotating the drive turbine in an emergency. The lube oil shall be made available to the bearing during such operation.

7.8.7 Drive turbine Lubricating oil system

(a) Each drive turbine shall be provided with a complete lubricating oil system which shall provide lube oil for drive turbine, main pump, booster pump and couplings and shall also cater the control oil of governing system and turning gear oil requirements. The lube oil system shall consist of

- One AC motor driven main oil pump
- One AC motor driven auxiliary oil pump
- Two full capacity oil coolers as specified in clause no. 7.7 of this section.
- Oil reservoir with five minutes retention time.
- An oil conditioning centrifuge of type as specified at clause no 1.18 (b) of this chapter above except moisture at outlet of purifying system not more than 0.05% by volume.
- One DC motor driven emergency oil pump for bearings oil requirements only.
- Duplex type full capacity oil filters of cartridge type with automatic bypass facility.
- 2x100% AC motor driven oil vapour extractors.
- One full capacity AC motor driven jacking oil pump (if required).
- Other accessories to render the system complete.

(b) It is preferable to have quality of lube oil/working oil for MDBFP and TDBFP identical to that of main turbine lube oil quality.

(c) Suitably sized hydraulic accumulators shall be provided in governing oil system to maintain system pressure, when there is a change over from one running pump to stand by oil pump. Also provision shall be made for initial air purging of the governor system.

(d) All the piping, fittings, lube oil cooler, oil tank, strainer etc shall be of stainless steel.

(e) **Type test(s) to be conducted**

Particle size impurities test, as detailed out in the technical specification, is to be carried out on one oil centrifuge of BFP drive turbine.

7.8.8 Turbine exhaust pipe

Separately piped to the main condenser of main TG unit in the downward direction.

Alternatively bidder can also offer separate condenser for the drive turbine. In such case all requirements, as applicable on the main condenser, condenser air

evacuation system and condenser on load tube cleaning system shall also be applicable for the condenser for BFP turbine, except the following:

a) Condenser shall be designed for the maximum heat load envisaged under various mode of operation.
b) Provision of LP heater in condenser neck is not applicable.
c) Connections for HP-LP bypass discharge, heater drains & vents, boiler separator drains, make-up are not applicable.
d) 2 X 100% condensate transfer pumps shall be provided for removal from condenser of BFP drive turbine to main condenser.

Capacity of condenser air evacuation pumps for condenser of BFP drive turbine shall be as per latest HEI.

7.8.9 Codes

Design of drive turbines generally in accordance with API 612 & 614 except as modified herein and proven practice of manufacturer and also generally followed in thermal power plants and testing in accordance with ASME PTC-6.

7.8.10 Blades tuning

Turbine blades, in particular last stage blades to be independently tuned to keep the blade resonant frequencies away from operating speed.

7.8.11 Turbine to be designed for protection against water induction. All drains consisting of motorised drain valves with isolating valves and drain piping for connection to drain flash tank for warming up drains before and after valve seats, casing drains. Gland steam system drain, IP extraction, CRH and auxiliary steam lines alongwith necessary controls.

7.8.12 Last stage blading of turbine to be designed for protection against erosion/corrosion by moisture.

7.8.13 Turbine to be designed for electro hydraulic control system to control speed from 0% to 100%. It shall be of the type which provides continuous corrective action until equilibrium conditions are obtained in response to changes in external signals or speed change resulting from other causes, such as changes in energy of the steam available to a turbine during sudden load pick ups or rejection on the main turbine generator unit. The system shall ensure controlled accelerating of the drive turbine and shall prevent over speeding without tripping of the equipment under any operating condition or in the event of maximum load rejection.

7.8.14 Operational Requirement

a) Drive turbine of BFP shall get normal motive steam from IP-LP crossover/cross around pipe or from a point as per optimized cycle of bidder during operation of turbine from full load to 60% EMCR load or below, if possible.

b) During low unit load conditions, turbine bypass operation, shutdown operation when extraction pressure of the normal motive steam source is insufficient to operate the drive turbine, steam from alternate source, from the same unit, shall be admitted through a seperate set of stop and

control valves. Both sets of control valves to be controlled by electro hydraulic governing system. Bidder can offer single admission turbine with an external control valve (to be operated from the governing system).

c) An additional alternate source of steam from other unit shall be provided by the bidder for Drive turbine of BFP for cold/hot start of boiler (in case MDBFP is inoperative). For this additional alternate source during startup, bidder may opt for the auxiliary steam supply at parameters 16 ata/310 deg.C at auxiliary steam unit header. Bidder may however note that it is not envisaged to start the unit with TDBFP when auxiliary steam is available only from auxiliary boiler at 210^0C.

d) All other auxiliaries to be designed for auto start-up on tripping of running auxiliaries.

7.8.15 Couplings

a) The disconnect coupling shall automatically disconnect the pumps from the drive turbine so as to permit independent operation of turbine on turning gear. Alternatively, dry type flexible membrane coupling may also be provided between BFP and drive turbine to facilitate disengagement by dismantling of spacer bolts as per standard practice of the manufacturer.

b) Other couplings to be flexible metal diaphragm type, requiring no oil lubrication from the external source. However, the coupling between gear box and drive turbine may be oil filled flexible type without requiring external oil supply. Closure plates shall be supplied to allow drive turbine to be disconnected for spin testing.

7.9 STRAINERS AT BOOSTER PUMP AND BOILER FEED PUMP

(a) Strainer body simplex and cylindrical pipe

(b) The clear area of strainer to be five times the inlet cross sectional area of connecting piping.

(c) Strainer to be constructed 16 gauge perforated stainless steel (304 grade) and lined with stainless steel (316 grade) screen.

(d) At design flow and clean condition, Pressure drop not to exceed 0.1 Kg/cm2.

(e) At design flow and 50% clogged condition, Pressure drop not to exceed 0.15 kg/cm2.

(f) Strainer design to permit ease of inspection and cleanliness.

7.10 Type Test(s) to be conducted

Following type tests as detailed in QA portion of the technical specification to be carried out;

(a) NPSH (R) Test on one BFP and one BP

(b) Pressure pulsation test on one BFP

(c) Dry running withstand capability test on one BFP and preferably with corresponding BP.

(d) Axial thrust measurement on one BFP

(e) Visual cavitation test on one BFP

(f) Complete strip down test of BFP which undergone above tests

(g) Pressure drop test on one strainer for each type and size

7.11 Location of TDBFPs & MDBFP

TDBFPs will be located on operating floor.
And MDBFP to be located either on zero (+0.00M) meter floor or any intermediate TG floor (not on operating floor)

8.0 TURBINE HALL EOT CRANE:

For details refer Chapter 28.

9.0 PRECOMMISSIONING ACTIVITIES

The pre-commissioning activities including some of the important checks & tests for certain major equipment/ systems are mentioned under respective equipment, although it is the Contractor's responsibility to draw up a detailed sequential & systematic list of checks / tests and various activities / procedures connected with pre-commissioning of the complete facilities with all systems, sub-systems and equipment supplied and installed by him and get the same approved by the Owner.

10.0 COMMISSIONING OF FACILITIES

Upon completion of pre-commissioning activities/test the Contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carryout system checking and reliability trials on various parts of the facilities.

Contractor shall carry out these checks/tests at site to prove to the Owner that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified. Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.

11.0 NOISE LEVEL

In case the noise level pertaining to the equipments covered under the scope exceeds the specified values as specified elsewhere in the specification, suitable acoustic enclosure along with all accessories in order to complete the system shall be provided to achieve the specified values. The Acoustic enclosures & accessories shall be designed as per internationally accepted standards and shall be subjected to owner approval.

12.0 INSULATION

(a) Bidder shall provide insulation for all equipment, valves, piping etc. with surface temperature more than 60°C. The insulation and sheet covering should be so designed and erected as to provide easy accessibility to parts requiring frequent inspection.

(b) The density of the mineral fiber felt shall be carefully controlled at about 200 kg/m³ and the thermal conductivity of mineral wool shall be 0.052kcal/m.hr.°C at mean temperature.

(c) The mineral wool shall be capable of passing standard combustibility test, both immediately after application and also after being subjected to its maximum operating temperature for not less than 100 hours. The mineral wool shall be free from objectionable odour at the ambient conditions in which it is used. The mineral wool shall not contain substances, which will support pests or encourage growth of fungi. The mineral wool shall not suffer permanent deterioration as a result of contact with moisture due to condensation. The mineral wool shall not suffer quality deterioration under the specified conditions of use. In this connection, both hot and cold face temperatures are relevant. The mineral wool shall be capable of being applied to the surface concerned without causing corrosion of the surface being insulated or the cladding on it under normal site conditions.

(d) The temperature difference between the cold face of finished insulation and ambient shall not be more than 20°C. The ambient temperature shall be considered as 40°C.

13.0 AVAILABILITY REQUIREMENTS OF TG AND AUXILIARIES

The steam turbine generator unit and auxiliaries shall be designed for maximum reliability and availability, operability and maintainability particularly in respect of the following:

13.1 All equipment and systems shall be of proven design, using proven materials with well established physical and chemical properties and as appropriate to the service as intended.

13.2 The steam turbine generator unit and its auxiliaries shall be suitably designed and provided with required instrumentation for rapid starting, loading and unloading without causing undue vibration, distortion, differential expansion or producing excessive thermal stresses. Complete technical data including criteria for thermal stresses, cyclic loading, thermal fatigue, together with values of thermal stresses at critical locations shall be furnished to establish the suitability of design for cyclic and two shift operation.

13.3 The steam turbine generator unit alongwith auxiliaries is normally expected to operate in sliding pressure mode from rated pressure down to 40% of rated pressure in conjunction with steam generator, HP-LP bypass system and plant instrumentation and control system.

13.4 All stand-by auxiliaries shall be designed for auto start up, on failure of running auxiliaries with minimum time delay and without runback on unit load.

13.5 Adequate maintenance facilities shall be provided as required for assembly, disassembly, alignment work particularly in respect of HP barrel, casing, inner and outer casings, diaphragm glands, steam valves, journal bearings, thrust bearings, turbine rotors, generator rotor, particularly end rings, shaft seals, generator bearings, hydrogen coolers, condenser water box, vacuum pumps, condensate extraction pumps and boiler feed pump cartridges, BFP drive turbines, regenerative feed heaters, turbine oil coolers and pumps, etc. The offer shall give details like components requiring replacement or repairs during the life cycle of the plant, meantime between failures and list of tasks to be carried out during major overhauls.

14.0 TYPE TESTS

14.1 The contractor shall carry out the type tests as listed in the **"TYPE TEST(S) TO BE CONDUCTED"** on the equipment mentioned therein. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of 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 Owner's Engineer.

14.2 The type tests shall be carried out in presence of the Owner's representative, for which minimum 15 days notice shall be given by the Contractor. The Contractor shall obtain the Owner's approval for the type test procedure before 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.

14.3 Irrespective of the requirement of conducting the type tests under this contract, the Contractor shall submit the reports of the type tests listed in the **"TYPE TEST(S) TO BE CONDUCTED"** and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment same (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 Owner 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 Owner.

14.4 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.

15.0 Other conditions for computing heat balance diagrams:

1.	Throttle steam pressure	Kg/cm^2(abs)	270
2.	Throttle steam temperature	°C	600 *
3.	Reheat steam temperature	°C	600 *

4.	Worst pressure in the condenser	mm Hg (abs)	89
5.	Design condenser pressure.	mm Hg (abs)	As optimized by the bidder at 1 % make-up and 32.5^{0}C CW temperature at VWO condition (not more than 77 mm of Hg (abs)).
6.	Make up water (as applicable)	% throttle flow	1 % of throttle steam flow.
7.	Quantity of steam tapped off from cold reheat line for meeting normal (tentative) auxiliary steam requirement	TPH	15 (normal)
8.	Final feed water temperature optimized at 100% TMCR	°C	As optimized by the bidder but not less than 293^{0}C.
9.	Pressure drop in the reheat circuit (from HP turbine exhaust flange to IP turbine inlet) (Refer Note -11 below)	% of HP turbine exhaust pressure	As Optimized by the bidder, not exceeding 10% of H.P turbine exhaust Pressure..
10.	HPT Exhaust Pressure	Kg/cm^2 (abs)	To be optimised by bidder
11.	Design pressure drop in :		
i.	All extraction steam lines except to the deaerating heater	% of the pressure (abs) at the turbine extraction flange	5 (maximum)
ii.	Steam extraction line deaerator	% of the pressure (abs) at the turbine extraction flange	8 (maximum)
iii.	Steam extraction line boiler feed pump drive turbine	% of the pressure (abs) at the turbine extraction flange	12 (maximum)
12.	Feed Water Pressure at economiser inlet		
(i)	At 105% TMCR (840 MW) Unit load	Kg/cm²(abs)	To be optimised by bidder
(ii)	At 100% TMCR (800 MW) unit load under modified sliding pressure operation.	Kg/cm²(abs)	To be optimised by bidder

Note: - * Maximum Operating Main Steam & Hot reheat temperature at Turbine inlet shall be 605°C. ±5 DegC is operating margin. Turbine shall be designed for 605°C temperature.

Note:

(1) The above mentioned values of final feed water temperature and pressure drop in reheater circuit and extraction lines shall be at the heat rate guarantee point of 800 MW output at design back pressure and 0% make-up.

(2) During H.P/L.P. bypass operation, the source of steam supply of deaerator shall be from cold reheat line and the deaerator shall be pegged at 3.5 Kg/cm^2 (abs). For heat balance diagrams and for sizing of the HP-LP bypass system, no steam shall be tapped off for any of the feed water heaters other than the deaerator.

(3) The heat balances with zero percent make up shall be computed without any auxiliary steam tapped off from CRH line. Other heat balances with 1% cycle make-up shall be computed with 15 T/hr. of steam tapped off from CRH line for meeting auxiliary steam requirements of the unit.

(4) The auxiliary steam drawn off from CRH line shall be treated as loss from the cycle which in turn shall be made up in the condenser hot well.

(5) The temperature of make-up water shall be taken same as that of the hot well condensate under any load condition.

(6) In the sliding pressure mode of operation the throttle pressure will slide down from rated pressure to a value corresponding to 40% of rated pressure. For computing heat balance for sliding pressure mode of operation at 80%, 70%,60%, 50% & 30% of Unit rated load, rated temperature of atleast 565 deg.C and 593 deg.C* shall be used for main steam and hot reheat steam respectively.

(7) The 1.0% make-up to the cycle will be 1.0% of the main steam flow at HP turbine inlet. For the purpose of computation of heat and mass balance with 1.0% cycle make-up the difference of the mass flow between the make-up and the mass of steam drawn from CRH line for auxiliary steam shall be assumed to be lost from the cycle as feed water downstream of the top HP heater.

(8) It may be noted that the heat balance diagrams and guarantees shall be furnished considering zero spray water quantity for superheater and reheater spray. During Performance Guarantee Testing, in case water is required for superheater and/or reheater temperature control, the contractor shall be entitled to heat rate correction as per correction curves to be submitted by him with his offer.

SECTION – 3

LP CHEMICAL DOSING SYSTEM

1.0. GENERAL

1.1.1 To maintain chemistry of boiler feed water under Combined Water Treatment (CWT) Oxygen Dosing shall be used in the feed water, as per the guidelines of EPRI, USA/VGB, Germany/CEGB, UK / relevant Japanese standard. The following parameters of feed water are proposed to be maintained:

i)	Cation Conductivity	< 0.15 micro siemens / cm
ii)	Hydrazine	Nil
iii)	pH value (25 degree C)	8-8.5
iv)	Oxygen	20-200 ppb
v)	Iron	< 10 ppb
vi)	Copper	< 2 ppb
vii)	Silica	< 10 ppb

1.1.2 However, during startup or chemistry excursions, **All Volatile type of Treatment (AVT)** using ammonia and hydrazine dosing shall be used. The following parameters shall be maintained in case of AVT.

i)	Cation Conductivity	< 0.25 ms/cm
ii)	Hydrazine	10-15 ppb
iii)	pH value (25 degree C)	9.0-9.6
iv)	Oxygen	< 7 ppb
v)	Iron	< 10 ppb
vi)	Copper	< 2 ppb
vii)	Silica	< 10 ppb

1.1.3 The concentration of sodium and chloride under both CWT & AVT treatment, at the outlet of CPU shall be considered as 2 ppb each under normal operating conditions. During start-up condition, the sodium and chloride content at the outlet of CPU shall be considered as ≤ 5 and ≤ 10 ppb respectively.

1.1.4 The chemical regime given above is indicative only. Bidder shall furnish in his offer the appropriate chemical regime, which shall be discussed & finalised in case of award.

1.1. Design Features of Condensate Polishing Unit (CPU):

a) Shall have two (2) service vessels (2W), each of 50% capacity.

b) The design flow shall be the corresponding condensate flow shall be as indicated in Chapter 9.

c) The following dissolved solids concentration and conditions shall be used as a basis of design for the condensate polishing system

S. No.	Parameter	Unit	Normal Condition		Start-up or Condender Leak	
			I/L	O/L	I/L	O/L
1.	Crud	ppb	50	5	500	150
2.	TDS	ppb	20	5	2000	---
3.	Sodium	ppb	10	2	50	20
4.	Iron (dissolved)	ppb	50	5	---	---
5.	Ammonia	ppb	100	NIL	---	---
6.	Silica (dissolved)	ppb	30	5	150	20
7.	Chloride	ppb	10	2	---	---
8.	Conductivity	Micro mhos/cm	----	<0.1 after cation column		

Under the above operating and design flow through the polisher units, the unammoniated resins shall not reach "ammonia break point" in less than 30 days (720 hrs) of continuous operation while maintaining the above effluent quality.

d) In addition to the dissolved solids, the influent condensate shall also contain some quantities of suspended solids (crud) derived from the corrosion of water and steam carrying pipelines, turbine condenser and steam side of the feed water heater. Normally this concentration will not exceed about 50 ppb and the polisher beds shall be provide sufficient filtering action to restrict the effluent crud content to less than 5 ppb.

e) During start up conditions, quality of the influent may deteriorate to : -

Total dissolved solids, ppb	2000 Max
Silica, ppb	150 Max
Crud, ppb (mostly black oxide of Iron)	1000 Max

For design purposes, average crud loading shall be considered as 500 ppb. Under such conditions, total crud content of the effluent shall not exceed 50 ppb.

Under condenser tube-leakage condition, the plant shall be designed for 2000 ppb TDS in addition to the normal influent contaminants stated in as specified at (c) above. The cation and anion load in 2000 ppb TDS shall be based on the circulating water analysis. Under such condition, both sodium content and silica content of the effluent shall be limited to 20 ppb maximum.

1.2 OXYGEN DOSING SYSTEM

1.2.1 Complete Oxygen Dosing System shall be supplied and installed by the Bidder. It is proposed to dose Oxygen at two (minimum) locations in the Condensate and in Feed water circuit i.e. one at outlet of condensate polishing Plant and another at the outlet of deaerator (suction line to feed water pumps). Additional dosing points if required as per manufacturer's standard practice shall also be included by the Bidder.

1.2.2 Each of the dosing locations shall be provided with a set of Oxygen cylinders with required cylinder isolation/check valves, cylinder manifolds, isolation valves in the common manifold, piping from manifold, dosing (automatic type) valves of regulating valve, check (non-return type) valve, Instruments for measurement of oxygen & conductivity of condensate & feed water lines at the downstream of dosing locations, associated control system etc.

1.2.3 The dosing rate shall be regulated automatically by control system based on the quality of condensate water and feed water quality as the case may be. The control system shall facilitate selection of oxygen dosing locations. Regulating type valves shall be provided with isolation valves at upstream & downstream end to facilitate replacement/repair of regulating valve.

1.2.4 At each dosing locations, system shall be designed for a maximum dosage rate of 150 ppb and number of oxygen cylinders to supplied and installed by the Contractor shall cater for one month requirement. The condensate and feedwater flow shall be of the order of 1500 CU.M/hr.

A.	**Oxygen Dosing System**	
i)	Oxygen dosing skid	Two (2) nos. per unit (total 4 nos.)
ii)	Filled oxygen cylinder	
	(a) Quantity	Four (4) nos. cylinders mounted on each skid & thirty five (35) cylinders as loose per unit (total 86 nos.)
	(b) Design standard	IS-7285
	(c) Capacity	10 M^3
	(d) Working pressure	204 Kg/cm^2
	(e) Accessories	One (1) nos. storing rack of 30 cylinder
iii)	Ball Valves	
	(a) Body, Bonnet, Stem	ASTM A182 Gr. TP 316
	(b) Trim material	SS 316
	(c) Design standard	BS 5351 & 5159
	(d) Test standad	
iv)	Check vavles / NRV	
	(a) Body, cover, disc/piston & seat	ASTM A182 Gr. TP 316
	(b) Design standard	ANSI B 16.34/API 602
	(c) Test standad	API 598
v)	Pressure relief valve	
	(a) Type	Spring loaded, angle type
	(b) Body, bonnet, disc & nozzle	ASTM A182 Gr. TP 316
vi)	Fittings	SS to A276 or A479 F316, dimension to ANSI B 16.11 socket weld ends
vii)	Pressure Regulator	

	(a) Quantity	Four per skid each mounted to an oxygen cylinder
	(b) Body, bonnet, disc & nozzle	SS 316/Brass
viii)	Flanges	SS316, ANSI B 16.5 CL 300
ix)	Structural steel	IS 2062
x)	Nuts & bolts	SS 304

1.3 ALL VOLATILE TREATMENT (AVT)

1.3.1 Under AVT, ammonia and hydrazine shall be dosed in the feed water at suction lines to the boiler feed pumps as well as at the condensate pumps discharge after the condensate polishing unit. Ammonia shall be used as pH control agent and hydrazine as oxygen scavenger for AVT, Bidder shall include in his scope all necessary hardware including storage tanks, measuring tanks, mixing arrangement, However, generally all the tanks, oxygen cylinders, dosing facilities shall have redundancy of 100%. However minimum details for AVT are given below:

1.3.2 **Tanks per unit**

Vertical and cylindrical design with dished/conical ends, SS-304 material of construction, shell thickness 3 mm for the tanks. Each chemical storage tank shall be having a capacity of two (2) days requirement with 20% margin or 2300 litres, which ever is higher.

S. No.	Descripion	Ammonia Measuring tank	Ammonia Mixing/ storage tank	Hydrazine Measuring tank	Hydrazine Mixing/ Storage tank
1	Storage Capacity (in litres)	125	2300	30	2300
2	Nos.	1 No./skid	1 No./skid	1 No./skid	1 No/skid
3	Concentration of aqueous ammonia solution shall be 30%				
4	Concentration of hydrazine solution shall be 50%				

1.3.3 Electrically operated barrel pumps complete with flexible hose and couplings for transferring hydrazine & ammonia from storage drum to mixing / storage tank shall be provided by the bidder.

1.3.4 **Transfer pumps per unit**

Item Description	Ammonia pump	Hydrazine pump
Material (Pump internals in contact with chemicals)	SS-304	SS-304
Capacity	To suit requirement	To suit requirement
No's required	1 no. (1x100%)	1 no. (1x100%)

Concentration	30 % concentration	51 % concentration
Type of pump	Electrically operated barrel pump	Electrically operated barrel pump

1.3.5 **Metering pumps per unit**

Item Description	**Ammonia pump**	**Hydrazine pump**
Material (Pump internals in contact with chemicals)	SS-304	SS-304
Capacity (LPH)	0-100	0-100
No's required	2 nos. (2x100%)	2 nos. (2x100%)
Rated pressure	As per process requirment	As per process requirment
Type of pump	Reciprocating Pump	Reciprocating Pump

1.3.6 **Material for Piping & Fittings**

Item Description	**Ammonia pump**	**Hydrazine pump**
Piping	SS-304 /316	SS-304/316
Fittings	A 182 GR.F304/316	A 182 GR.F304/316
VALVES	A182 GR.F304/316	A182 GR.F304 /316
END CONNECTION	SW/ ANSI B16.11	SW/ ANSI B16.11

Note:

1. Capacity of various tanks & pumps are tentative minimum. It is contractor's responsibility to design/size these tanks & pumps depending upon system requirement/design and submit the same to Owner for approval. The minimum storage capacity for storage tanks of both Ammonia & Hydrazine shall be for 48 hours requirement.
2. Space provision shall be kept in the main plant building for storage of ammonia and hydrazine containers/barrels as per one month requirement of the unit.

1.3.7 TG shall be provided with skid mounted hydrazine & ammonia dosing system comprising of 1x100% capacity measuring tank, 1x120% capacity preparation/ dosing tank and 2x100% metering pumps complete with strainers, piping, valves, fittings, instrumentation and control panel etc. Ammonia and hydrazine shall be received in containers/ barrels and electrically operted pumps (drum pumps) shall be provided for transfer of ammonia and hydrazine to the respective measuring tanks. The flow of chemical from measuring tank to the preparation/ storage tank shall be by gravity. The capacity of tanks and parameters of pumps given are indicative & minimum. Final parameters shall be as per system requirements.

1.3.8 Bidder shall provide all the consumable including chemicals as per the volume I of the specification.

1.3.9 Strainer

All strainer shall be Y-type with stainless steel body and 50 mesh stainless steel screen. The screen opening area shall be atleast 4 times the pipe cross sectional area. Necessary screwed blow off connection fitted with plug shall be provided.

1.3.10 Piping

All piping shall be supplied under the specification shall be of stainless steel SS304 for LP dosing system. The size of the piping shall be selected in conformity with the maximum design temperature and pressure of the system

1.3.11 Valves

All manual operated valves shall be stainless steel SS 304 body and trim for LP dosing system, and shall be related to withstand the design pressure of the system. The valve shall be welded/socket welded ends as applicable.

All flanged terminal shall be provided with necessary counter flanges, bolts, nuts gaskets.

1.3.12 Control Skid

A group alarm for dosing system shall be provided in the control room for the following conditions:

i) Pump and stirrer trip due to low level in the tank.
ii) Pump trip due to low level.

iii) Manual starting and stopping of stirrer motors and dosing pumps from control room.

1.3.13 Inspection and Testing

Performance test (head, capacity, efficiency & BHP) of the pump shall be done according to the requirement of the hydraulic institute of USA or approved equivalent.

The pump accessories will be subjected to the tests as per OEM standard

1.4 OPERATION & CONTROL PHILOSOPHY

1.4.1 The bidder shall supply all necessary contol & instrumentation for satisfactory operation of dosing system. The control of system shall be through main plant DDCMIS.

1.4.2 It is intended to control dosing system from main plant DDCMIS, including ON/OFF command of individual pumps. However, bidder shall provide local prewired control panel complete with i) start/stop push buttons ii) indicating lamps iii) local/remote selection iv) stroke position indicator v) risk lower push buttons for stroke position vi) local LED based annunciation driven by DDCMIS vii) stroke position indicator on the panel.

1.4.3 The normal mode of operation of dosing system shall be through DDCMIS. Local/remote selection is to be done from remote (CR) and indication for the same is to be provided on local panel.

1.4.4 The ON/OFF commands for individual pumps from local push buttons shall act on the respective drives through DDCMIS.

1.4.5 The stroke position and adjustment will be done by 4-20 mA D.C. signal from DDCMIS and pumps stroke actuation should be suitable for accepting 4-20mA D.C. signal. The pumps are to be provided with 24 V DC, two wire LVDT type position feed back transmitter which will generate 4-20mA signal indicating stroke position.

SECTION – 4

PRE-COMMISSIONING ACTIVITIES & COMMISSIONING ACTIVITIES

1.00.00 PRECOMMISSIONING & COMMISSIONING ACTIVITIES OF TG & AUX

1.00.01 Hydraulic Test for STG integral piping, heat exchangers, condenser tubes & condenser, equipment cooling water system pipes and associated equipment etc. shall be done. The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out. All equipment needed for the tests shall be furnished by the Bidder.

1.00.02 Oil flushing of lube oil system, control & jacking oil system, etc. for turbines shall be done. Entire flushing oil requirement & refilling with fresh oil and other consumables alongwith flushing equipment shall be met by the Bidder.

1.00.03 High Pressure/Low Pressure (HP/LP) bypass tests, vacuum tightness test as per approved procedures shall be done by the Bidder after arranging & lining up of all the necessary equipment by him.

1.00.04 Steam blowing & chemical cleaning, as applicable of integral piping of the turbo-generator & other piping in the scope of the Bidder shall be done by the Bidder.

1.00.05 All tests and activities pertaining to the STG as per manufacturer's recommendations and as given below.

1.00.06 Any other pre-commissioning checks/ tests and activities as described below and those mutually agreed between the Bidder & the Owner shall be undertaken by the Bidder.

	LIST OF TEST / ACTIVITIES TO BE PERFORMED ON TG & AUXILIARY (BUT NOT LIMITED TO THE FOLLOWING)
	TESTING SCHEDULES
1.	TURBINE ON BARRING GEAR
2.	BEARING AND JACKING OIL INITIAL CIRCULATION
3.	HP BYPASS SYSTEM
4.	LP BYPASS SYSTEM
5.	GOVERNOR OIL CONTROL SYSTEM
6.	VACUUM RAISING PLANT
7.	CONDENSER
8.	HYDRAULIC TEST PROCEUDRE FOR A) LUB OIL SYSTEM B) CONTROL OIL & JACKING OIL SYSTEM C) SEAL OIL SYSTEM D) WATER SYSTEM E) HEATERS

9.	OIL FLUSHING OF LUB OIL SYSTEM
10.	OIL FLUSHING OF CONTROL & JACKING OIL SYSTEM
11.	OIL FLUSHING OF GENERATOR SEAL OIL SYSTEM
12.	ALKALI FLUSHING FOR CONDENSATE SYSTEM
13.	HP/ LP BYPASS SYSTEM
14.	CONDENSER FLOOD TEST
15.	CONDENSER VACUUM TIGHTNESS TEST
16.	STEAM BLOWING OF GLAND SEAL PIPE LINES, AUX. STEAM PIPELINE
	COMMISSIONING SCHEDULE
1.	TURBINE GLAND SEALING SYSTEM
2.	HP-LP BYPASS SYSTEM
3.	TURBINE INITIAL RUN UP
4.	LUBE OIL / GOVERNING OIL SYSTEM
	COMMISSIONING TESTS/CHECKS
1.	TEST RUNNING OF ALL PUMPS
2.	CONDENSER VACUUM TEST, FEED WATER HEATER OPERATIONAL TESTS FOR ESTABLISHING CORRECT CASCADED FLOW, HEATER WATER LEVELS ETC. & CHECKING OF ALL PARAMETERS AS PER APPROVED HEAT BALANCE DIAGRAMS.
3.	TEST FOR HP/LP BYPASS VALVES OPERATION & THEIR CONTROL SYSTEM.
4.	TEST FOR OPERATION OF GOVERNING CONTROL SYSTEM FOR TURBINES.
5.	STANDARD COMMISSIONING TESTS AND PROCEDURES AS PER BIDDER'S PRACTICE FOR STEAM TURBINE GENERATOR AND OTHER EQUIPMENT / AUXILIARIES WITHIN THE BIDDER'S SCOPE OF WORK.
6.	CHECKS ON OPERATION OF ALL INDIVIDUAL CONTROL LOOPS IN THE TURBINE GENERATOR CONTROL SYSTEM.
7.	CHECKS ON CORRECT FUNCTIONING OF THE TURBINE PROTECTION SYSTEM (TPS), TURBINE SUPERVISORY CONTROL SYSTEM (TSCS) FOR MAIN TURBINE, AUTOMATIC TURBINE RUN-UP SYSTEM (ATRS), AUTOMATIC TESTING OF TURBINE (ATT).
8.	CALIBRATION TESTS OF ORIFICE, FLOW NOZZLES, INSTRUMENTS AND CONTROL EQUIPMENT TO THE EXTENT INCLUDED IN THESE SPECIFICATIONS.
9.	CHECKS ON OPERATION OF ALL ROTATING EQUIPMENTS TO ASCERTAIN LEVEL OF NOISE AND VIBRATION

1.01.00 **PRECOMMISSIONING & COMMISSIONING ACTIVITIES OF CEP**

Hydraulic Test for equipments and associated system shall be done. The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out. All equipment needed for the tests shall be furnished by the Bidder.

Steam blowing & chemical cleaning, as applicable of integral piping of CEP sets & other piping in the scope of the Bidder shall be done by the Bidder.

All tests and activities pertaining to the CEP and its drive as per manufacturer's recommendations and as given below.

Any other pre-commissioning checks/ tests and activities as described elsewhere in the technical specifications and those mutually agreed between the Bidder & the Owner shall be undertaken by the Bidder.

TESTING SCHEDULES

1. CEP

   COMMISSIONING SCHEDULE

   NIL

   COMMISSIONING TESTS/CHECKS

1. Test running of all pumps
2. Standard commissioning tests and procedures as per Bidder's practice for CEP and other equipment / auxiliaries within the Bidder's scope of work.
3. Checks on operation of all individual control loops in the CEP control system.
4. Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.
5. Checks on operation of all rotating equipments to ascertain level of noise and vibration

1.02.00 **Pre-commissioning & Commissioning Activities of Feed Water Heating Plant**

(a) Hydraulic Test for heat exchangers and associated equipment etc. shall be done. The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out. All equipment needed for the tests shall be furnished by the Bidder.

(b) Steam blowing & chemical cleaning, as applicable of integral piping of the Heaters & other components in the scope of the Bidder shall be done by the Bidder.

(c) All tests and activities pertaining to the Heater as per manufacturer's recommendations and as given below.

(d) Any other pre-commissioning checks/ tests and activities as described elsewhere in the technical specifications and those mutually agreed between the Bidder & the Owner shall be undertaken by the Bidder.

LIST OF TESTS / ACTIVITIES TO BE PERFORMED ON HEATER / DEAERATOR BUT NOT LIMITED TO THE FOLLOWING

TESTING SCHEDULES

1. HEATER
2. DEAERATOR

COMMISSIONING SCHEDULE

1. LP HEATERS
2. HP HEATERS
3. DEAERATOR STEAM OPERATION

COMMISSIONING TESTS/CHECKS

1. Feed Water Heater operational test for establishing correct cascaded flow, heater water levels and checking of all parameters as per approved heat balance diagram
2. Standard commissioning tests and procedures as per Bidder's practice for heaters and deaerator and other equipment / auxiliaries within the Bidder's scope of work.
3. Checks on operation of all individual control loops in the heater control system.
4. Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.
5. Checks on operation of all equipments to ascertain level of noise and vibration.

1.03.00 **Pre-commissioning & Commissioning Activities of BFP**

Hydraulic Test for equipments and associated system shall be done. The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out. All equipment needed for the tests shall be furnished by the Bidder.

Oil flushing of lube oil system, for BFP sets shall be done. Entire flushing oil requirement & refilling with fresh oil and other consumables alongwith flushing equipment shall be met by the Bidder.

Steam blowing & chemical cleaning, as applicable of integral piping of BFP sets & other piping in the scope of the Bidder shall be done by the Bidder.

All tests and activities pertaining to the BFP and its drive as per manufacturer's recommendations and as given below.

Any other pre-commissioning checks/ tests and activities as described elsewhere in the technical specifications and those mutually agreed between the Bidder & the Owner shall be undertaken by the Bidder.

LIST OF TESTS / ACTIVITIES TO BE PERFORMED BFP AND AUXILIARIES BUT NOT LIMITED TO THE FOLLOWING

TESTING SCHEDULES

1. BFP
2. INITIAL LUBE OIL CIRCULATION
3. HYDRAULIC TEST PROCEUDRE FOR
   A) LUB OIL SYSTEM
   B) WATER SYSTEM
   C) HEAT EXCHANGERS
4. OIL FLUSHING OF LUB OIL SYSTEM

COMMISSIONING SCHEDULE

1. Lube Oil System

COMMISSIONING TESTS/CHECKS

1. Test running of all pumps
2. Standard commissioning tests and procedures as per Bidder's practice for BFP and other equipment / auxiliaries within the Bidder's scope of work.
3. Checks on operation of all individual control loops in the BFP control system.
4. Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.
5. Checks on operation of all rotating equipments to ascertain level of noise and vibration

CHAPTER – 3

HYDROGEN GENERATION PLANT

CONTENTS

CHAPTER – 3

HYDROGEN GENERATION PLANT

3.1 GENERAL

Hydrogen gas is required for cooling of rotor winding and stator core of generators. For the proposed power plant, requirement of Hydrogen gas for initial filling and continuous make-up is proposed to be met by installation of a Hydrogen generating plant within the power plant area. Hydrogen gas produced shall be stored in cylinders under pressure and shall be used in the power station, as and when required.

3.2 INTENT

This chapter is intended to cover design, engineering, manufacture, supply, assembly, testing, shop painting, inspection, delivery to site including packing & forwarding, transportation, insurance, unloading at site, storage under safe custody of the Hydrogen Generation Plant & interconnecting pipelines together with all the auxiliaries and accessories. Obtaining statutory approval from the chief controller of Petroleum and Explosive safety organization and other statutory authorties, Central and State govt. authorities (including payment fees) for the installation shall be in included in the scope of work.

Hydrogen Generation Plant along with auxiliaries shall be sized for **20 Nm^3/hr (2 x 10 Nm^3/hr).**

3.3 GENERAL PLANT DESIGN CRITERIA

3.3.1 For continuous parallel as well as for two shift or one shift operation of both streams in part load from control panel/OWS.

3.3.2 To trip the plant in case of high hydrogen level inside the building with suitable hydrogen gas detectors.

3.3.3 To maintain set pressure with help of back pressure regulation valve.

3.3.4 PLC based control with fully automatic operation and integrated safety controls.

3.3.5 The scheme & construction details of equipment shall be based on manufacturer's standard for Bipolar Proton Exchange Membrane (PEM) Solid polymer electrolyte type- of the Hydrogen plant.

3.3.6 Capacity to be sized as follows:

i) Leakage rate per generator : "A" Nm^3/day

ii) Requirement of one generator filling : "B" Nm^3

iii) Number of TG units : 'C'

iv) Hydrogen generation plant capacity : [C*1.5*A+B/30]/10 Nm^3/hr

However, total plant capacity shall not be less than 20 Nm^3/hr with two streams of 10 Nm^3/Hr capacity.

v)	Hydrogen Gas generation	:	10 Nm^3/Hrs (min) per stream
vi)	Purity of Hydrogen	:	99.999% (after drier)
vii)	Oxygen impurity in Hydrogen	:	1 ppm (max) at solid polymer electrolyser outlet
viii)	Dew point	:	(-) 70^0C (after drier)
ix)	Delivery pressure	:	30 bar(g) directly from the solid polymer electrolyser
x)	Oxygen pressure	:	< 2 bar (g) directly from Solid polymer Electrolyser

3.3.7 All statutory approvals required for the installation of Hydrogen Generation Plant shall be obtained by the bidder..

3.3.8 The complete Hydrogen generation plant equipment layout etc. shall be designed as per the explosive authority's requirements and the bidder shall obtain the approval from chief controller of Petrolium and Explosive safety organization & other authorities, Central and State govt. authorities (including payment fees) for design and installation of the plant are also included in the scope of the Bidder.

3.3.9 All electrical equipment, fittings & illumination in Hazardous Area of Hydrogen Generation Plant shall be of explosion proof Ex d II C type.

3.3.10 For electrical works please refer Volume IV of specification. For C & I works refer Volume V of specification. For drawings refer Volume VII of specification.

3.4 EQUIPMENT DETAILS

3.4.1 Common MCC and PLC panel along with EWS/OWS with A3 size printer. Separate silicon controlled / IGBT switch mode type rectifier panel with all accessories i.e. rectifier, transformer etc.

3.4.2 One (1) Electrolyzer unit per stream -bipolar sealed compact design Proton Exchange Membrane (PEM) Solid polymer electrolyte type of the Hydrogen plant to generate rated quantity of hydrogen, complete with all accessories and safety features.

3.4.3 Hydrogen Compressor and drives:

i) Two (2), (1W+1S) single / multistage stage oil free diaphragm type Hydrogen Gas Compressors each having gas handling capacity of 20 Nm^3/hr, complete with drive unit, intercoolers and after coolers having effective sealing to eliminate hydrogen leakage to atomosphere other accessories and instrumentation. Each compressor shall be capable of compressing Hydrogen gas from suction pressure corresponding to that of the low pressure at generation point to the pressure required to fill the hydrogen cylinders i.e. 150 Kg/cm^2 (gauge), with pressure gauge, safety relief valve, temperature gauge etc. along with explosion proof electric motors.

ii) Electric drive motor of the above compressors shall be explosion proof type. Power rating of the motor shall be selected such that a minimum margin of 15% is available over the power required to deliver the required capacity against rated pressure. When the driver is not directly coupled to the compressor, due account shall be made for losses in power transmission, in addition to the above margin. In case of driven compressor, 5% belt loss should be considered over and above the 15% spare margin stipulated above.

iii) Material of Construction

S.No	Item	Material of Construction
1	Casing	SS 316
2	Base Plate	IS 2062
3	Delivery Check valve	316 SS
4	Closure Seal	Buna "N"/ Viton
5	Diaphragm	SS 316
6	Hydraulic Head	CS
7	Process Head	SS 316
8	Crank Shaft	Forged Steel
9	Crank Case	Cast Iron

iv) Lubrication

(a) A crankshaft driven positive displacement pump shall draw lubricating oil from the crankcase sump through a strainer and shall provide forced feed lubrication to the bearings.

(b) All instrumentation and accessories in the lubrication circuit namely discharge pressure gauge, pressure switch, relief valve etc. shall be provided. Suitable time delay relay or equivalent device to by pass low oil-pressure switch during start-up shall be provided.

(c) Each compressor shall be provided with one (1) automatic solenoid operated shut off valve, with a bypass line, in cooling water inlet line to stop cooling water flow through the compressor in stand-by service. The design of Compressor should ensure to avoid any deposition in the compressor during its in-operative condition.

3.4.4 Two (2) Hydrogen Gas Coolers

i) The coolers (intercoolers, after coolers, post-purifier coolers and return Hydrogen gas coolers) shall be shell and tube type with provision for tube bundle removal. The cooler tubes shall be SS-316. The design of the coolers shall be as per Heat Exchangers Institute Standards/ASME Codes or equivalent code.

ii) The coolers shall have hydrogen gas in shell and water in tube and temperature rise shall be limited to 8° C.

iii) Coolers shall be provided with condensed moisture purge stations including strainer, bypass and double isolating valves for the purge station

3.4.5 Two (2) Hydrogen Gas Dual Tower Gas Dryer/twin tower moisture separating columns of reactivation features/regenerative design one in each stream along with valve arrangement or any other alternative device so as to suit operation of one column & regeneration of the other.

3.4.5.1 Hydrogen shall have moisture content less than 0.01% by volume at the outlet of the drier, (i.e. the purity of the H_2 gas shall be 99.999% (by Vol.) without negative tolerance) which shall be achievable with the inlet gas stream being saturated with moisture.

3.4.5.2 Regeneration of the desiccant bed shall be by recirculation. The capacity of hydrogen compressor shall be suitably increased so as to obtain 10 NM^3/hr (dry) hydrogen throughout at the bottle filling stations of each stream.

3.4.5.3 Change-over of towers from adsorption to reactivation cycle after depressurization and vice-versa shall be automatic.

3.4.6 Two (2) Portable Hydrogen Gas Purity Meters. These meters shall be battery operated.

3.4.7 Two (2) Dual Type -Filters or any other alternative device to prevent entrainment of desiccant particles with the effluent gas from the dryer unit.

3.4.8 Two (2) Hydrogen filling stations with manifold isolating valve, safety valve etc. for both evacuation and simultaneous filling of minimum 8 cylinders shall be provided with hydrogen at a maximum filling pressure of 150 Kg/cm^2 (gauge). Each filling manifold shall be provided with a common vacuum pump for evacuation of air from hydrogen cylinder prior to filling sixteen nos. of empty Hydrogen cylinders. This manifold shall be located outside TG Building.

3.4.9 One (1) Nitrogen manifold common for both streams. Nitrogen gas filled cylinders shall be adequate for two complete purging of the hydrogen gas streams (8 nos. min.), along with complete scavenging system comprising necessary piping network, all fittings, pressure reducing station etc.

3.4.10 Two (2) Hydrogen Cylinder Hold Racks, each capable of holding sixty (60) cylinders shall be arranged in two adjacent areas of the plant. One for storing filled H_2 cycliners and another for storing empty H_2 cylinders.

3.4.11 DM Water Supply

i) DM Water Storage tank of 5 M^3 capacity shall be provided along with drain connections & level switches/level gauges. The drains & over flow from DM tank shall be provided with suitable arrangement to ensure that no air ingress takes place. The MOC of the DM water storage shall be of SS 316.

ii) The Pipe/Cable rack for supporting the DM Water piping upto the Hydrogen generation plant building shall be included.

3.4.12 Two (2) Chiller units each having capacity for each 10 Nm^3/hr electrolyser stream and compressor.

4.4.13 Two (2) - One per stream return hydrogen gas cooler with all fittings, moisture purge station and instruments.

3.4.14 Suitable Leak Detection and interlock system in electrolyser room, compressor room and filling area.

3.4.15 All integral and inter-connected piping, valves, fittings, specialties, hangers, supports, insulation and cladding etc., as required to make the system complete.

Complete instrumentation (pressure, temperature, flow, level etc) and control for the entire plant as necessary for measuring the process parameter and also for safe running of the plant shall be provided. Complete instrumentation including alarm annunciation for stages of the the compressor set shall be furnished. The list of instruments shall include continuous hydrogen purity meters i.e, trace oxygen analyser and Dew point meter with alarm facility in each stream before buffer tank with recording and alarm facilities. Similarly, continuous oxygen purity meters in each electrolyser outlet shall be provided with alarm facility.

3.4.16 One (1) hydrogen cylinder testing facility as required by statutory authorities.

3.4.17 Lubricants, electrolytes and other chemicals till provisional taking over of system by the Owner and additional chemicals of two (2) months requirement.

3.4.18 **Compressed Air (Instruments and Service Air)**

Required instrument air and service air for Hydrogen generation plant shall be tapped from Instrument air header and Service air header respectively.

3.4.19 **Oxygen vent to atmosphere**

At an appropriate and safe location away from the building, venting arrangement for oxygen shall be provided.

3.4.20 **Vacuum Pump**

Each hydrogen gas filling stream shall be provided with one (1) vacuum pump for evacuating the air prior to admission of hydrogen. The design of pump shall be suitable for the intended service and shall be furnished as a package unit complete with drive motor, coupling, guards, seals, associated piping, valves, instruments and controls. The material of construction of various components shall be of proven metallurgy and as per manufacturer's standard for the service intended.

3.4.21 **Hydrogen, Nitrogen and Carbon Dioxide Cylinders**

i) 200 Hydrogen gas cylinders each of 6 NM^3 capacity or 45 litre water capacity shall be supplied. The material of construction of the cylinders shall be of magneese steel. The bottom shape of cylinders shall be convex inverse so that the cylinders shall be kept in standing position. The cylinders shall conform to IS:8198.

ii) 50 Nitrogen Cylinders of 6NM^3 capacity or 45 litre water capacity shall be supplied and shall conform to IS-7285. The cylinders shall be filled and supplied.

iii) 100 Carbon Dioxide Cylinders of 6NM^3 capacity or 45 litre water capacity shall be supplied under this specification and shall conform to IS-7285. The cylinders shall be filled and supplied. CO_2 manifold shall be located outside TG building.

iv) Heating arrangement for heating CO_2 cylinders shall be included in the scope of work.

v) Each gas cylinder shall be complete with cap and valve as per IS-3224.

vi) Each cylinder shall be hydro tested at a pressure of minimum 250 Kg/cm^2 (g) as per relevant IS code.

vii) Maximum filling pressure of the cylinders shall be 150 Kg/cm^2 (g).

viii) Covered storage space within the Hydrogen Generation plant building shall be provided to accommodate all the abobe mentioned cylinders.

3.4.22 Rectifier

Two rectifiers (one for each of the PEM electrolyser to cater the load of each of the PEM electrolyser. The rectifier equipment shall be complete in all respects with air cooled rectifier transformer, electronic control and annunciation etc.

3.4.23 Pressure regulating valve

Self actuating type pressure regulating valve to maintain steady pressure across dryer shall be provided.

3.4.24 Flushing system

Flushing system shall be provided with proper isolation devices, valves manifolds piping etc to enable purging the system with nitrogen during commissioning and maintenance work.

3.4.25 Cooling/service water supply system

Cooling/Service water shall be taken from service water network system. All pipings, valves, fittings, supports shall be supplied. If pumping station is deemed necessary for the cooling/service water system, the same shall be supplied.

3.4.26 Hydrogen Buffer tanks

Two (2) hydrogen buffer tanks one in each stream of 10 M^3 capacity, made of SS 304 and complying with ASME Sec. VIII Div.I shall be provided. The operating pressure shall be 30 kg/cm^2 (g) (minimum). The design of the buffer tanks shall be as per the applicable codes.

3.4.27 Pipes, Fittings & Valves

i) All pipes, fittings and valves to be supplied under the specification shall be of reputed make. Material of construction, type, ratings etc. shall be as per the attached pipe schedule

ii) All HP drains shall be terminated through H_2 traps and LP drains through U-bends.

iii) Hydrogen vents shall be provided with flame arrester

3.4.28 **Pipe/Cable rack.**

The pipe/Cable rack for supporting the potable water, service water, compressed air, DM water piping upto the hydrogen generation plant building shall be included.

3.4.29 Two (2) adequately sized wheel mounted trolleys shall be included in the scope to transport cylinders from the H_2 Generation Plant storage area to TG Building.

3.5 AIR CONDITIONING AND VENTILATION

Ventilation system & air conditioning system shall be provided to maintain proper working conditions environment compatible with human hygienic requirements and to maintain conditions necessary for proper storage of materials and working of plant and equipment etc.

S. No.	Premises Served	System envisaged	Description of equipment	Quantity
I.	**AC System**			
1.	H_2 PLC / Plant Control Room	Air conditioning system with split air conditioner	Split air conditioner consisting of outdoor condensing & indoor air handling units (AHU) cooling capacity of each split AC=2TR (minimum)	2 Nos. (1W+1S)
II	**Ventilation System**			
1.	LT, PMCC Panel, MLDB, PDP, Rectifier, transformer and Emergency Board Room	Exhaust ventilation	Wall mounted exhaust fans of suitable capacity with drive motor and accessories	2 nos.
2.	Electrolyser & Compressor room	Exhaust ventilation	Wall mounted explosion proof exhaust fans of suitable capacity with motor and accessories. The fan and motor shall be spark proof. The drive shall preferably be v-belt and motor shall be mounted outside the fan casing.	2 nos.
3.	Toilet	Exhaust ventilation	Wall mounted exhaust fans of suitable capacity with motor and accessories	1 No.
4.	H_2 cylinder Filling & storage room	Exhaust ventilation	Wall mounted explosion proof exhaust fans of suitable capacity with motor and accessories. The fan and motor shall be spark proof. The fan shall preferably be belt driven and the drive shall be mounted out side the fan.	1 no.

Note:

1. The cooling capacity of air conditioning system shall be decided on the basis of heat dissipated in the premises, building heat radiation, illumination heat, occupancy heat, make-up air heat etc. in the premises. The bidder shall calculate the capacity based on the above and furnish the A.C schedule accordingly to meet the system requirement. However, the minimum capacity as indicated above shall be provided.

2. Capacity of the ventilation system for the H_2 generation plant shall be arrived at based on the drive motors of H_2 generation plant equipments provided. Bidder may note that the quantity indicated is tentative. Bidder may calculate the actual load and furnish the ventilation schedule accordingly to meet the system requirement.

3.6 MATERIAL HANDLING

One (1) 2T capacity manual hoist for Electrolyser room and Compressor room shall be provided for handling the equipment. For Detailed Specification refer Volume – III Chapter 28: Cranes and Hoists.

3.7 CODES AND STANDARDS

3.7.1 Codes

S. No	Code	Description
1	ISO 22734-1	Hydrogen generators using water electrolysis process - Part 1: Industrial and commercial application
2	IS 5120	Technical requirements for roto-dynamic special purpose pumps
3	IS 6595 Part-2	Horizontal Centrifugal pumps for clear, cold and fresh water general purpose other than agricultural and rural water supply
4	IS 9137	Code for acceptance test for centrifugal, mixed flow and axial flow pumps - Class `C'
5	BS EN ISO 9906	Roto-dynamic pumps. Hydraulic performance acceptance tests. Grades 1 and 2
6	IS – 4503/1967	Specification for shell and tube type heat exchanger
7	PTC 8.2	Performance test codes – Centrifugal Pumps
8	ISO 2548	Centrifugal, mixed flow and axial pumps- Code for acceptance test- Class C
9	IS 2062	Steel for general structural purposes – specification
11	IS – 2825/1969	Code for unfired pressure vessels
12	NFPA – 2	Hydrogen Technologies Code
13	IS 5456/1985	Code of Practice for testing of positive displacement type air compressors and exhausters

S. No	Code	Description
14	IS 6206/1985	Guide for selection, installation and maintenance of air compressors/plants with operating pressure up to 10 bars.
15	IS 11989	Specification for Compressed air dryer
16	ISO 7183	Compressed air dryers – Specification and Testing
17	IS 7285	Specification for seamless steel cylinders for permanent and high pressure liquefiable gases
18	IS 3224	Valve fittings for compressed gas cylinders excluding Liquefied Petroleum Gas (LPG) cylinders
19	IS 2148	Electrical apparatus for explosive gas atmosphere flameproof enclosures "d"

3.7.2 **Standards**

S. No	TITLE
1.0	American National Standard Institute (ANSI)
2.0	American Society for Testing Materials (ASTM)
3.0	American Society of Mechanical Engineers (ASME)
3.1	ASME section II (Part A, B and C)- Materials (Ferrous, Non Ferrous and filler materials respectively.)
3.2	ASME Section V – code of practice for Non Destructive Testing
3.3	ANSI B 16. 104 – Valve leakages acceptance.
3.4	ASME B16.10 - Face-to-face and end-to-end dimensions of valves
3.5	ASME B16.11 - Forged steel fittings, socket-welding and threaded
3.6	ASME B16.34 - Valves – flanged, threaded and welding end
3.7	ASME B16.5 - Pipe flanges and flanged fittings
3.8	ASME PV CODE 8 - DIV.1 Pressure vessels – division 1
3.9	ASTM A 105 / A105M - Specification for carbon steel forging for piping applications
4.0	EN 287 PT1 - Approval testing of welders – fusion welding – steels
4.1	EN 288 PT3 - Specification and approval of welding procedures for metallic materials – welding procedure tests for the arc welding of steels
5.0	American Welding Society (AWS)
6.0	BS 848 – Fans for general purpose
7.0	Hydraulic Institute Standards (HIS)
8.0	Heat Exchange Institute (HEI)
9.0	Tubular Exchange Manufacturer's Association (TEMA)
10.0	Deutsche Industrie Normen (DIN)

S. No	TITLE
12.0	VDI
12.0	American Petroleum Institute
i)	API 617: Centrifugal Compressors for Petroleum, Chemical and Gas Service Industry Services
ii)	API 672: Packaged Integrally Geared Centrifugal Air compressors for Petroleum, Chemical and Gas Industry Services.
13.0	Indian Standards (IS)
i)	IS 5: Colours for ready mixed paints and enamels
ii)	IS 277: Galvanised Steel sheets
iii)	IS 520: Standard for positive displacement refrigerant condenser and refrigerant units
iv)	IS 659: Safety code for air conditioning/mechanical refrigeration
v)	IS 803: Code of practice for design, fabrication, erection of vertical mild steel cylindrical welded oil storage tanks.
vi)	IS 807: Code of practice for design, manufacture, erection, testing (structural portion) of cranes and hoists
vii)	IS 1239: Mild steel tubes, Tubular and other wrought steel Fittings, specification – Part 1
viii)	IS 1303: Glossary of terms relating to paints
ix)	IS 2062: Steel for general structural purposes
x)	IS 2312: Propeller type AC ventilation fans
xi)	IS 3034: Fire safety of industrial buildings: Electrical generating and distribution stations – Code of practice
xii)	IS 3041: Silica Gel
xiii)	IS 3588: Electric axial fans
xiv)	IS 3589: Seamless or electrically welded steel pipes for water gas and sewage (168.3 mm to 2032 mm outside diameter)
xv)	IS 3938: Electric wire rope hoists
xvi)	IS 4671: Expanded polystyrene for thermal insulation purposes
xvii)	IS 4894: Centrifugal fans
xviii)	IS 5290: Specification for landing valves
xxi)	IS 5312: Specification for Swing check type Reflux (Non return) valves for water works purposes – Part –1: Single door Pattern.
xx)	IS 7413: Code of practice for application and finishing of thermal industrial application and finishing of thermal insulation
xxi)	IS 7613: Method of testing panel type air filters for air conditioning and ventilation purposes
xxii)	IS 7938: Code for Air receivers
xxiii)	IS 8148: Packaged air conditioners

S. No	TITLE
xxvi)	IS 8183: Bonded mineral wool
xxv)	IS 9137: Code of acceptance test for centrifugal, mixed flow and axial pumps – Class C
xxvi)	IS 14164: Industrial application and finishing of thermal insulation material at temperature above –80 Deg C and up to 700 Deg C – Code of practice
xxvii)	IS 14846: Sluice valve for water works purposes (50 mm to 1200 mm size) – Specification

In case of any contradiction with the aforesaid standards and the stipulations of the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail.

DATA SHEET

HYDROGEN GENERATION PLANT

S. No.	Item	Unit	Description
1.	Technology		Bipolar Proton Exchange Membrane/ solid polymer electrolyte pressurized water electrolysis
2.	Capacity	Nm^3/hr	10 x 2 streams
3.	Purity of hydrogen	%	99.999
4.	Dew point	^0C	(-) 70
5.	Pressure after booster	Bar(g)	150
6.	Electrolyser		
i)	H_2 capacity Net	Nm^3/hr	10 per STREAM
ii)	O_2 capacity	Nm^3/hr	5
iii)	H_2 purity (by Vol.)	%	≥ 99.999 (After drier)
iv)	O_2 Purity (by Vol.)	%	≥ 99.5
v)	DM water consumption	Liters/hr	10
vi)	Eletrolyte	%	Solid Polymer – Nafion® or equivalent
vii)	Operating temperature	^0C	55
viii)	Design tempeasture	^0C	65
ix)	Operating voltage	V	DC; 0–175 V Adjustable
x)	Operating DC current	Amp	0 – 410 adjsutable
xi)	Working / Design Pressure	Bar (g)	30/34
xii)	Hydrogen production pressure at electrolyser	Bar (g)	30
xiii)	Oxygen production pressure at electrolyser	Bar (g)	1.5
xiv)	Hydrogen Discharge pressure	Bar (g)	30
xv)	No. of modules		One per stream
xvi)	No. of cell per module		As per manufacturer standard

S. No.	Item	Unit	Description
xvii)	MOC of construction of cell		as per manufacturer standard
xviii)	Electrode material		
	(a) Cathode		As per manufacturer standard.
	(b) Anode		As per manufacturer standard.
xix)	Turn down ratio	%	0 to 100
i)	MOC of DM water tank		SS 316
ii)	Capacity of DM water tank	Ltrs	5000
iii)	DM Feed pump (if required)	Nos.	2 (1 for each stream)
	(a) Pumping head	M	as per manufacturer requirement
	(b) Power		415V, 50Hz
	(c) Enclosure		IP 55. Insulation class H

GAS DRYER

S. No.	Item	Unit	Description
1.	Operating pressure	Bar (g)	30
2.	Design pressure	Bar (g)	33
3.	Hydro test pressure	Bar (g)	75
4.	Design temperature	^{0}C	65
5.	Pressur vessel design code		ASME Sec-VIII
6.	Type of hydrogen dryer		Twin bed desiccant type (heated / Pressure Swing Adsorption)
7.	No. of desiccant bed	Nos.	2
8.	Inlet H_2 capacity	Nm^3/hr	11
9.	Outlet H_2 capacity	Nm^3/hr	10
10.	Desiccant type		Molecular sieve 13 X / Activated Alumina
11.	Absorber Bed MOC		SS 304
12.	Total cycle time	Hours	24

13.	Regeneration cycle time	Hours	12
14.	Outlet dew point	^{0}C	(-) 70
15.	Regeneration gas		Dried hydrogen
16.	Consumption of regeneration gas Maximum		7 to 8 % of gas

HYDROGEN COMPRESSOR

S. No.	Item	Unit	Description
1.	Compressor Type		Single/Multi stage Diaphragm type – oil free having effective sealing
2.	Quantity	Nos.	2
3.	Capacity	Nm^3/hr	20
4.	Stages	Nos.	Single/Multi stage
5.	Pressure	kg/cm^2 (g)	
i)	Suction		30
ii)	Discharge		150
6.	Temperature	^{0}C	
i)	Suction	-	Ambient
ii)	Discharge	-	Ambinet
7.	Type of cooler	-	Water cooled cooler
8.	Location	-	Indoor
9.	Fluid handled	-	Cooling water
10.	Design Standard	-	IS-6206/1985/Manufacturer's standard
11.	Performance standard	-	ASME PTC-9
12.	Material of construction		
i)	Diaphragm		SS 316
ii)	Diaphragm cover		SS

S. No.	Item	Unit	Description
iii)	Process Head		SS 316
iv)	Hydraulic Head		Cast Steel
v)	Crank shaft		Ductile Iron / Forged Steel
vi)	Casing		ASTM A-240, 316SS
vii)	Base Plate		IS 2062
viii)	Shaft		ASTM A473 Gr. 410 (13% Cr. Hardened)
ix)	Piston		Aluminium BS-1490, LM-13
x)	Piston Ring		Teflon with 25-30% Carbon
xi)	Shaft Bearing		SS 316 / Better Quality
xii)	Wearing rings		Hardened ASTM-A743 Gr.CF8M
xiii)	Main Bearings		White Metal
xiv)	Piston Rod		EN-8
xv)	Crank Case		Cast Iron
xvi)	Delivery Check Valve		316SS
xvii)	Closure Seal	-	Buna "N"
xviii	Valves		
	(a) Suction		SS 316
	(b) Discharge		SS 316
xix)	Type of lubrication		Oil
13.	Drive motor		Electric Motor
i)	Rated voltage, phase & frequency		415V, 3 phase, 50Hz
ii)	Type of enclosure		TEFC, explosion proof
iii)	Insulation class		F
14.	Accessories required		Coupling, coupling guard etc.

WATER CHILLER

S. No.	Item	Unit	Description
1.	Type		Air cooled
2.	Cooling capacity	Kcal/hr	1,50,000
3.	Cooling water inlet temp.	^{0}C	15 ^{0}C
4.	Cooling water outlet temp.	^{0}C	10 ^{0}C
5.	Compressor type		Hermetic sealed
6.	Condenser type		Air cooled
7.	Evaporator		
i)	Type		Shell-Tube
ii)	Inlet temp of water	^{0}C	15 ^{0}C
iii)	Outlet temp of water	^{0}C	10 ^{0}C
iv)	Flow rate of chilled water	LPH	7500 per Hydrogen electrolyser and Hydrogen compressor.
8.	Accessories		LP/ HP switch, Temp. controller, Antifreeze Thermostat, Water level switch, Refrigerant etc.

Data Sheets for Piping

a) PIPING CLASS - "A"

1	Service	:	Service Water
2	Pipe Material	:	ASTM A-106 Grade B carbon steel.
3	Pipe Schedule	:	Standard
4	Fittings	:	50 mm & below: Class 3000; forged carbon steel, socket welding type, ANSI B 16. 11, ASTM A-105. 65mm and larger, standard weight carbon steel, butt welding type, ANSI B16. 9, ASTM A-234 Grade WPB
5	Flanges	:	Class 150 forged carbon steel, flat face, ANSI B16.5, ASTM A-105 50 mm & below;; socket welding type (Back fillet welded). 65 mm and larger: slip-on or welding neck type.
6	Gaskets	:	Teflon or red rubber, full face, 1.6mm thick but 3.2mm thick for red rubber, ANSI B16.21.

7	Valves	:	50 mm & below: bronze, threaded ends, ASTM B-61 or B-62 65mm and larger: Class 125 cast iron, flanged ends, ASTM A-126.

b) PIPING CLASS - "B"

1	Service	:	Demineralized water.
2	Pipe Material	:	15 mm to 150mm: ASTM A-312 Grade TP304L seamless or welded stainless steel.
3	Pipe Schedule	:	15 mm to 150mm:Schedule 10S.
4	Fittings	:	15 mm to 150 mm: Wrought stainless steel socket welding, Schedule 10S, ASTM A-403 Grade WP304L.
5	Flanges	:	15 mm to 150mm: Forged carbon steel (ASTM A-105 or A-181 Class 70) with Type 316 stainless steel insert 1.6mm, raised face, ANSI B16.5 dimensions. Insert to be welded front and back to pipe. Expansion not required.
6	Gaskets	:	Neoprene or Teflon, ring type, 1.6mm thick, ANSI B16.21.
7	Valves	:	50 mm & below: Class 300 stainless steel, socket welding ends, Type 316 stainless steel.

c) PIPING CLASS - "C"

1	Service	:	Hydrogen/Nitrogen (Low Pressure, Upstream of compressor)
2	Pipe Material	:	ASTM A-106 Grade B carbon steel & piping as per ANSI B 31.1
3	Fittings	:	50 mm & below: Class 3000 forged carbon steel, socket welding type, ANSI B16.11, ASTM A-105 65mm and larger: Standard weight, carbon steel, butt welding type, ANSI B16.9, ASTM A-234 Grade WPB.
4	Flanges	:	50mm & smaller: class 150 forged carbon steel, 1.6mm raised face, socket welding type, (Back fillet welded) ANSI B16.5, ASTM A-105. 65mm & and larger Class 150 forged carbon steel 1.6mm raised face, slip-on or welding neck type, ANSI B16.5, ASTM A-105.

5	Gaskets	:	Teflon full face, 1.6 mm thick for teflon but 3.2mm for red rubber, ANSI B16.21
6	Valves	:	To suit service and design P-T conditions.

NOTE: Threads for pipes, fittings, valves etc. handling hydrogen, oxygen and nitrogen gas will conform to ANSI B2.1.

The pipe schedules shown in the Tables are minimum schedules but do not necessarily have sufficient thickness to fully account for erosion, corrosion, thinning due to bending, threading, grooving and mechanical strength allowances which may be required for the system design conditions. These allowances are the responsibility of the CONTRACTOR in his calculations which shall be reviewed and approved during detailed engineering.

High pressure hydrogen gas piping downstream of compressor will also be ASTM A-106 Grade B seamless carbon steel. Thickness and ratings of pipe, fittings will be selected by the Contractor based on pressure and temperature conditions with due considerations to aging and thinning during fabrication and erection of pipe**.**

CHAPTER – 4

RAW WATER INTAKE & PLANT WATER SYSTEM

CONTENTS

CHAPTER – 4

RAW WATER INTAKE & PLANT RAW WATER SYSTEM

4.1.0 Scope of Work

4.1.1 Raw Water required for Deen Bandhu Chhotu Ram Thermal Power Plant (Existing 2x300 MW) is drawn from West Yamuna Canal and pumped/routed by gravity through channel to Raw Water reservoir constructed inside the power plant. Existing raw water reservoir has 2 compartments with a Raw Water Pump House connected to both the compartmrnts.

4.1.2 Three (3) Raw water Intake Pumps are installed in the Intake Pump House which are operating since 2010. The parameters of the existing Raw Water Intake Pumps are as follows:

Make	:	Flowmore Private Limited
Capacity	:	2550 M^3/Hr
Head	:	4.5 MWC
Speed	:	965 RPM
Motor rating	:	75 KW
Make of motor	:	Marathon Electric
Voltage	:	415 V

4.1.3 The raw water required for the proposed 800 MW Unit shall be drawn from one of the compartments of existing raw water reservoir (Location of raw water pump house shown in the Plot Plan). The pump house shall be constructed inside the raw water reservoir or adjacent to the raw water reservoir.

Bidder shall replace (supply and install) all the three (3) existing vertical turbine type Raw water Intake Pumps with new pumps of same capacity & head.

4.1.4 Plant raw water system shall consist of raw water pump house with two (2) raw water (RW) pumps & two (2) Ash Handling makeup (AHP) pumps and water piping. Raw water & Ash handling make up piping shall be as per Chapter – 27: LP Piping, Valves & Specialities.

4.1.5 Raw water required for the proposed 800 MW Unit shall be drawn from existing raw water reservoir. Needed modifications in the existing reservoir shall be in bidder's scope of work.

4.1.6 Raw water Intake and Plant Raw water System includes, but shall not be limited to the following:

i. Three (3) (2W + 1S) Raw Water Intake Pumps

ii. Disilting of the existing raw water reservoir (both compartments).

iii. Two (2) nos.100% (1W+1S) RW Pumps

iv. Two (2) nos.100% (1W+1S) AHP Pumps.

v. Raw water piping from raw water pumps discharge to the Pre-treatment Plant

vi. Ash water make-up piping from Ash water make up pumps discharge to Ash water sump/ash slurry sump.

vii. Non return valves, Rubber expansion joints, motorised butterfly valves at each pump discharge

viii. Valves and Specialities including air release valves.

ix. EOT crane & hoists as per Volume III Chapter - 28: Cranes & Hoists

4.1.7 The RW pumps shall be controlled from the proposed PT plant control room.

4.1.8 The AHP pumps shall be controlled from the Ash Handling System control room.

4.2.0 **Plant Raw Water Pump House**

4.2.1 The Plant Raw water pumphouse shall house two (2) raw water pumps and two (2) Ash handling make (AHP) pumps of adequate capacities.

4.2.2 The pumps shall be vertical wet pit type. Each pump shall be provided with expansion joint, NRV and electrically operated butterfly valve at discharge side.

4.2.3 Each pump shall be located in individual sump, dimension of which shall be decided as per HIS. Each sump shall be provided with a drain sump to empty the sump for attending to maintenance requirements of the pump. Stop log gate and coarse screen shall be provided at the inlet of each pump sump. All the openings shall be covered with galvanized mild steel gratings when the stop logs/ travelling water screens are placed in position.

4.2.4 Handling arrangement for stop log gates/coarse screens shall be provided as per Volume III, Chapter 28.

4.2.5 Adquate handling & hoisting facilities shall be provided for the pumps, motors, valves and the other equipment installed in the pumphouse. One (1) EOT crane of adequate capacity (minimum 5 tonnes capacity) shall be provided for handling of pumps, motors, valves etc. depending on system requirements.

4.2.6 Raw water pump house shall accommodate one maintenance bay. The entire pump house shall be constructed in line with the requirements stipulated in the specification.

4.2.7 Adequate ventilation facilities shall also be provided. All inter connecting piping, civil and structural design and construction works are also included in the scope of work.

4.3.0 **Discharge pipe from raw water pump house**

4.3.1 Raw water pipe supplying process make-up to PTP & Ash water make-up pipe supplying make-up to AHP shall be run underground.

4.3.2 Pipe material shall conform to stipulations under chapter-27 (Low pressure piping).

4.3.3 The pipe protection for buried pipes shall be as described in Chapter – 27.

4.3.4 Butterfly valves & rubber expansion joints shall comply with the datasheets described in the circulating water system.

4.4.0 **Control & Operation Philosophy**

4.4.1 This control write-up/ operation philosophy briefs the control/operation requirements of the Raw Water Pumps and AHP Pumps as a general guideline only and Contractor shall furnish his proposed philosophy during detailed engineering for approval of the Employer.

4.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

4.4.3 An interlock shall be provided to trip the pumps from very low (low low) level of water in the respective sumps. To achieve the above interlock there shall be level transmitters which shall operate on one (1) out of two (2) voting philosophy. The same level transmitters shall also be used for pump start permissive from normal water level in the respective sump.

4.4.4 Pumps shall have auto start facility. The standby pump shall start automatically in case of tripping of the running pump or if the discharge header falls below a preset low value.

4.4.5 All pumps shall have the following safety features:

- Sump level high and low – annunciation
- Sump level very low (low low) – annunciation and trip
- Pressure on pump discharge high due to incomplete opening of discharge valve –annunciation.
- Pressure on pump discharge very high (high high) due to accidental closure of discharge valve –annunciation & trip.
- Pressure on pump discharge very low (low low) due to NRV failure – annunciation & trip

4.4.6 Any other protective feature deemed necessary for safe and reliable operation.

4.4.7 Plant Raw Water System

Make-up to Pre Treatment Plant

Normal make-up supplied by the RW pump to the PTP shall be regulated in the Flow control station (upstream of cascade aerator) as per signals received from LTs installed in Filtered water storage tank (Refer chapter-5 for details).

Ash Handling Plant Make-up system

Make-up to Ash Water Sump shall be regulated by the flow control valve (located in the pump discharge header) as per signals received from LTs in the ash water sump/ash slurry sump.

DATA SHEETS

RAW WATER INTAKE PUMPS

S. No.	Item	Units	Description
1.	Total no. of pumps	Nos.	3 x 100% capacity (2W + 1S)
2.	Pump capacity	M^3/hr	2550
3.	Pump total head excluding losses in the pump	MWC	4.5
4.	Pump Speed (max.)	RPM	1000
5.	Type of Pump		Vertical Wet pit type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Raw water
9.	Type of line bearing lubrication		Forced lubrication (self)
10.	Liquid for lubrication		Filtered water
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		Bidder to indicate
14.	Material of construction		
a.	Pump column pipe		Fabricated steel to IS2062 with epoxy painting
b.	Pump bowl and discharge elbow		2% Ni-CI to IS 210 FG 260
c.	Impeller		SS, CF8M
d.	Shaft		SS 410
e.	Line shaft coupling		SS 410
f.	Line shaft bearing		Cutless rubber in SS shell
g.	All hardware under water		SS 304
h.	Base plate		CI / MS
i.	Shaft sleeve		SS-316
j.	Suction strainer		SS
j.	Thrust bearing cooling system pipes and valves		SS

RAW WATER PUMPS

S. No.	Item	Units	Description
1.	Total no. of pumps	Nos.	2 x 100% capacity (1W + 1S)
2.	Pump capacity	M^3/hr	Bidder to indicate (taking 10% margin on required flow).
3.	Pump total head excluding losses in the pump	MWC	By Bidder (pump shall have 10% margin on friction head over actual requirement)
4.	Pump Speed (max.)	RPM	1500
5.	Type of Pump		Vertical Wet pit type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Raw water
9.	Type of line bearing lubrication		Forced lubrication (self)
10.	Liquid for lubrication		Filtered water
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		Bidder to indicate
14.	Material of construction		
a.	Pump column pipe		Fabricated steel to IS2062 with epoxy painting
b.	Pump bowl and discharge elbow		2% Ni-CI to IS 210 FG 260
c.	Impeller		SS, CF8M
d.	Shaft		SS 410
e.	Line shaft coupling		SS 410
f.	Line shaft bearing		Cutless rubber in SS shell
g.	All hardware under water		SS 304
h.	Base plate		CI / MS
i.	Shaft sleeve		SS-316
j.	Suction strainer		SS
k.	Thrust bearing cooling system pipes and valves		SS

ASH HANDLING MAKEUP (AHP) PUMPS

S. No.	Item	Units	Description
1.	Total no. of pumps	Nos.	2 x 100% capacity (1 working + 1 standby)
2.	Pump capacity	M^3/hr	Bidder to indicate (taking 10% margin on required flow).
3.	Pump total head excluding losses in the pump	MWC	By Bidder (pump shall have 10% margin on friction head over actual requirement)
4.	Pump Speed (max.)	RPM	1500
5.	Type of Pump		Vertical Wet pit type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Raw water
9.	Type of line bearing lubrication		Forced lubrication
10.	Liquid for lubrication		Clarified water
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		Bidder to indicate
14.	Material of construction		
a.	Pump column pipe		Fabricated steel to IS: 2062 with epoxy painting
b.	Pump bowl and discharge elbow		2% Ni-CI to IS 210 FG 260
c.	Impeller		SS, CF8M
d.	Shaft		SS 410
e.	Line shaft coupling		SS 410
f.	Line shaft bearing		Cutless rubber in SS shell
g.	All hardware under water		SS 304
h.	Base plate		CI / MS
i.	Shaft sleeve		SS-316
j.	Suction strainer		SS
k.	Thrust bearing cooling system pipes and valves		SS

COARSE SCREENS & STOP LOG GATES

Coarse Screens

1.	Clear Opening	:	10 mm x 10 mm
2.	Material of Construction	:	-
a.	Screen Wire	:	SS 304
b.	Side guide-cum-track	:	CS IS 2062 Gr B
c.	Frame	:	IS 2062 Gr B
d.	Mechanical fasteners	:	SS 304

Stoplog Gates

1.	Guides/ Anchors	:	CS IS 2062 Gr B
2.	Gate leaf & lifting beam	:	CS IS 2062 Gr B
3.	Rubber seals	:	As per Appendix-B of IS: 4622
4.	Lifting Beam	:	CS IS 2062 Gr B

CHAPTER – 5

WATER TREATMENT PLANT

CONTENTS

CHAPTER – 5

WATER TREATMENT PLANT

5.1 General

5.1.1 The source of raw water for the project is Western Yamuna canal. The river water intake pumps shall be installed in the existing pump house and shall supply raw water to existing In Plant Raw Water Reservoir. Two (2) nos. each Raw water and AHP Pumps shall be installed in a proposed raw water pump house. The proposed raw water pump house shall be installed in one of the compartments of the existing raw water reservoir (as shown in the Plot Plan) or adjacent to the existing raw water reservoir. Necessary modicications as required in the existing raw water reservoir shall be in the scope of bidder.

Raw Water shall be fed to the clariflocculators through two (2) Plant Raw Water Pumps and an adequately sized pipeline, control station and cascade aerator. The exact capacity will have to be worked out by the bidder as per system requirement.

5.1.2 Raw water analysis is enclosed (Volume II, Chapter 2, Appendix I)

5.2 Scope of Work

5.2.1 Pretreament Plant

a) Flow control station upstream of cascade Aerator consisting of a regulating type motorized butterfly valve with isolation valves and by pass valves along with by-pass line.

b) One (1) Cascade type aerator to oxidize ferrous to ferric and to remove dissolved carbon dioxide

c) One(1) stilling chamber with baffle & retention time of min. 1 minute. Drainage to be connected with sludge sump.

d) One (1) flow measuring element (Parshall flume) and 1 no. flow transmitter at the inlet channel to flash mixer.

e) One(1)flash mixer with retention time of min. 1 minute and slow speed agitator etc. Drainage to be connected with the sludge sump.

f) Two(2) clariflocculators (over ground as much as possible), complete with rake mechanism, flocculator mechanism alongwith drive and drive motors, telescopic type continuous sludge discharge arrangement, intermittent sludge disposal system, flushing arrangement etc. for clariflocculator.

g) Coagulant(Alum) Dosing system consisting of three (3) dosing tanks having minimum total effective capacity of 24 hours requirement with 20% margin and 2x100% capacity dosing pumps complete with associated piping and valves.

h) Lime Dosing system consisting of three (3) dosing tanks having minimum total effective capacity of 24 hrs requirement with 20% margin and 2 x 100% capacity dosing pumps complete with associated piping and valves.

i) Coagulant aid (Polyelectrolyte) Dosing system consisting of 2nos. dosing tanks having minimum total effective capacity of 24 hours requirement with 20% margin and 2 x 100% capacity dosing pumps complete with associated piping and valves.

j) Six (6) Rapid Gravity Filters (4W+2S) of adequate capacity with dual media filtering material as per specification along with the necessary valves and instrumentation.

k) Filtered water storage tank of RCC construction of effective capacity 5000 m^3 for filtered water storage. Separate dedicated effective fire water storage of capacity 2500 M^3 shall also be provided in the filtered water tank.–The filtered water storage shall be in two compartments with common suction sump for all the pumps. The fire water storage shall be housed in za third compartment. Pumphouse housing all the pumps including fire water pumps shall be provided.

l) One (1) Chemical house (two storied) for housing various chemical solution tanks & pumps along with centrifuge at first floor. Chemicals storage space sufficient for 30 days requriement with toilet block shall be housed at ground floor.

The various chemical handling and dosing equipment in the plant shall be designed for the following dosing rates:

i)	Non - Ferric Alum	:	50 ppm (max.)
ii)	Lime	:	25 ppm (max.)
iii)	Polyelectrolyte	:	1 ppm (max.)

A minimum free board of 300 mm shall be provided in all the water retaining structures of PT Plant (such as stilling chamber, clarifier, filtered water storage tank etc.) in between the maximum water level and BOP of over flow pipe excluding slab / beam if any.

All pipes shall be routed through pipe racks only.

m) One (1) complete sludge handling system consisting of sludge sump of effective capacity 250 M^3 two (2) (1W+1S) of Sludge Transfer pumps, one(1) no. sludge thickner, two (2) (1W+1S) thickened sludge transfer pumps along with sludge flushing & recirculation arrangement etc.

n) Necessary flushing arrangement in the Lime dosing line, sludge pipes shall be provided. Bypass line from sludge disposal pumps to AHP slurry pit shall also be provided.

o) Safety equipment – Gas mask, oxygen breathing apparatus, weather cock, safety shower.

p) One (1) platform digital type weighing scale of 500 kg capacity. An electric hoist with electric driven travelling trolley of 2 ton capacity in the chemical house.

q) All pipes or RCC channels/ ducts and hume pipes required for sludge disposal drain shall be led to sludge sump.

Note: All the Pre-Treatment equipment shall be capable of running on 20% overloading.

Bidder shall provide all the consumables including chemicals till the handing over the plant and additional chemicals of two (2) months requirement. Pre-treatment plant shall be sized considering reusable water from ETP as zero (0).

5.3 Control Philosophy

1. The operation of pre-treatment plant shall be provided with stand alone DDCMIS based semi-automatic plant water control system. The DDCMIS shall be modular design and shall be provided with hot redundant processors.

2. Operation of all the pumps shall be through stand alone DDCMIS.

3. Plant water system DDCMIS shall be connected with main plant DDCMIS through redundant softlink for monitoring at cental control room. Remote I/O panel and GIU shall also be provided by bidder as per requirement. Furniture for OS, printers and chair for operating personnel shall also be provided.

4. Industrial grade parallel redundant UPS System and 24V DC charger system with 60 minutes battery backup shall be provided for the plant water system DDCMIS including peripherals.

5. Control desk for the operator work stations and annunciation with adequate number of windows.

6. All the field instrument e.g. Pressure gauges, Pressue Transmitter Flow Indicator (Rota meter type), Flow Transmitter, Level Indicator (G. Glass), Non Contact Type Level Indicating Transmitter, Differential Pressure transmitters, non contact type level transmitters and indictors for sumps as shown in flow diagrams.

7. Three (3) nos. flow transmitters, one each at parshall flume, DM feed pump & RGF back wash pump discharge header shall be provided.

8. Pressure gauge & pressure switch at each pump outlet shall be provided.

9. Turbidity analyser at the inlet of control station shall be provided.

10. Residual chlorine analyser at the clarifloculator outlet shall be provided.

11. This is the minimum requirement. For detailing, bidder shall refer C&I Specification Vol. V chapter-3 for control systems, chapter-2 for field & measuring instruments and Annexure-A for control philosophy.

DATA SHEET – WATER TREATMENT PLANT

S. No.	Description	Units	Parameter
1.0	Cascade Aerator		
a.	Type		Casacade Type
b.	Number required	No.	One (1)
c.	Construction		RCC with peripheral walkway
d.	Design Flow	Cum/hr.	2200
e.	Surface Loading	M3/m2/hr	0.045
f.	Residence time	Sec	1
g.	Riser	mm	250 (max.)
h.	Tread	mm	400 (min.)
i	Free Board	mm	300 minimum
j.	Size	M	~ 12.0
2.0	Stilling Chamber		
a.	Number required	No.	One (1)
b.	Construction		RCC
c.	Detention time	min.	One (1)
d.	Rated Capacity	Cum/hr.	2200
e.	Free Board	mm	300 minimum
f.	Accessories		Suitable Draining arrangement to be provided with drain line to be extended to common sludge sump.
3.0	Parshall Flume		
a.	Number required		One (1)
b.	Construction		RCC
c.	Rated Capacity	Cum/hr.	2700 (max)
d.	Minimum Free board	mm.	300
e.	Design Temp.	Deg C	60
f.	Size	mm	Bidder to indicate
4.0	Flash mixer		
a.	Number required	No.	One (1)
b.	Rated Capacity	m3/hr	2200
c.	Construction		RCC
d.	Detention time (approx.)	min.	One (1)
e.	Free-board	mm	Minimum 300

S. No.	Description	Units	Parameter
f.	Agitator		Turbine type ac electric motor operated thru reduction gear, slow speed MOC : SS-316 Ratio of Tank & agitator Dia : 4:1
g.	Protective cover of GI construction for motors and gear drives.		Required – protection for motors – IPW-55 (outdoor duty)
h.	Accessories		Suitable Draining arrangement to be provided with drain line to be extended to common sludge sump.
5.0	Clariflocculator		
a.	MOC of inlet pipe		M.S. ERW pipe for 10 Kg/cm2 (g) Pressure Class
b.	Number required	No.	Two (2)
c.	Type & Construction		Radial, RCC
d.	Rated Effluent Capacity	Cum/hr	1100 (minimum)
e.	Effluent quality	NTU	<10
f.	Detention period- - Flocculation Zone - Clarification Zone	Min.	 30(min.) 150(min.)
g.	Rise rate	Cu.M/hr/m2	1.2
h.	Wier Loading rate	M3/day/m	≤300
i.	Water Depth	M	3.0
j	Walkway		1 M wide along the periphery of clariflocculator with hand railing. Walkway shall be connected with the first floor of chemical house.
k.	Rake bridge:		
i)	Material		MS IS: 2062 Epoxy painted
ii)	Other features		Suitably braced to provide rigidity. Gear boxes for bridge drive shall be either oil-free type or suitable arrangement for collecting leak oil shall be provided.
l.	Sludge blow-off:		
i)	Continuous		By gravity through telescopic stand pipe for continuous discharge.
ii)	Intermittent		Through blow-off valve
m.	Size:	M	By bidder

S. No.	Description	Units	Parameter		
n.	Flocculation Agitator		Vertical Slow speed motor driven thru reduction gear		
o.	Clarifier launder width	mm	500		
p.	Wier Plate		V Notch Type		
q.	MOC of Wier Plate		SS/FRP , 6mm thk		
r.	Sampling Point		Required at inlet & oulet		
s.	Torque switch for clarifier bridge drive		To be provided		
6.0	Chemical House				
a.	Number	No	One		
b.	Type		Two (2) storied building		
c.	Ground Floor		Chemical storage for PT Plant for 30 days (min.) and Raw Water Chlorination System		
d.	First Floor		Location of Chemical Tanks EL 5.5m (approx) / near Flash mixer		
e.	Handling Facility		An electric hoist with electric driven travelling trolley of capacity 1.0 Ton		
f.	Weighing scale for weighing chemicals capacity 500 Kg.	No.	One		
7.0	Chemical Dosing System				
7.1	Dosing Tanks		Alum Tank	Lime Tank	Polyelectrolyte Tank
a.	Numbers required		Three (3)	Three (3)	Two (2)
b.	Construction		RCC	RCC	MSRL
c.	Internal lining		PPG lining	Coal tar epoxy paint	Rubber line
d.	Minimum effective Capacity of each tank	Cum.	12	10	6
e.	Solution strength	%	10	5	0.5
f.	Agitator – type		Vertical	Vertical	Vertical
	- MOC		SS	MS	SS
g.	Dissolving basket		In SS Construction with 10 mm dia holes on 50mm triangular pitch.		
h.	M.O.C. for piping valves, & fittings		CPVC PN 10 for alum & poly electrolyte & MS/GI for lime		

S. No.	Description	Units	Parameter
i.	Accessories:		
1.	Level Guages	No.	One (1) Mechanical Float & Board Type
2.	Level Switches	No.	One (1) to trip the pumps. Top Mounted Float operated Magnetic Type
7.2	Chemical Dosing Pumps		
a.	Alum Dosing Pumps		
i.	Qty	Nos.	2(1W+1S)
ii	Type		Positive displacement and hydraulically diaphragm type with stroke adjustment
iii	Location		Indoor
iv.	Fluid to be handled		10% Alum Solution
v.	Service		To dose Alum solution to the flash mixer
vi.	Duty:		Continous and suitable for parallel operation
vii.	Suction Condition		Flooded
viii.	Rtaed Capacity	Lph	1500
ix.	Head	MWC	To meet system requirement
x.	Design Temperature	$^{\circ}$C	50
xi.	Range of operation		30-100%
xii.	Rated speed	spm	100
xiii.	MOC:		
	- All Wetted Parts		PP
	- Diaphragm		PTFE
	- Nuts & Bolts		SS-316
	- Base Plate		MS
xiv.	Type of drive		Electrical Motor
xv.	Criteria for selection of drive motor		Minimum 15% margin over Bkw rated duty point
xvi.	Motor Rated Speed		1500(syn) maximum
xvii.	Type of Coupling between pump and motor		Flexible spacer
xviii.	Noise level (for complete set of pump and motor)		Not more than 85 db (At a distance of 1 mtr from outer surface of motor)

S. No.	Description	Units	Parameter
xix	Instruments		
xx	-Pressure Guage		
	-Numbers		1
	- Location		At the discharge of each pump
	- Type		Bourdon Guage with Diaphragm
	Start stop facility provided at both local and remote		Required
xxi	Trip Interlock		Required
	Accessories to be provided		
xxii	- Pulsation Dampner		Required
	- Pressure Relief Valve		Required
b.	Lime Dosing Pumps		
i.	Qty	Nos.	2(1W+1S)
ii.	Type		Screw type
iii.	Pump speed	rpm	200
iv.	Fluid to be handled		5% Lime Solution
v.	Service		To dose Lime solution to the clarifier
vi.	Duty:		Continous and suitable for parallel operation
vii.	Suction Condition		Flooded
viii.	Rated Capacity	lph	1300
ix.	Head	MWC	To meet system requiremnet
x.	Design Temperature	$^{\circ}$C	50
xi.	Range of operation		30-100%
xii.	MOC:		
	- Pump Casing		2% Ni -CI To IS 210 FG 260
	- Stator		EPDM Rubber
	- Shaft & Shaft sleeve		SS-410 & SS 316
	- Eccentric Rotor		MS
xiii.	Type of drive		Electrical Motor
xiv.	Criteria for selection of drive motor		Minimum 15% margin over Bkw rated duty point
xv.	Motor Rated Speed		1500(syn) maximum
xvi.	Speed Reducer		Through gear box
xvii.	Noise level (for complete set of pump and motor)		Not more than 85 db (At a distance of 1 mtr from outer surface of motor)

S. No.	Description	Units	Parameter	
xviii.	Instruments – Pressure Guage			
xix.	- Numbers		1	
	- Location		At the discharge of each pump	
	- Type		Bourdon Guage with Diaphragm	
	Start stop facility provided at both local and panel		Required	
xx.	Trip Interlock		Required	
c.	PE Dosing Pumps			
i.	Qty	Nos.	2(1w+1s)	2(1w+1s)
ii.	Type		Positive displacement and hydraulically diaphragm type with stroke adjustment	
iii.	Location		Indoor	
iv.	Fluid to be handled		0.5% PE Solution	
v.	Design Code		API 675	
vi.	Service		To dose PE solution to the clarifier	Thickner/ Centrifuge
vii.	Duty:		Continous and suitable for parallel operation	
viii.	Suction Condition		Flooded	
ix.	Rated Capacity	lph	500	25
x.	Head		To meet system requiremnet	
xi.	Design Temperature	$^{\circ}$C	50	
xii.	Range of operation		30-100%	
xiii.	Rated speed	spm	100	
xiv.	MOC:			
	- All Wetted Parts		SS-316	
	- Diaphragm		PTFE	
	- Nuts & Bolts		SS-316	
	- Base Plate		MS	
xv.	Type of drive		Electrical Motor	
xvi.	Motor Rated Speed		1500(syn) maximum	
xvii.	Type of Coupling between pump and motor		Flexible spacer	
xviii.	Noise level (for complete set of pump and motor)		Not more than 85 db (At a distance of 1 mtr from outer surface of motor)	

S. No.	Description	Units	Parameter
xix.	Instruments - Pressure Guage		
xx.	- Numbers		1
	- Location		At the discharge of each pump
	- Type		Bourdon Guage with Diaphragm
	Start stop facility provided at both local and panel		Required
xxi.	Trip Interlock		Required
xxii.	Accessories to be provided		
xxiii.	- Pulsation Dampner		Required
	- Pressure Relief Valve		Required
8.0	Sump		Sludge
a.	Number	No.	One (1)
b.	MOC & Type		RCC, Under ground, Outdoor location
c.	Capacity (Effective) (min.)	Cu.m	250
d.	Instruments		Level switch with indication on panel
e.	Inside Protection		coal tar epoxy paint
9.0	Disposal Pumps		Sludge
a.	Numbers	No.	Two (2) (1W + 1S)
b.	Type		Vertical, Sump Pumps
c.	Capacity rate	Cum/hr	70
d.	Head	mwc	As per requirement.
e.	Type of lubrication		Oil lubrication
f.	Material of Construction		
i.	Casing		2.5% Ni-Cast iron IS210 FG260
ii.	Impeller		SS-CF8M
iii.	Shaft		SS-410
iv.	Shaft sleeves		SS-316
v.	Column pipe		ERW to IS: 3589
vi.	Packing		Braided Impregnated Teflon
vii.	Flexible coupling		Forged steel
viii.	Bolts & Nuts		
	- In corrosive locations		SS-316
	- In other places		MS cadmium plated
ix.	Electric supply		415V, 3 phase, 50 Hz.

S. No.	Description	Units	Parameter
x.	Enclosure		TEFC, Outdoor type, Class 'B' IPW-55
xi.	Speed of pump motor rating	rpm	1450
10.0	Sludge Thickener		
a.	Number	Nos.	One (1) 1x100%
b.	Capacity	Cum/hr	60
c.	Inlet solid concentration		2% from Clarifier
d.	Outlet Concentration		5% Min.
e.	MOC		RCC with coal tar epoxy pint
11.0	Thicked Sludge Sump		
a.	Number		One
b.	MOC & Type		RCC under ground, outdoor local
c.	Capacity	cum	100
d.	Instrumnet		LS
e.	Inside Protection		coal tar epoxy paint
12.0	Thickened sludge transfer pumps		
a.	Number	Nos.	2 (1W+1S)
b.	Type		Screw
c.	Capacity & head	M3/hr & mwc	10(Min) Bidder to indicate
d.	Liquid to handled		Thickened sludge at 5% conc.
e.	MOC i. Pump Casing ii. Stator iii. Shaft iv. Eccentric Rotor		 Cast Iron IS: 210 FG 260, 2% Ni EPDM SS: 316 SS: 316
13.0	Centrifuge		
a.	Number	Nos.	Two (2) (1W+1S) 2x100%
b.	Type		Solid Bowl
c.	Capacity	Cum/hr	10 (approx)
d.	Inlet solid concentration		5% from sludge thickner
e.	Outlet Concentration		20% Min.
	MOC Bowl: Conveyor:		 SS-316 SS-316

S. No.	Description	Units	Parameter
14.0	Rapid Gravity Filter (Dual Media)		
a.	Numbers required		Six (6) (4W+2S)
b.	Construction		RCC
c.	Capacity	m3/hr	By bidder
d.	Filtration rate	m3/hr/m2	Not more than 8
e.	Effluent quality	NTU	<2
f.	Backwash rate	m3/hr/m2	30
g.	Air scouring rate	Nm3/hr	As required by bidder
h.	Backwash interval	Hr	24
i.	Media Gravel, Quartz Sand and Anthracite shall confirm to the following:		
i.	Gravel		Hard, durable and shall not disintegrate under the action of water, Particle size 3.175 mm to 50 mm, aggregate depth=400mm min.
ii.	Quartz Sand		Crushed, Powdered, granular, hard, free from clay, dust, vegetation and other impurities, aggregate depth=400 mm min.
iii.	Anthracite		Appearance : Black uniform clean Granules Specific Gravity : 1.5-1.6 Packing Density : 800-900 kg/m^3 Ash content : 10% (max.) Carbon : 80% (min.) Size : 1-2 mm aggregate depth=400 mm min.
j.	Under drain system		Lateral header system with strainers on CPVC pipe
15.0	Filter Air Blower		
a.	Number required	No.	Two (2) (1 W + 1 S)
b.	Capacity	m3/hr	By bidder
c.	Discharge pressure	MWC	By bidder
d.	Type		Twin Lobe/Centrifugal
e.	Operating Speed	RPM	1500
f.	MOC – Casing/Lobes		CI as per IS 210 FG 260
g.	Accessories		Suction filter, belt drive, silencers etc.

S. No.	Description	Units	Parameter
16.0	Filtered Water Reservoir		
a.	Number	No.	One (1)
b.	Effective capacity	m3	5000 (Filtered Water) + 2500 (Fire Water).
c.	MOC		RCC. Tank shall be completely covered. Tank shall be in three compartments. Two compartments shall be for filtered water and one for fire water.
d.	Type of tank		Partially below ground
e.	Inside protection		Shall be coated with acrylic reinforced cementitous, flexible water proof coating conforming to BS 1881 Pts 1983/ DIN 1048- water penetration test
f.	Free board	mm	300 (min)
17.0	Safety & supervisory equipment		
17.1	Gas Mask Oxygen Breathing Equipment alonmg with Breathing Apparatus		
17.1.1	Quantity	Nos.	Two (2)
17.1.2	Capacity		One(1) hour minimum
17.1.3	Accessories to be provided		Full Mask , full vision face pieces, flow regulating valves and all other accessories
17.2.0	Canister type breathing Apparatus		
17.2.1	Number	Nos.	One (1)
17.2.2	Type		The moisture content from exhaled air of the user should react with granular chemical in breathing apparatus and liberates oxygen. The Released oxygen should enter the breathing bag from which the user can inhale.
17.3.0	Ammonia Bottles		
17.3.1	Number	Nos.	Four(4) Nos.
17.3.2	Capacity	ml	500
17.3.3	Accessories to be provided		Filled up with commercial grade ammonia solution (26 Deg Be) to detect leakage of chlorine.
17.8.0	Weather Cock		
17.8.1	Number	Nos.	One(1)

CHAPTER – 6

FILTERED WATER SYSTEM

CONTENTS

CHAPTER – 6

FILTERED WATER SYSTEM

6.1 INTRODUCTION

6.1.1 This chapter covers the system description, basic design criteria, performance requirements, broad scope of supply and operation and control philosophy of the Filtered Water System.

6.1.2 System Description

The filtered water system shall convey water from filtered water tank to various systems like DM feed, CW make up, Service Water, Potable Water, AHP Seal Water, APH/ESP wash water, CHP, HVAC, FGD Process etc., by means of vertical wet pit type pumps.

6.2 SCOPE OF SUPPLY

6.2.1 Partially underground covered RCC filtered water storage tank shall be provided having an effective capacity of 5,000 M^3 in two compartments. A separate dedicated covered storage tank of not be less than 2500 M^3 shall be provided for fire water system. For other details refer Volume III, Chapter 5.

6.2.2 Filtered water pumps as detailed hereunder shall be installed in the filtered water tank:

i) Two (2) (1W+1S) vertical CW make up pumps.

ii) Two (2) (1W+1S) vertical DM feed pumps

iii) Two (2) (1W+1S) vertical APH/ ESP Water wash pumps

iv) Two (2) (1W+1S) vertical service water pumps

v) Two (2) (1W+1S) vertical potable water pumps

vi) Two (2) (1W+1S) vertical AHP seal water pumps

vii) Two (2 (1W+1S) vertical FGD process water pumps

viii) Two (2) (1W+1S) vertical Mist Eliminator wash pumps

ix) Lot Fire water pumps as follows:

a. Three (3) (2W+1S) vertical motor driven fire water Hydrant/spray pumps **with VFD Drives.**

b. Three (3) (2W+1S) vertical diesel engine operated fire water Hydrant/spray.

c. Two (2) (1W+1S) vertical fire water jockey pumps.

6.2.3 The pumphouse shall also accommodate the following equipment facilities:

All auxiliary equipment related to pumpsets such as electric motors, discharge piping complete with valves and specialties, etc.

Ventilation system for pumphouse.

Separate bays for unloading and maintenance.

EOT Crane and hoists as specified in Volume III, Chapter 28.

Necessary toilets with basin & mirror and operator's cabin with drinking water facility.

6.3 GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMNETS

6.3.1 The filtered water system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Volume III, Chapter 27.

6.3.2 The total dynamic head of the pumps shall be selected by conducting detailed system resistance calculations. Bidder shall furnish these calculations and system resistance curves superimposed on pump characteristic curves. However the actual TDH shall be finalized by the bidder and following general guidelines shall be adhered to towards computation of the same.

a) Static head in each pumping system from minimum suction level to highest discharge point. It shall also take into account highest level encountered on the route.

b) Frictional losses shall be calculated based on pumping capacity as specified assuming C=100 on Hazen & Williams formula for design purpose. A minimum margin of 10% shall be provided over and above the calculated frictional losses.

6.3.3 All piping and related accessories shall be designed to withstand a pressure not less than the shut off head of respective pumps. Bidder shall also conduct water hammer analysis of the piping system in different transient conditions such as closure of valves, tripping of pumps etc. Bidder shall also consider such transient pressure surges in designing of the piping systems. The procedure and results of water hammer analysis shall be furnished to purchaser for his information and approval.

Following valves, fittings and appurtenances shall be provided by the bidder as minimum requirement.

a) Motorized butterfly valves, gate valves/globe valves/check valves as required.

b) Air vacuum Valve – These valves shall serve the function of air release and air inlet.

c) Air release valve (Dynamic type) – These valves shall admit / release air in the pipeline and prevent any partial vacuum in the pipelines.

d) Isolating valves shall be provided at suitable intervals and at suitable locations to isolate a particular section of pipeline for maintenance which will be decided during detailed engineering stage.

e) Scour or drain valves at suitable locations for adequate drainage of pipelines.

f) Pipe supports/ racks complete with all accessories as required.

g) Any other accessories as required for safe and reliable operation of respective pumping system.

h) Pumphouse accommodating the vertical pumps shall be designed in accordance with the following layout criteria as generally specified below:

i) The pump sumps shall be designed in strict conformance to the recommendations of Hydraulic Institute Standard/ BHRA.

j) If not specified in this specification, the invert level of the sump shall be guided by the minimum submergence required by the respective pumps.

k) Adequate provision shall be made in the pump sumps wherever required so as to facilitate insertion of isolation gates. Gates fabricated of mild steel, shall be of water tight type and shall be of preferably of identical sizes/ dimensions to facilitate interchangeability. Sump gates shall be accessible by pumphouse overhead crane/ hoist.

6.4 OPERATIONAL & CONTROL PHILOSOPHY

6.4.1 All pumps and motorized valves (except fire water pumps which will be operated from fire fighting panels) shall be controlled and operated from the DM plant DCS through operator workstations located in DM plant control room. The DCS shall be interfaced with plant DCS system for monitoring the parameters in DCS workstations located in Central Control Room.

6.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

6.4.3 An interlock shall be provided to trip the pumps from very low level (LL) of water in the tank.To achieve the above interlock there shall be two nos. of level transmitters which shall operate on one (1) out of two (2) voting philosophy. The same level transmitters shall also be used to ascertain pump start permissive on normal water level in the tank.

6.4.4 All pumps shall have auto starting facility. The standby pump shall start automatically in case of tripping of any running pump or if its discharge header pressure falls below a preset low value.

6.4.5 All pumps shall have the following safety features:

a) Tank level high and low – annunciation
b) Tank level very low (LL) – annunciation and trip
c) Any other protective feature deemed necessary for safe and reliable operation.
d) Pressure Transmitter on pump discharge due to accidental closure of valve – trip and annunciation.
e) Flow Transmitter at the discharge header of the Pumps

6.4.6 For display of status of fire pumps in main control room refer Volume V, Control & Instrumentation.

DATA SHEET FOR ALL WATER PUMPS

(As mentioned at Clause 6.2.2 above)

S. No.	Item	Units	Description
1.	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	By bidder after taking 10% margin on required flow.
3.	Pump total head excluding losses in the pump	MWC	By bidder (pump shall have 10% margin on friction head over actual requirement)
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Vertical wet pit type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Filtered Water
9.	Type of line bearing lubrication		Self
10.	Liquid for lubrication		Pumped liquid
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		70% to 130% of rated capacity
14.	Materials of construction		
a.	Casing		2% NiCi IS 210 Gr FG 260
b.	Impeller		SS CF 8M
c.	Shaft		SS 410
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 304
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 2062 epoxy painted
i.	Column Pipe		MS as per IS 2062 (min 10mm thk)
j.	Discharge Elbow		MS as per IS 2062 (min 10mm thk)

Refer Chapter - 24: Fire Detection, Alarm & Protection System for datasheet of following pumps:

- Motor driven Fire Water Hydrant / Spray Pumps with VFD Drives.
- Diesel Engine driven Fire Water Hydrant / Spray Pumps
- Hydrant / Spray Jockey Pumps

CHAPTER – 7

SERVICE & POTABLE WATER SYSTEM

CONTENTS

CHAPTER – 7

SERVICE & POTABLE WATER SYSTEMS

7.1 INTRODUCTION

7.1.1 This chapter covers the system description, basic design criteria and performance requirements, broad scope of supply and operation and control philosophy of the Service & Potable Water Systems.

7.2 SYSTEM DESCRIPTION

The service water system shall use filtered water pumped by the service water pumps installed in the filtered water pump house and subsequently stored in the service water storage tank located on Bunker Bay roof for further distribution as indicated in the Flow Diagram for Service water system (Drg. 111-12-3304). The distribution shown is minimum & indicative and exact distribution shall be worked out during detailed engineering by the bidder.

The potable water system shall use filtered water pumped by the potable water pumps installed in the filtered water pump house and subsequently stored in the potable water storage tank located on Bunker Bay roof for further distribution as indicated in Flow Diagram for Potable water system (Drg. 111-12-3307). The distribution shown is minimum & indicative and exact distribution shall be worked out during detailed engineering by the bidder.

7.3 SCOPE OF SUPPLY

7.3.1 Service water system

a) Two 2 (1W+1S) Service water pumps taking suction from fiter water storage tank as indicated in Volume III, Chapter 6.

b) Service water over head Tank (rectangular, MS construction) of 50 M^3 effective capacity on bunker bay roof.

c) One (1) 5 M^3 service water tank of MS construction on roof of service building.

d) O/H service water HDPE tanks of 2 M^3 effective capacity located on roof of DM Plant Building etc as indicated in the Service water P & ID .

e) O/H service water HDPE tanks of 1 M^3 capacity as and where required and as indicated in the Service water P & ID.

f) Service Water Booster pumps (2 x 100%) as and where required to pump water to higher levels shall be provided. MOC of booster pumps shall be similar to service water pumps.

g) Two (2) (1W+1S) HVAC Make up Pumps taking suction from service water tank located on bunker building roof.

h) Two (2) (1W+1S) CHP Make up Pumps taking suction from service water tank located on bunker building roof.

i) Distribution as indicated in Service water flow diagram. The distribution shown is only tentative. Bidder to distribute water as per requirement and layout finally developed.

7.3.2 **Potable water system**

a) Two 2 (1W+1S) Potable water pumps taking suction from fiter water storage tank as indicated in Volume III, Chapter 6.

b) Potable water over head Tank (rectangular, MS construction) of 25 M^3 effective capacity on bunker bay roof.

c) One (1) 5 M^3 potable water tank of MS construction on roof of service building as indicated in the Potable water P & ID.

d) O/H potable water HDPE tanks of 2 M^3 effective capacity located on roof of DM Plant Building, Chemical House, Chlorine Dioxide Building as indicated in the Potable water P & ID etc.,

e) O/H potable water HDPE tanks of 1 M^3 capacity as and where required and as indicated in the Potable water P & ID

f) Potable water Booster pumps (2 x 100%) as and where required to pump water to higher levels shall be provided. MOC of booster pumps shall be similar to potable water pumps.

g) Distribution of potable water shall be minimum to all areas as indicated in the potable water flow diagram. However the distribution shown is only tentative. Bidder to distribute water as per requirement and layout finally developed.

7.4 GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS

7.4.1 The Service & potable water systems shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Volume III, Chapter-27: Low pressure piping.

7.4.2 The total dynamic head of the pumps shall be selected by conducting detailed system resistance calculations. Bidder shall furnish these calculations and system resistance curves superimposed on pump characteristic curves. However the actual TDH shall be finalized by the bidder and following general guidelines shall be adhered to by the bidder towards computation of the same.

a) Static head in each pumping system from minimum suction level to highest discharge point. It shall also take into account highest level encountered on the route.

b) Frictional losses shall be calculated based on pumping capacity as specified assuming C=100 on Hazen & Williams formula for design purpose. A minimum margin of 10% shall be provided over and above the calculated frictional losses.

7.4.3 All piping and related accessories shall be designed to withstand a pressure not less than the shut off head of respective pumps. Bidder shall also conduct water hammer analysis of the piping system in different transient conditions such as closure of valves, tripping of pumps etc. Bidder shall also consider such transient pressure surges in designing of the piping systems. The procedure and results of water hammer analysis shall be furnished to Owner for his information and approval.

Following valves, fittings and appurtenances shall be provided by the bidder as minimum requirement:

a) Motorized discharge butterfly valves, gate valves/check valves as required.

b) Motorized valves at inlet to each tank with suitable interlocking with level transmitters in the tanks.

c) Air vacuum valve – This shall serve the function of air release and air inlet.

d) Air cushion valve – These valves will admit air in the pipeline and prevent any partial vacuum near the pumps.

e) Isolating valves shall be provided at suitable intervals and at suitable locations to isolate a particular section of pipeline for maintenance which shall be decided during detailed engineering stage.

f) Scour or drain valves at suitable locations for adequate drainage of pipelines.

g) Pipe supports/ racks complete with all accessories as required.

h) Any other accessories as required for safe and reliable operation of the system.

7.5 OPERATIONAL & CONTROL PHILOSOPHY

7.5.1 All pumps and motorized valves shall be controlled and operated from the DM plant PLC through operator workstations located in DM plant control room. The PLC shall be interfaced with plant DCS systems for monitoring the parameters in DCS workstations located in Central Control Room.

7.5.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

7.5.3 An interlock shall be provided to trip the pumps from very low level (LL) of water in the tank.To achieve the above interlock there shall be two nos. of level transmitters which shall operate on one (1) out of two (2) voting philosophy. The same level transmitters shall also be used to ascertain pump start permissive on normal water level in the tank.

7.5.4 Pumps shall have auto starting facility. The standby pump shall start automatically in case of tripping of any running pump or if its discharge header pressure falls below a preset low value.

7.5.5 All pumps shall have the following safety features:

- Tank level high and low – annunciation
- Tank level very low (LL) – annunciation and trip
- Any other protective feature deemed necessary for safe and reliable operation.
- Pressure Transmitter on pump discharge due to accidental closure of valve – trip and annunciation.
- Flow Transmitter at the Discharge header of the Pumps.

DATA SHEET FOR SERVICE WATER/ POTABLE WATER BOOSTER PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	2 (1W + 1S) as and where required
2.	Pump capacity (approx.)	M^3/ hr	By bidder after taking 10% margin on required flow.
3.	Pump total head excluding losses in the pump	MWC	By bidder (pump shall have 10% margin on friction head over actual requirement)
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Horizontal split casing
6.	Location		Outdoor as and where required
7.	Liquid handled		Filtered Water
9.	Type bearing lubrication		Self
10.	Liquid for lubrication		Pumped liquid
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		70% to 130% of rated capacity
14.	Materials of construction		
a.	Casing		2% NiCi IS 210 Gr FG 260
b.	Impeller		SS CF 8M
c.	Shaft		SS 410
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 304
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 2062 epoxy painted

DATA SHEET FOR HVAC MAKE UP PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	By bidder after taking 10% margin on required flow.
3.	Pump total head excluding losses in the pump	MWC	By bidder (pump shall have 10% margin on friction head over actual requirement)
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Horizontal split casing
6.	Location		Located under shed
7.	Liquid handled		Filtered Water
9.	Type bearing lubrication		Self
10.	Liquid for lubrication		Pumped liquid
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		70% to 130% of rated capacity
14.	Materials of construction		
a.	Casing		2% NiCi IS 210 Gr FG 260
b.	Impeller		SS CF 8M
c.	Shaft		SS 410
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 304
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 2062 epoxy painted

DATA SHEET FOR CHP MAKE UP PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	By bidder after taking 10% margin on required flow.
3.	Pump total head excluding losses in the pump	MWC	By bidder (pump shall have 10% margin on friction head over actual requirement)
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Horizontal split casing
6.	Location		Located under shed
7.	Liquid handled		Filtered Water
9.	Type bearing lubrication		Self
10.	Liquid for lubrication		Pumped liquid
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		70% to 130% of rated capacity
14.	Materials of construction		
a.	Casing		2% NiCi IS 210 Gr FG 260
b.	Impeller		SS CF 8M
c.	Shaft		SS 410
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 304
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 2062 epoxy painted

CHAPTER – 8

DEMINERALISING PLANT

CONTENTS

CHAPTER – 8

DEMINERALISING PLANT

8.0 SCOPE OF WORK

8.1.1 The scope of supply for DM Plant shall include two (2) (1w+1s) DM streams each of net capacity 50 M^3/hr (minimum). Complete with regeneration facilities, chemical storage and handling equipments, two (2) nos. DM Water storage tanks of capacity 1000 M^3 each, waste neutralizing facilities with interconnecting pipings, valves and other accessories as detailed in data sheets and drawings.

8.1.2 The DM Plant shall be supplied complete and shall include, but not limited to the following. It shall also include the Interconnecting piping, valves & other accessories.

a) Two (2) nos. (1W+1S) Activated Carbon Filter with all accessories

b) Two (2) nos. (1W+1S) Weak Acid Cation exchanger with all accessories.

c) Two (2) nos. (1W+1S) Strong Acid Cation exchanger with all accessories.

d) Two (2) nos. (1W+1S) Degasser system consisting of DG tower, DG sump, air blowers with drives and degassed water transfer pumps with drives.

e) Two (2) nos. (1W+1S) Weak Base Anion exchanger with all accessories

f) Two (2) nos. (1W+1S) Strong Base Anion exchanger with all accessories

g) Two (2) nos. (1W+1S) Mixed Bed exchanger along with 2 nos. blowers with all accessories.

h) Complete acid / alkali handling, storage and regeneration system including pumps with drive motors and interconnecting piping & valves.

i) Two (2) nos. Demineralised water storage tanks complete with all accessories.

j) Two (2) nos. safety shower with eye fountain & all accessories.

k) One (1) no. centralized sampling rack for DM stream.

l) All auto valves shall be pneumatic operated diaphragm valves.

m) One (1) no. Air receiver having capacity of minimum 5 M3.

n) One (1) no. neutralizing Pit in two compartments complete with integral pipe, valves & accessories common for DM & CPU regeneration waste.

o) Two (2) nos. (1W+1S) Neutralisation pit Disposal pumps housed in a common sump in the neutralisation pit complete with electrical drive motors and other accessories as required.

p) One (1) no. of brine preparation tank with injection Pumps complete with all accessories.

q) One (1) no. of hot water tank complete with all accessories common for DM & CPU regeneration.

r) One (1) no. of alkali filter complete with all accessories.

s) One (1) no. filter water tank along with 2 no. pumps for each filter.

t) One (1) Overhead service water tank of capacity 5.0 cum complete with all accessories with 2 x 100% pumps.

u) The DM plant shall be designed for 20 hours operation and four (4) hours regeneration. Thus the DM water required/ day for the power plant shall be generated in 20 hours.

8.2 ION EXCHANGE RESINS FOR CATION, ANION & MB

RESINS shall be of reputed make and must have been in use in demineralising plants capable of producing water as specified or better for a period of not less than five (5) years.

a. The weak acid cation resin shall be with carboxylic acid group suitable for cocurrent regeneration in thoroughfare and strong cation resins shall be high capacity premium grade sulphonated strong acidic cation resin in sodium form, microporous polystyrene bead type suitable for counter current regeneration. The attrition loss of the cation resins shall be guaranteed not to exceed three (3) percent per year for the five (5) years of operation. Resin quantity for cation exchanger shall be supplied to ensure minimum cation leak and regeneration level shall be selected so as keep sodium slip less than 0.5 ppm as Na in the treated water.

b. The weak base anion resin shall be containing tertiary & quaternary ammonium group suitable for cocurrent regeneration in thoroughfare and strong anion resin shall be high capacity strong base, quaternary ammonium type-1 anion resin in chloride form, macroporous or isoporous, resistant to organic fouling suitable for counter – current regeneration. Anion resin should be able to with stand a temperature of 60^0 C. The attrition loss of the anion resins shall be guaranteed not to exceed five (5) percent per year for the first five (5) years of operation. Resin quantity for anion exchanger shall be supplied to ensure minimum anion leak and regeneration level shall be selected so as to keep silica slip less than 0.1 ppm as SiO_2 in the treated water.

c. The mixed bed cation & anion resins shall be strong acid cation & strong base anion resin as described above suitable for co-current regeneration.

d. Effective bed depth for each exchanger shall be 1.0m minimum.

e. Quantity of 100 mm bed depth inert resin provided in cation & anion exchanger shall be indicated separately.

f. Quantity of resins in each exchanger shall be adequate so as to require not more than one (1) regeneration per day at design capacity.

g. At least 100% free-board shall be provided over resin bed for expansion during backwashing or addition of some extra resins if required.

h. Regeneration effluent generated from cation and anion exchangers and also acidic and alkaline effluents from mixed bed shall be self neutralizing.

i. Complete performance characteristics of the selected offered resins along with regenerant/neutralizing chemical consumption calculations shall be furnished.

j. The resin shall be unaffected by acids, alkalis or common solvents. The resin shall be able to withstand a temperature of 60^0 C. (minimum) continuously.

k. All Resins shall be supplied in manufacture's own sealed containers. No broken drum/containers or loose packing for resins will be accepted.

l. The bidder should consider 10% (minimum) deration over the corrected exchange capacity, obtained from the manufacturer's published resin literature.

m. The uniformity co-efficient of resins shall be less than 1.2.

8.3 GENERAL

8.3.1 Simultaneous semi-auto regeneration facility of one (1) stream shall be provided.

(i) For the regeneration of cation exchanger units power water used shall be degassed water.

(ii) For the regeneration of anion/mixed bed exchanger units power water used shall be deionised water.

8.3.2 All header pipes shall be sized considering simultaneous operations of all streams at rated conditions. Regeneration system shall be sized for regeneration of one (1) stream at a time. All valves shall be located at an accessible height. All auto valves shall also be capable of operating manually.

8.3.3 All the storage/dosing tanks/pressure vessels etc. shall be fabricated considering minimum 2 mm corrosion allowance (if unlined), 0.3mm milling allowance and 2mm thinning allowance.

8.3.4 Bidder shall supply first charge of filter media, resin, degasser tower rings, lubricating oil, inhibitor of oil & all the consumables including chemicals till the handling over of the plant & additional chemicals of two (2) months requirement.

8.4 CONTROL PHILOSOPHY

a) The operation of DM water plant shall be from DCS.

b) Industrial grade parallel redundant UPS System with 60 minutes battery backup shall be provided for the plant water system DCS including peripherals.

d) Control desk for the operator work stations and annunciation with adequate number of windows.

e) All the field instruments e.g., Pressure gauges, Flow Indicator (Rota meter type), Flow Indicating transmitter (D.P. Type), Flow Transmitter, Density Indicator, Level Indicator (G. Glass), Non Contact Type Level Indicating Transmitter, Differential Pressure transmitters as shown in P&ID's.

f) Ten (10) conductivity transmitters out of which 2 Nos. on each strong acid cation exchangers and 1 No. at outlet of each weak base anion & strong base anion and MB exchanger. Five (5) Nos. pH transmitter analyzers one (1) at outlet of each strong base anion/ MB exchanger & one (1) at effluent pump discharge header. 2 Nos. silica analyzer (four channel) one for Anion Exchangers and one for both MBs. 1 No. Residual Chlorine Analysers at the outlet of each ACF (total 2 nos.). 1 no. Sodium Analyser (four channel for Cation Exchangers)

g) Solenoid valve boxes for the ON/OFF type diaphragm and butterfly valves along with tubing.

h) For further details refer C&I Specification Vol. V, Part B.

TECHNICAL DATA SHEETS - DM PLANT

1.0	**Activated Carbon Filters**	Nos.	Two (2) (1W+1S) Vertical
i)	Design Flow per unit (net)	m^3 / hr	By bidder
ii)	Design Surface Flow Rate	$m^3/m^2/hr$	15
iii)	Free Board Space	%	75 min.
iv)	Fill Material		Activated Carbon.
v)	Media Trap	No.	Two (2) per unit. At service & rinse outlet of filter.
vi)	Design code for Shell & Dish		IS:2825, IS:2062 for Shell and IS:2002, Gr I/SA515 Gr. 70 for Dish.
vii)	Material of Construction for Vessel Internals		Epoxy coated carbon steel
viii)	Internal painting Primer: Finish:		 Two (2) coats of high built epoxy zinc phosphate DFT 50 microns Two (2) coats of high built epoxy zinc phosphate DFT 200 micron.
ix)	External painting Primer: Finish:		Two (2) coats of chlorinated rubber paint DFT 50 microns. Two (2) coats of chlorinated rubber paint DFT 100 microns.
x)	Manhole /Handhole	No. mm	One (1) No. dia 500 mm/100 mm
xi)	Sight windows.	No.	One (1)
xii)	Guaranteed Effluent		
	a. Free Chlorine		Non-detectable
	b. Organic Matte		Traces
	c. Turbidity		<1
xiii)	Back wash flow rate	m^3 / m^2/ hr	15
xiv)	Filter Material depth	mm	1200
xv)	Under Drain System		Strainers on plate
xvi)	Characterstics of Activated Carbon		
a.	Grade:		Dechlorination Grade
b.	Bulk Density:	Kg/m3	>400
c.	Particle Density wetted in water:	gm/cc	1.3-1.4
d.	Uniformity Coefficient		1.5-1.6
e.	Mean Particle Diameter	mm	1.2-1.4
f.	Total Surface Area	m2/gm	>850
g.	Iodine No.	Min.	850
h.	Moisture Content		5%(Max.)
i.	Ash Content		8%(Max.)

DATA SHEETS – DM PLANT

S. No.	Description	Units	Parameter				
			Cation		Anion		Mixed Bed
2.0	Exchanger Vessels		**WAC**	**SAC**	**WBA**	**SBA**	
i)	Number of streams		Two (2) (1W+ 1S)	Two (2) (1W+ 1S)	Two (2) (1W+ 1S)	Two (2) (1W+ 1S)	Two (2) (1W+ 1S)
ii)	Service		Down flow		Down flow		Down flow
iii)	Design flow per stream (net)	m^3 / hr	50 (minimum)		50 (minimum)		50 (minimum)
iv)	Output per stream between two consecutive regenerations - Nett - Gross	 m^3 m^3	By bidder By bidder + regeneration requirement down stream		By bidder By bidder + regeneration requirement down stream.		By bidder By bidder + regeneration requirement upstream.
v)	Cycle time	Hrs.	20		20		140
vi)	Regeneration time	Hrs.	4		4		4
vii)	Design surface flow rate	$m^3/m^2/hr$	Not more than 35		Not more than 35		Not more than 40
viii)	Free board		At least 100% above resin bed				
ix)	Design code Material of Construction		IS:2825, Shell IS:2062 and Dish IS:2002, Gr I/SA 515 Gr. 70				
x)	Shell lining (internal)		Natural Rubber, 4.5 (minimum) in 3 layers, 65 ± 5 shore A to IS:4682 Part-I				
xi)	External painting		Three (3) coats of chlorinated rubber paint DFT 150 microns with two coats of primer.				
xii)	Manhole and hand Hole	mm	Two (2) each dia 500 and hand hole 100				
xiii)	Sight windows.	Nos.	Two (2) in each vessel				
xiv)	Resin						
	a. Type		WAC resin with carboxylic	SAC resin with polystyrene	WBA resin with tertiary &	SBA resin with polystyrene	Mixed ions polystyrene resin in uniform bead form.

S. No.	Description	Units	Parameter				
			Cation		Anion		Mixed Bed
			acid group	resin	Quatarnary ammonium group	resin.	
	b. Minimum Resin Bed Depth	mm	1000		1000		500 for each type of resin
xv)	Regeneration		Thoroughfare by Hydrochloric Acid		Thoroughfare by Sodium Hydroxide		By HCI and NaOH
xvi)	Resin Trap		Two (2) per unit at service & rinse outlet				
xvii)	Material of Construction of Internals		As per manufacturer standard				

Guaranteed Effluent Quality from DM Plant :

S.No.	Description		Outlet Parameters
1.	SAC Outlet	Sodium Leakage ppm as NA	<0.5
2.	Degasser Unit	CO2 Content ppm as CaCo3	<5.0
3.	SBA Outlet	Total Silica ppm as SiO2	<0.1
		Conductivity Micromho	< 5
		Total Electrolyte ppm	< 1
4.	MB Outlet	Total Silica ppm as SiO2	<0.01
		Total Electrolyte ppm	<0.05
		Total Hardness	*Nil*
		Conductivity Micromho	≤ 0.1 at 25^0C
		pH value at 25 Deg.C	6.8 – 7.2

S. No.	Description	Units	Parameter
3.0	**Degasser System**		
i)	**Degasser Tower**	No.	Two (2) Forced draft Vertical Cylindrical type
	a. Normal flow rate	m^3 /hr	By bidder
	b. Packing Rings (Fill) Material.		Polypropylene or equivalent.
	c. CO_2 content in treated water	ppm as CaCo3	≤ 5
	d. External painting		Three (3) coats of chlorinated rubber paint DFT 300 microns with two coats of primer
	e. Shell material		FRP
	f. Internal Distributors		Non-clogging, Non corrosive type.
	g. All internal fittings, water distribution tray and hand holes for loading and removal of packing rings etc.		To be provided.
ii)	**Degassed Water Storage Tank**		Two (2) nos. RCC tanks (One for each degasser Tower) having 3mm thick jointless solvent free epoxy lining/PPG lining
	a. Useful capacity of tank	M^3	Suffcient to store 60 min downstaem requirement + water requirement for one regeneration
iii)	**Degasser Control Valve**	No.	One (1) Butterfly Valve. There shall be a bypass line with butterfly control valve for healthiness of the system.
	a. Location		Inlet to degasser
	b. Material of construction		
	1) Body		ASME SA 351 CF8M
	2) Stem		ASME SA 479 Gr. 316
	3) Actuator		Pneumatic operated.
iv)	**Degasser Air Blowers**	No.	Two (2) (1W + 1S) 100%
	a. Type & Duty		Centrifugal; Continuous
	b. Capacity		100% requirement of one degasser tower.
	c. Location		Outdoor on degasser tank
	d. Drive motor type		Induction motor,415V,3Φ, 50 HZ.
v)	**Degassed Water Transfer Pumps**	Nos.	Two (2) (1W+1S) 100% taking suction from each degasser tank
	a. Type & Operation		Horizontal, Centrifugal, Continuous
	b. Suction condition		Flooded.
	c. Material of Construction		

S. No.	Description	Units	Parameter
	- Casing		Stainless steel CF 8M
	- Impeller		Stainless steel CF 8M
	- Shaft & Shaft sleeve material		Stainless steel SS Gr. 410 & SS316
	- Packing seal		Mechanical type
	- Drive motor		Induction motor, 415V, 3 Φ, 50 Hz, TEFC.
	- Common base plate		Carbon steel IS:2062
	d. Noise level		85 DBA
	e. Vibration		As per HIS
	f. RPM		1480
	g. Drive motor		Induction Motor 415V, 3 Phase, 50 Hz, TEFC
	h. Interconnecting Piping Material		Carbon Steel with Rubber lining.
4.0	**Regeneration System**		
4.1	**Acid / Alkali Unloading Pumps**		
i)	Numbers required	Nos.	Two (2) for acid / alkali each
ii)	Type & Location		Horizontal Centrifugal; Outdoor
iii)	Service		Intermittent
iv)	Capacity and head	M3/hr., MWC	25 and head 15 (min)
v)	Material of Construction		PP
vi)	Liquid to be handled		30-35% HCI or 45-48% NaOH
vii)	Suction condition		Flooded
viii)	Suction strainer		Required
ix)	Material of Construction.		
	a. Casing		Polypropylene
	b. Impeller		Polypropylene
	c. Shaft		BS 970, 080 M40 (EN-8)
	d. Shaft Sleeves		Ceramic / Alloy 20
x)	Types of shaft sealing		Mechanical
xi)	Pump speed	RPM	1450
xii)	Operating range	%	20-120 of design capacity
xiii)	Drive motor		415 V, 3Φ, 50 HZ TEFC.
xiv)	Accessories required between motor and pump		Coupling guard, drain plug, vent valve etc.
xv)	Type of coupling between motor and pump		Flexible coupling

S. No.	Description	Units	Parameter					
4.2	**Bulk Storage Tank**		**Acid**			**Alkali**		
i)	Numbers required	Nos.	Two (2) nos.			Two (2) nos.		
ii)	Location		Outdoor			Outdoor		
iii)	Capacity	M3	Each tank shall be of Min 30 cum or Capacity required for 30 days operation of CPU, DM & Chlorine Dioxide Generation (all systems)			Each Tank shall be of min 30 cum or Capacity required for 30 days operation of CPU & DM Plant		
iv)	Type		Horizontal Cylindrical with Dished ends, Atmospheric.					
v)	Material of Construction.		Carbon steel					
	Protection							
	a. Inside		Rubber lining 4.5 mm thick in 3 layers					
	b. Outside		Chlorinated rubber paint DFT 150 microns.			Chlorinated rubber paint DFT 150 microns.		
vi)	Concentration		30-33%			45-48%		
vii)	Vent, overflow, Drain, fume absorber and sample connection		All pipe, flange & valves MOC CPVC. Piping upto inlet of each exchanger. Except Bulk Tank isolation valve					
ix)	Manhole, staircase, platform		Required					
4.3	**Fume Absorbers**							
i)	Numbers Required		One per tank					
ii)	Material of construction		CPVC					
4.4	**Measuring Tanks** **For DM Plant** **For measuring tanks of CPU & Chlorine Dioxide system refer respective chapters**		**Acid**			**Alkali**		
			Cation Unit	**MB**	**NP**	**Anion Unit**	**MB**	**NP**
i)	Numbers required		2	2	1	2	2	1
ii)	Type		----------Vertical----------					
iii)	Useful capacity of each tank		125% of chemical requirement for one regeneration.					
iv)	Material of Construction.		Carbon Steel with 4.5 mm thick rubber lining inside in 3 layers					
v)	External protection		Chlorinated rubber paint DFT 300 microns with two coats of primer.					
vi)	Vent, overflow, Drain connection		Required, all pipe, flange & valves MOC-CPVC					

S. No.	Description	Units	Parameter		
vii)	Agitator		---		One (1) per tank SS slow speed agitator with reduction gear & motor.
viii)	MOC for Shaft & Impeller				ASME SA 479 Gr. 316
ix)	Dissolving baskets No. & MOC				One (1) per tank having MOC ASME SA 479 Gr. 316
4.5	**Preparation Tanks/Vessels**		**AC Filter**	**Hot Water tank**	**Brine Preparation Tank**
i)	Type		**Vertical Cylinder Pressure Vessels with Dished Ends**		
ii)	Numbers Required	Nos.	One(1)		
iii)	Liquid To be Handled		NaOH	Hot Water	Brine
iv)	Type Of Heater		Not applicable	Electric (2x50%)	Not applicable
v)	Location		Outdoor		
vi)	Capacity	m3/hr/ m3	10	10	5
vii)	Design Surface Flow Rate	m3/m2/ hr	15	Not Applicable	Not Applicable
viii)	Design Pressure		8 kg/cm^2 (min.)		
ix)	Filter Media		Activated Carbon	Not Applicable	Not Applicable
x)	Minimum Bed depth	mm	1000	Not Applicable	Not Applicable
xi)	Underdrain System		Strainer on plate	Not Applicable	Not Applicable
xii)	Shell material		MS	SS with Insulation	MS
xiii)	Shell Lining		Epoxy	-------	Rubber lining
xiv)	External Painting		Chlorinated Rubber paint	-------	Chlorinated Rubber paint
xv)	Accessories		Manhole, Handholes, vent & Drain Connection with required Valves	Manhole, Handholes	Vent Overflow& Drain connection with required Valves

S. No.	Description	Units	Parameter	
4.6	**Concentration Meter**		**Acid**	**Alkali**
i)	Number		-------One (1) per ejector--------	
ii)	Type		Density indicator (Hydrometer type)	
iii)	Indication		---------Online & Offline (Local)-- ------	
iv)	Location		----------Diluted Acid/Alkali line---------	
5.0	**Neutralising System**			
5.1	**Neutralisation Pit**		One (1) (twin compartment)	
i)	MOC & Protection		RCC & Acid / Alkali proof PPG lining	
ii)	Effective capacity of each compartment	M3	To hold one (1) regeneration waste + CPU Waste + 20% Margin.	
iii)	Isolation gate valves		To be provided	
5.2	**Neutralised Waste Disposal Pumps**		Two (2) (1w+1s) housed in common sump	
i)	Capacity and Head	M3/hr, MWC	To empty neutralization pit in Two (2) Hours	
ii)	Type		Vertical , Centrifugal	
iii)	Lubrication		Grease	
iv)	Noise Level		85 DBA	
v)	Material of Construction			
	- Column Pipe		Stainless Steel 304	
	- Casing		Stainless Steel CF 8M	
	- Base Plate		Carbon Steel IS:2062	
	- Impeller		Stainless Steel CF 8M	
	- Shaft		Stainless Steel CF 8M	
	- Shaft coupling		Stainless Steel SS 304	
	- Shaft sleeve		SS 316	
vii)	Drive motor		Induction motor 415V, 3 phase 50Hz, TEFC	
5.3	**Blowers**		**MB/N-PIT**	
i)	Quantity	Nos.	Two (1W + 1S)	
ii)	Type		Twin lobe	
iii)	Location		Indoor inside DM Plant Building	
iv)	Duty		Continuous	
v)	Capacity		As per process requirements	
vi)	Drive motor		Induction Motor 415 V; 3 Ph, 50 Hz	

S. No.	Description	Units	Parameter		
5.4	**D.M. Water Storage Tanks**				
	i. Quantity	No.	Two (2)		
	ii. Capacity (effective)	Cu.m.	1000		
	iii. M.O.C.		MS epoxy painted inside (DFT 500 microns)		
	iv. Accessories		The tanks shall be provided with 3 layers of floating polypropylene balls to avoid contact with CO_2 atmospheric oxygen along with breather and water seal		
6.0	**DM Water Pumps**		**DM Regeneration**	**DM Water Transfer**	**CPU Regeneration**
i)	Number		Two (2) (1W+1S)	Two (2) (1W+1S)	Two (2) (1W+1S)
ii)	Type		Horizontal Centrifugal		
iii)	Operation		Intermittent		
iv)	Suction condition		Floooded		
v)	Capacity & head m^3/hr MWC		As per process requirement		
vi)	Material of Construction				
	- Casing		Stainless Steel CF 8M		
	- Base plate		Carbon steel IS:2062		
	- Impeller		Stainless Steel CF 8M		
	- Shaft		Stainless Steel CF 8M		
	- Shaft coupling		Stainless Steel SS 304		
	- Shaft sleeve		SS 316		
vii)	Vibration		As per HIS		
viii)	Lubrication		Grease		
ix)	Noise Level		85 DBA		
x)	RPM		1500 (synchronous)		
xi)	Drive motor		Induction Motor 415 V, 3 Phase, 50 Hz, TEFC		
7.0	**Condensate Storage Tanks**				
	i. Quantity	No.	One (1)		
	ii. Capacity (effective)	Cu.m.	500		
	iii. M.O.C.		MS epoxy painted inside (DFT 500 microns)		
	iv. Accessories		The tanks shall be provided with 3 layers of floating polypropylene balls to avoid contact with CO_2 atmospheric oxygen along with breather and water seal		

S. No.	Description	Units	Parameter
8.0	**Air Receiver Vessel**		
i)	Quantity	No.	One (1)
ii)	Capacity	Cu.m.	5
iii)	Design code		IS 2825
iv)	MOC		IS 2062
v)	Design Pressure	Kg/hr	10
vi)	Manhole	No.	2
9.0	**Filter Water Tanks**		**O/H**
i)	Quantity	No.	One (1)
ii)	Capacity	Cu.m.	5
iii)	MOC		MSEP (DFT 200 microns)
iv)	Accessories		Level Switch & Control Valves etc
10.0	**Pumps**		Installed at outlet of Service water tank
i)	Number		Two (2) 1W+1S)
ii)	Type		Horizontal Centrifugal
iii)	Operation		Intermittent
iv)	Suction condition		Flooded
v)	Capacity & head	m^3/hr MWC	As per process requirment
vi)	Material of Construction		
	- Casing		Stainless Steel CF 8M
	- Base plate		Carbon steel IS:2062
	- Impeller		Stainless Steel CF 8M
	- Shaft		Stainless steel SS 410
	- Shaft coupling		Stainless Steel SS 304
	- Shaft sleeve		SS 316
vii)	Vibration		As per HIS
viii)	Lubrication		Grease
ix)	Noise Level		85 DBA
x)	RPM		1500 (synchronous)
xi)	Drive motor		Induction Motor 415 V, 3 Phase, 50 Hz, TEFC

CHAPTER – 9

CONDENSATE POLISHING UNIT

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CHAPTER – 9

CONDENSATE POLISHING SYSTEM

9.1 Design Criteria

9.1.1 There shall be two (2) vessels, each polishing vessel of 50% capacity of Condensate flow corresponding to maximum:

- VWO (Valve Wide Open) condition at 1% make-up and designed condenser pressure
  OR
- HP / LP bypass charge condition
  OR
- All HP heaters out of service

9.1.2 Operating pressure shall be normal operating pressure of condensate extraction pump.

9.1.3 (i) Under the above operating and design flow through the polisher, each service vessel shall be designed to operate continuously for at least 30 days in Hydrogen Cycle.

In addition to the above, 2 ppb Sodium in effluent shall also be guaranteed for entire cycle for each service vessel.

(ii) In addition to the dissolved solids, the influent condensate shall also contain some quantities of suspended solids (crud) derived from the corrosion of water and steam carrying pipe lines, turbine condenser and steam side of the feed water heater. Normaly this concentration will not exceed about 25 ppb and the polisher beds shall provide sufficient filtering action to restrict the effluent crud content to less than 5 ppb.

(iii) During start up or condenser tube leakage service cycle shall be of minimum 50 hours on TDS load of 2000 ppb and a crud load of 500 ppb.

9.1.4 At the design flow rate, the pressure drop across the polisher service vessels with clean resin bed shall not exceed 2.1 kg/cm^2. Maximum pressure drop under dirty conditions will be restricted to 3.5 kg/cm^2 including the pressure drop across effluent resin traps.

9.1.5 The bed cross section of CPU service vessels shall be such that the average velocity of condensate through it shall not exceed 2 meter / min. at design flow rate. For vessels of spherical shape, where the bed cross sections vary, the diameter of the vessel shall be selected considering velocity not exceeding 1.75 meter/min.

9.1.6 The effective depth of the mixed resin bed in the condensate service vessels shall not be less than 1100 mm.

9.1.7 The inlet and outlet quality for design of CPU exchanger shall be as under:

S. No.	Parameter	Unit	Normal Condition		Start-up or Condender Leak	
			I/L	O/L	I/L	O/L
1.	Crud	ppb	25	5	500	150
2.	TDS	ppb	100	20	2000	---
3.	Sodium	ppb	10	2	50	20
4.	Iron (dissolved)	ppb	50	5	---	---
5.	Ammonia	ppb	100	NIL	---	---
6.	Silica (dissolved)	ppb	30	5	150	20
7.	Chloride	ppb	10	2	---	---
8.	Conductivity	Micro mhos/cm	----	<0.1 after cation column		
9.	pH		8.0 – 8.5			

9.1.8 The condensate polisher service vessel shall be located in the TG hall of unit. The resin shall be transferred to and from the regeneration facility by sluicing through a pipeline.

9.1.9 The regeneration process shall be of proven design and shall give resin–separation compatible with the desired effluent quality.

9.1.10 External Regeneration Facility shall be located in DM Plant area as shown in layout of DM Plant/CPU regeneration area.

9.2 **Condensate Polishing Units**

(i) Condensate Polisher Spherical service vessels as specified in technical data sheet complete with condensate inlet and outlet connections, connections for resin transfer to and from the vessels, bed support-cum-under drain system, inlet water distributors, air distribution arrangement for resin mixing all fittings and appurtenances etc. as specified and as required.

(ii) External resin traps at condenste & rinse outlet of each of the polisher vessels, designed for in-place manual back flushing.

(iii) Condensate inlet and outlet headers with pipe connections to the condensate polisher vessels.

(iv) Resin transfer headers and pipe lines connecting the external regeneration facilities to the condensate polisher vessels of each installation. The resin transfer pipe lines shall be of SS-304 and sized for a flow velocity of between 2-3 M/sec.

(v) Rinse water outlet headers from condensate-polisher vessels shall be provided with a pressure reducing valve and orifice plate, suitably designed to enable the water entry to the condenser hot well under all operating condition of condenser.

(vi) All necessary valves and fittings for the installations with actuators necessary for their remote operation. These shall include suitable fullproof arrangement to prevent accidental over pressurization of the resin transfer pipeline and regeneration facilities connected to it, which are designed for pressure much lower than that of the polisher service vessels.

(vii) A common drain header for the condensate polisher service vessels .All necessary drains, vents and sampling points, with valves as required.

(viii) Gland sealing water piping for the valves in the rinse water line.

(ix) All pressure vessels shall be designed and constructed in strict accordance with the ASME code Section VIII/IS 2825 or acceptable equivalent international standard.

(x) All pressure vessels shall be fabricated from carbon steel plates as per SA-515/516 Gr. 60/ 70 and lined internally.

(xi) Lining used shall be natural rubber having a shore durometer reading of 65 ± 5 Shore 'A' as per IS 4682 Part I.

(xii) The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.

(xiii) Vessel internal shall meet the following requirements:

Inlet water and under drains distributor

Hub and internals diffuser splash plate or header and perforated laterals. Material of construction shall be SS-316.

Same as above with screened laterals with internal perforated pipes and rubber lined flat bottom.

All internal fasteners shall be of SS-316 and heavy duty locknuts shall be used throughout.

(xiv) **Analytical Instruments (Normal)**

The polisher units shall be provided at common inlet and each outlet unit with a minimum of following analytical on line analysers.

- pH Analyser
- Conductivity Analyser
- Cation Conductivity Analyser
- Sodium Analyser
- Silica Analyser
- Chloride Analyser

(xv) Two (2) (1W + 1S) oil free type air blowers with electric motor drive for supplying air required for mixing the resins in service vessels.

(xvi) Adequate resins for each condensate polisher service vessels along with one (1) spare change of resin in the mixed resin storge tank. One (1) spare charge of resins during commissioning and one (1) spare charge of resins as mandatory spares. Total charges shall be six (6).

9.3 Emergency Bypass System

9.3.1 Each Condensate polisher service unit shall be provided with an automatic bypass for the condensate polisher on the condensate inlet and outlet headers of the unit with a globe type control valve and globe type isolation valves (resilient material seated, to ensure bubble-tight shut off) on the upstream and down stream sides of the control valve.

9.3.2 In the event of excessive pressure differential between the condensate inlet and outlet headers, this control valve will open automatically to bypass requisite quantity of condensate to prevent this pressure differential from exceeding a preset limit when two vessels/one vessel/no vessel is in operation.

9.3.3 Either 2x50% or 1x100% capacity control valve shall be provided to achieve proper control under all operating conditions.

9.3.4 Complete instrumentation and controls for this system, including the differential pressure transmitters, panel mounted indicating type controller with provision for remote manual operation, and actuator for the control valve with position indicator shall be furnished. All tubing, wiring air sets and other fittings required to complete the system shall be installed.

9.3.5 The isolation valve shall be provided with geared operator for manual operation and shall be located at a height which can be easily operatable.

9.3.6 The entire system shall be designed for an internal pressure of at least the design pressure of service vessels and for a maximum condensate flow of not less than total design flow of all the working service vessels.

9.3.7 The control system shall be so designed that the control valve is able to bypass 50% of rated flow when any of the service vessel is out of service and 100% of flow when both the service vessels are out of service.

9.4 Exchange Resins

9.4.1 Cation-Anion resin ratio shall be 1.5 parts Cation to 1.0 part anion by volume. In case the process require any non ionic resin the same shall represent at least 10 percent of the bed volume, but not less than 15 cm of the bed depth in the resin separation/Cation regeneration tank of the external regeneration facility.

9.4.2 The resins shall be of reputed manufacturer with adequate past record of successful service for not less than 3 years in similar application. Some of these possible resin makes are as follows:

(i) Duolite.

(ii) Rohm and Hass

(iii) Dowex

(iv) Purolite.

The CPU Grade resin shall be of uniform particle size quality with uniformity co-efficient of 1.2 and suitable for short term excursion of temperature upto 60 °C.

9.4.3 Base of the ion-exchange resins shall be copolymer of styrene and divinylbenzene forming a macroporous or macroreticular structure.

The type of resins shall be as below:

1. Cation resin : Strong acid, with sulfonic acid functional group.
2. Anion resin : Strong base, with quaternary ammonium (type- I) functional group.
3. Inert resin : Non ionic, compatible with the (if applicable) above type resins.

9.4.4 The resin shall be suitable for the condensate temperature that may be achieved in all operating regimes of TG cycle. However, the anion resin shall be suitable for temperature upto 60^0 C.

9.5 External Regeneration Facility

9.5.1 The regeneration of the ion-exchange resins from the condensate polishers of the turbo-generator unit shall consists of following:

- Resin Separation & Cation Regeneration Vessel
- Anion resin Regeneration Vessel
- Mixed resin storage vessel

The type of above vessels shall be as per process requirement.

9.5.2 Vessel Freeboard Requirements

The pressure vessels in the external regeneration facility shall be provided with adequate freeboards over the top of the settled resins, to minimize resin loss during their use. Minimum permissible freeboards are as follows:

Mixed resin storage vessel	-	50%
Resin separation vessel	-	75%
Anion and cation regeneration vessels	-	100%
Activated carbon filter	-	75%

Suitable mill tolerances shall be considered for determining the thickness of the shells and dished ends. A minimum thinning allowance of 2 mm shall be considered for the dished ends.

- Resin Injection Hopper, complete with water ejector system for resin make-up. The tank shall be sized to handle up to 150 liters of as received new resins.
- All internals, fittings and appurtenances for these vessels.
- All necessary piping, valves and fittings for this installation with the actuators necessary for their remote automatic operation. These shall include all drains, vents and sampling points with valves as specified and as required.
- Common waste effluent header with one resin trap designed for in-place manual backwashing.

- Two (2) (1W + 1S) DM regeneration pumps with electric motor drives, one normally operating & other stand-by for water supply for chemical preparation / dosing & transfer of resin from service vessel to regenerating vessels & vice-versa shall be provided.
- Two (2) (1W + 1S) oil free type air blowers with electric drive motors, for suppling all the process air required for cleaning of resins and their regeneration processes. Each blower shall be complete with motor, V-belt drive with belt guard, inlet filter / silencer, flexible coupling and discharge snubber, all mounted on a single base, along with Relief valves, Acoustic hood etc. as required.

9.5.1 **Chemical Dosing System**

All equipment for dosing of acid and alkali solutions shall be rated to provide a maximum dosing rate at least 20% in excess of that required from process calculation. The Acid and alkali dosing equipment for regeneration of condensate polishing resins shall preferably be mounted on skid, which shall consist of at least the following:

(i) Acid and alkali shall be dosed by means of metering pumps depending upon regeneration technique used for CPU. There would be separate metering pumps for acid & alkali. There shall be 2 x 100% metering pumps for each application.

(ii) For heating of alkali diluent water a hot water tank with electric heater adequately insulated of stainless steel construction shall be provided. The capacity of tank shall be minimum 20% higher than the maximum water demand. This tank shall be provided with burn out protection, pressure relief valve, level switches, temperature indicator etc. The temperature switches provided on the tank shall control the heater. The heaters shall be sized for heating the water from a temperature of 15 to 50 deg. C at the outlet of ejector.

(iii) One (1) no. acid measuring tank of adequate capacity to hold 120% acid required for one regeneration.

(iv) One (1) no. alkali preparation cum measuring tank complete with electrically driven stirrer, and dissolving basket. The tank capacity shall be equal to 120% of regeneration requirement of one polisher vessel.

(v) All interconnecting piping, valves and fittings as required for the system.

9.5.2 Bulk acid and alkali storage tanks

DM Plant Bulk acid / alkali storage tanks shall be used.

9.5.3 DM Water for regeneration

DM water required shall be drawn from DM Water Storage Tanks.

9.5.4 Effluent Disposal System

DM Plant neutralizing pit shall be used.

Note: All piping, valves & fitings in Regeneration Area and DM Water area shall be of CPVC PN10/SCH 40 Only.

Bidder shall provide all the consumable including chemicals till the handing over the plant and additional chemicals of two (2) months requirement.

9.6 Operation

9.6.1 Control & Operation of Plant

The regeneration system will be external. Under normal conditions, it will hold a complete charge of freshly regenerated and mixed resin, ready for use, in its storage tank. For regeneration, resin from the exhausted exchanger vessel will be transferred hydro pneumatic/hydraulically to this facility. The empty exchanger vessel will then be filled up with the already regenerated resin, which was stored in the regeneration facility. This exchange vessel shall come into service soon after perquisite condition is satisfied or as and when desired by the operator. In the meantime, the exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use.

The common influent headers of each polisher service unit will be connected to an automatic bypass line to be provided. This bypass line shall include a differential pressure device, which on a high signal will cause an automatic valve to open, bypassing the service vessels.

(i) It shall be possible to operate the regenerationplant in auto/semi-auto/manual mode. In 'Auto' mode, once the sequence has been initiated, it shall procees from step to step automatically. In 'Semi-auto' mode each step shall be performed only after initiation by the operator. In Manual mode, complete operation shall be by the operator by operation from the control panel. On DCS failure, it shall be possible to operate the valves by means of manual operation of solenoid valves also.

(ii) The condensate-polishing unit shall be controlled from DDCMIS. This system shall be suitably interlocked with the regeneration system.

(iii) Each of the solenoid valves in CPU plant shall be provided with 'close-Auto-open control switches. In 'Auto' position of the control switch the solenoid valve shall receive close/open command from the Automatic sequence logic.

(iv) Refer Violume V for control philosophy.

(v) It shall be possible to select each of the CPU vessels for any of the following operations.

(a) Service
(b) Resin Transfer from CPU vessel to Regeneration plant.
(c) Resin Transfer from Regeneration Plant to CPU vessel.
(d) Isolation from service.
(e) Rinse Recycle.

9.6.2 Condensate Polisher Control System

(i) The controls for CPU System shall be from DDCMIS.

(ii) The requirements of DDCMIS given are to be read in conjunction with detailed Technical specification & data sheets enclosed in the Volume V.

(iii) For CPU control Philosophy, C&I specification Volume V shall ne referred.

(iv) Plant schematic for monitoring & operation shall be available on OWS, bidder to further submit list of important signals along with applicable schematic for monitoring in DCS.

(v) All instruments required for package shall be supplied, mounted on the gauge board racks, along with accessories like impulse pipe, fittings & valve manifolds etc.

(vi) Time synchronization of control system with master clock system is to be carried out. Necessary hardware/software for same to be provided.

(vii) All bidirectional drives are with integral starter.

(viii) 2 x 100% parallel redundant UPS, 1 x 100% Bypass stabilizer & 1 set of battery bank for minimum 60 minute back up at 100% load shall be provided..

(ix) Smart positioners shall be provided for pneumatically controlled valves.

(x) For detailing of control systems & field and measuring instruments, bidder shall refer C&I specification Volume V.

DATASHEET - CONDENSATE POLISHING UNIT

1.0	**DESCRIPTION OF TURBO GENERATOR UNIT (TG) FOR WHICH CONDENSATE POLISHING IS TO BE PROVIDED :**	
(i)	No. of units	One (1)
(ii)	Capacity of each unit	800 MW
(iii)	Total flow in all the service vessels	2500 Tonnes per hour (Minimum)
2.0	**CONDENSATE POLISHER SERVICE VESSELS PER UNIT :**	
(i)	No. of condensate polisher service vessel	Three (3 x 50% Full flow condensate polishing
(ii)	Capacity of each condensate polisher service vessel	50 % of total condensate flow per unit
(iii)	Flow through each condensate polisher service vessel per unit	1250 Tonnes per hour
(iv)	Operating pressure of each condensate polisher service vessel	30 Kg / cm2 (g)
(v)	Design pressure of each condensate polisher service vessel	47 kg./sq.cm (g)
(vi)	Design code of each condensate polisher service vessel	ASME Sec VIII Div. I Ed 2010
(vii)	Design Temp.	55 ^{0} C
(viii)	Type of vessels	Vertical (spherical)
(ix)	Emergency by-pass system	To be provided
(x)	Material of construction of service vessel	Carbon steel plates to SA 516 Gr. 70 with minimum 4.5 mm thick rubber lining inside in three layers
(xi)	Resin traps at the outlet of each condensate polisher service vessel & rinse outlet	SS with SS 316 Internals
2.1	**AIR-BLOWERS FOR RESIN MIXING (SERVICE VESSELS AREA)**	
(i)	Number	Two (2 x 100%)
(ii)	Type	Centrifugal/Twin lobe type oil free, positive displacement
(iii)	Duty	Intermittent
(iv)	Capacity and head / Noise Level	As required/ 85dB(A) Max. at one meter
(v)	Pressure gauge	One per blower
(vi)	Location	Indoor
(vii)	Material of construction	Cast Iron
(viii)	Dive motor	The drive motor of each air blower will be energy Efficient-1 as per IS :12615
3.0	**EXTERNAL REGENERATION FACILITIES**	
3.1	**REGENERATION VESSELS**	
(i)	Resin Separation & Cation Regeneration	One (1)

	Vessel		
(ii)	Anion Regeneration Unit		One (1)
(iii)	Mixed Resin Storage Unit		One (1)
(iv)	Type		Vertical (Cylindrical)
(v)	Material of construction (shell & dished ends)		SA 516 Gr. 70 / SA 282 Gr. C with minimum 4.5 mm thick rubber lining inside in three layers.
(vi)	Design code		ASME sec. VIII div 1 ed. 2010 / IS 2825 as applicable
(vii)	Minimum Design Pressure for Pressure Vessels		10 Kg/cm2 (g) minimum
(viii)	Resin traps at the common outlet header of regeneration vessels		SS with SS 316 Internals
(ix)	Accessories		Operating platforms, ladders, supports, lifting lugs (4 nos. minimum) and other structural works for each regeneration vessel to facilitate accessibility for operation and other equipments etc.
3.2	**CHEMICAL HANDLNG, PREPARATION & DOSING SYSTEM**		
a)	**CHEMICAL TANKS**	**ALKALI PREPARATION CUM MEASURING TANK**	**ACID MEASURING TANK**
(i)	Number	One (1)	Two (2)
(ii)	Type	Vertical Cylindrical Atmospheric with dished bottom and top	
(iii)	Useful capacity	Adequate to hold quantity of alkali required (48% NaOH) for single regeneration of a condensate polisher mixed bed with 20% overall margin.	Adequate to hold quantity of acid required (30-33% HCL) for single regeneration of a condensate polisher mixed bed with 20% overall margin.
(iv)	Material (Shell, Dished end & top cover)	IS 2062 (External Pinting shall be as per Volume IIA, Chapter 7)	
(v)	External protection	Inside line with Natural rubber (minimum 4.5 mm thick in three layers)	
(vi)	Vent, Overflow, drain connection	Required	
(vii)	Level indicator	Gauge glass with overlap	
(viii)	Level transmitter per tank	One (1)	One (1)
(ix)	Stirrer per tank	Slow speed stirrer driven by motor drive and reduction gear. Speed of stirrer = 200 RPM Max.	Not Applicable

(x)	MOC of Agitator	Stainless Steel – 316	-
(xi)	Drive motor of stirrer	Energy Efficient	Not Applicable
(xii)	Dissolving Basket	Provide (50-60 mesh B.S.)	Not Applicable
(xiii)	MOC of Basket	Stainless Steel – 316	-
(xiv)	Accessories	Fume absorbers, carbon dioxide absorber, manhole, vent, drain, sample connection, level transmitter, operating platform, ladders, lifting lugs (4 Nos. minimum) etc.	
b)	**DOSING PUMPS**	**ACID DOSING**	**ALKALI DOSING**
(i)	Number	Two (2x100%)	Two (2x100%)
(ii)	Type	Simplex positive displacement hydraulically operated diaphragm type	
(iii)	Accessories		
a)	Pressure Dampener	One per pump	One per pump
b)	External safety relief valve (in addition to inbuilt safety valve)	Two	Two
c)	MOC of safety relief valve	Poly propylene	SS-316
(iv)	Pressure gauge	One per pump with Teflon diaphragm seal	
(v)	Maximum pump stroke speed per minute	100	
(vi)	**Material of construction**		
a)	Liquid End (Pump Head, Valves, Valve housing, valve spring etc.)	Polypropylene	SS 316
b)	Diaphragm	P.T.F.E.	
c)	Packing	P.T.F.E.	
d)	Shaft	Hardened steel EN 8 (BS : 970)	
e)	Worm & worm wheel(if applicable)	Manganese Bronze	
f)	Connecting rod	Manganese Bronze	
g)	Cross head guide	Bronze	
(vii)	Capacity & head	Capable of meeting regeneration one cation /Anion unit (with 20% margin); head as required (with 20% margin).	
(viii)	Accessories required for each pump	Coupling guard, drain plug, vent valve, isolation valves, Y-type strainers, pressure gauges, pulsation dampener etc.	
(ix)	Drive motor of pump	The drive motor of each pump will be Energy Efficient-1 as per IS : 12615	
3.3	**ALKALI DILUENT WATER HEATING TANK (HOT WATER TANK)**		
(i)	Number	One (1)	

(ii)	Type/Capacity	Vertical Cylindrical with dished end with Electric heater / 120% of water required for regeneration
(iii)	Temperature of alkali to be heated	To obtain temp. of 50^0 C at alkali mixing feed out let
(iv)	Temperature gauge	To be provided
(v)	Temp. transmitters	To be provided
(vi)	Burn out protection	To be provided
(vii)	**Material of construction of tank**	
(viii)	Shell & dished end	SS-304 adequately insulated
(ix)	Design code	ASME sec VIII div 1 ed. 2010 / IS 2825 as applicable
(x)	Minimum Design Pressure	10 Kg/cm2 (g) minimum
(xi)	Accessories	Manhole, vent, drain, sample connection, level transmitter, operating platform, ladders, lifting lugs (4 Nos. minimum) etc.
3.4	**CPU PUMPS FOR REGENERATION AND RESIN TRANSFER**	
(i)	Number	Two (2x100%)
(ii)	Type	Horizontal, centrifugal
(iii)	Operation	Continuous
(iv)	Capacity & head	As required (with 20% margin)
(v)	Suction condition	Flooded
(vi)	**Material of construction**	
a)	Casing, impeller	SS 316
b)	Shaft	SS 410
c)	Shaft sleeve material	SS 410
(vii)	Packing seal	Mechanical type
(viii)	Pump Speed	Maximum 1500 rpm
(ix)	Pressure gauge	One for each pump with teflon diaphragm seal
(x)	Recirculation line with motor actuated butterfly valve	Required
(xi)	Accessories required for each pump	Coupling guard, drain plug, vent valve, suction hoses, isolation valves, Y-type strainers, pressure gauges, pulsation dampener
(xii)	Pressure dampener	One number per pump
(xiii)	Dive motor	The drive motor of each Pump will be Energy Efficient -1as per IS 12615.
3.5	**AIR-BLOWERS FOR RESIN MIXING (REGENERATION AREA)**	
(i)	Number	Two (2x100%)
(ii)	Type	Centrifugal/Twin lobe type, oil free, positive displacement
(iii)	Duty	Intermittent
(iv)	Capacity and head/ Noise Level	As required/80 dB (A) Max. at one meter

(v)	Pressure gauge	One per blower
(vi)	Location	Indoor
(vii)	Material of construction	Cast Iron IS 210 Gr FG 260
(viii)	Dive motor	The drive motor of each air blower will be Energy Efficient-1 as per IS 12615
4.0	**PIPING & VALVES**	
(i)	Resin Transfer piping (full Port Ball Valves)	ASTM A 312 Gr. TP 304 sch 40 Minimum pipe Size : NB80 Velocity : 2-3 m/s
(ii)	DM water line	ASTM A 312 Gr. TP 304 sch 40
(iii)	Piping-Service vessel Inlet	Piping-ASTM A 106 Gr C Ball Valves – SS CF8M
(iv)	Piping-Service vessel Outlet	Piping – ASTMA 106 Gr.C BFV – SS CF8M Ball Valves – SS CF8M
(v)	Service vessel bypass piping Butterfly Valves of flangeless water type)	Piping – ASTMA 106 Gr. C BFV – A 216 WCB
(vi)	Service vessel rinse piping	CS to ASTM A 106 Gr.C
(vii)	Acid & Alkali Regeneration piping (Diaphragm Valves)	All piping, Valves & Fittings in regeneration area shall be CPVC PN10/Sch. 80 only
(viii)	Acid / Alkali Transfer piping (Diaphragm Valves)	
(ix)	Instrument Air piping (Full Port Ball Valves)	IS 1239 Galvanized
(x)	**BUTTERFLY VALVES**	Butterfly valves shall be of double flanged of low leakage rate confirming to AWWA-C-504 class 300 (min.) or BS:5155 PN 10 (min.) Condensate polishing plant outlet butterfly valves shall be of stainless steel construction, SS-316 (for body, disc and shaft). Condensate polishing plant inlet butterfly valves shall be of Carbon Steel construction. All the butterfly valves shall be provided with Hand wheel or lever as per the requirements. For larger sizes i.e. 150 NB and above, valve provided with motorized or pneumatic actuator shall be provided with a

		hand wheel for manual operation. All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Handwheel or Gear reduction unit or Motor actuator etc.) shall be designed as per relevant International Standard. All the butterfly valves shall be provided by the bidder with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 CI.300 (min.) Butterfly valves at the bypass line of service vessel shall be double flanged.
(xi)	**DIAPHRAGM VALVE**	The Diaphragm shall conform to following requirement for DM water application i) Design: BS: 5156 or equivalent of required rating / class. (Minimum rating of valves shall be PN 10). ii) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type iii) Material of Construction a) Body, Bonnet : Cast iron IS 210 Gr. FG 260 or equivalent or Cast steel ASTM A-216 Gr. WCB b) Body lining : Soft natural rubber, ebonite, Polypropelene c) Handwheel : Cast Iron d) Compressor : Stainless Steel e) Stem and Bush : Stainless Steel For Acid and Alkali services the valve shall be CPVC PN10/Sch 80 only.
	ECCENTRIC PLUG VALVE / BALL VALVE	These valves shall be used for resin transfer line. These valves shall be flanged type and of SS 316 construction.
5.0	**Flanges**	
(i)	Feed water / Condensate	ASTM 105
(ii)	DM water	ASTM A105 rubber lined (for NB 65 mm to 150 mm) ASTM A 182 F 304 (for NB 50 mm and below)
(iii)	Instrument Air	ASTM A 105 galvanized

CHAPTER – 10

HOTWELL MAKE UP & BOILER/DEAERATOR FILL SYSTEM

CONTENTS

CHAPTER – 10

HOTWELL MAKE UP & BOILER/DEAERATOR FILL SYSTEM

10.1 Introduction

10.1.1 This chapter presents the system description, basic design criteria and performance requirements, broad scope of supply and operation and control philosophy of the Hotwell Make up & Boiler/Deaerator fill System.

10.1.2 System Description

a) Hotwell make-up

Normal make-up

The normal hotwell make-up is a part of the DM cycle make-up (comprising of normal hotwell make-up, DMCW make-up for SG & TG, supply to CPU regeneration plant, LP dosing etc), which shall be catered from the DM storage tanks through the DM cycle make-up pumps/DM transfer pumps (1W+1S). Capacity of each pump shall be sufficient to cater to 100% cycle make-up requirement for the unit.

Emergency make-up

The system shall be able to supply emergency make-up water to condenser from condendate storage tank by (1W+1S) emergency hotwell make-up pumps. Capacity of each pump shall be designed considering minimum 20% of the condendate flow at VWO, 1% make-up condition and head to suit the system requirement.

b) Boiler Fill system

Boiler fill system shall supply DM water to fill the Boiler before start-up or to conduct hydraulic test. Suitable tap offs shall be provided for filling of the deaerator during initial stages or exegiencies. Water for this shall be drawn from the DM water storage tanks by (1W+1S) boiler fill/deaerator fill pumps.

10.2 Scope of Supply

a) Two (2) (1W+1S) DM cycle make-up/DM transfer pumps installed at outlet of DM storage tanks

b) Two (2) (1W+1S) boiler fill/Deaerator fill pumps installed at outlet of DM storage tanks.

c) Two (2) (1W+1S) Emergency hotwell make-up pumps installed at outlet of condensate storage tank.

(Normal & Emergency cycle make-up piping, valves, flow elements with flow transmitter and indicators, hotwell make-up control station (normal & emergency) including control valves, drain, vents, etc.)

d) Piping for make-up & Boiler fill/deaerator fill system.

e) Instrumentation for make-up and boiler fill/deaerator fill system.

10.3 General Design Criteria and Performance Requiremnets

10.3.1 The hotwell make up system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Volume III, Chapter 27.

10.3.2 The total dynamic head of the pumps shall be selected by conducting detailed system resistance calculations. Bidder shall furnish these calculations and system resistance curves superimposed on pump characteristic curves. However the actual TDH shall be finalized by the bidder and following general guidelines shall be adhered to by the bidder towards computation of the same.

a) Static head in each pumping system from minimum suction level to highest discharge point. It shall also take into account highest level encountered on the route.

b) Frictional losses shall be calculated based on pumping capacity as specified assuming C=100 on Hazen & Williams formula for design purpose. A minimum margin of 10% shall be provided over and above the calculated frictional losses.

10.3.3 All piping and related accessories shall be designed to withstand a pressure not less than the shut off head of respective pumps. Bidder shall also conduct water hammer analysis of the piping system in different transient conditions such as closure of valves, tripping of pumps etc. Bidder shall also consider such transient pressure surges in designing of the piping systems. The procedure and results of water hammer analysis shall be furnished to purchaser for his information and approval.

10.3.4 Following valves, fittings and appurtenances shall be provided by the bidder as minimum requirement.

(i) Motorized discharge valves. Gate valves/check valves as required.

(ii) Isolating valves shall be provided at suitable intervals and at suitable locations to isolate a particular section of pipeline for maintenance during detailed engineering stage.

(iii) Scour or drain valves at suitable locations for adequate drainage of pipelines.

(iv) Pipe supports/racks complete with all accessories as required.

(v) Any other accessories as required for safe and reliable operation of respective pumping system.

10.4 Operational & Control Philosophy

10.4.1 All pumps and motorized valves shall be controlled and operated through DCS Workstations located in central control Room.

10.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

10.4.3 An interlock shall be provided to trip the pumps from very low level of water in the tanks. To achieve the above interlock there shall be level transmitters

which shall operate on one (1) out of two (2) voting philosophy. The same level transmitters shall also be used for pump start permissive from normal water level in the tanks.

10.4.4 All pumps shall have auto starting facility. The standby pump shall start automatically in case of tripping of any running pump or if its discharge header falls below a preset low value.

10.4.5 All pumps shall have the following safety features:

- Tank level high and low – annunciation
- Tank level very low – annunciation and trip
- Pressure on pump discharge high due to incomplete opening of discharge valve –annunciation.
- Pressure on pump discharge very high due to accidental closure of discharge valve –annunciation & trip.
- Any other protective feature deemed necessary for safe and reliable operation.

10.4.6 Detailed Interlock & protection logic shall be finalized during detailed engineering.

DATA SHEETS

S. No.	DESCRIPTION	DM CYCLE MAKE-UP PUMPS	BOILER FILL/ DEAERATOR FILL PUMPS	EMERGENCY HOTWELL MAKE-UP PUMPS
1.0	**General Data**			
1.1	Location	Outdoor		
1.2	Working Fluid	D M Water		
1.3	Duty of Pump	Continuous	Intermittent	Continuous
1.4	No. of Pumps	Two (2) (1W+1S)	Two (2) (1W+1S)	Two (2) (1W+1S)
1.5	Prime Mover	Ac electric motor		
1.6	Suction Condition	Flooded suction		
2.0	**Design Data**			
2.1	Design Capacity	By Bidder (10 % margin on capacity over actual requirement)	200 m^3/hr or filling the Boiler/Deaerator in two hours whichever is higher	By Bidder (10 % margin on capacity over actual requirement)
2.2	TDH (MLC)	By Bidder	By Bidder	By Bidder
2.3	Speed (rpm)	1500	1500	1500
2.4	Acceptable noise level	As per HIS	As per HIS	As per HIS
3.0	**Construction features**			
3.1	Type of Pump	Horizontal centrifugal		
3.2	Type of impeller	Closed		
3.3	Type of pump casing	Preferably radially split type		
3.4	Drive transmission	Direct		
3.5	Type of Coupling	As per manufacturer's standard practice		
3.6	Type of shaft sealing	Mechanical		
3.7	Type of Lubrication	Grease		
4.0	**Material of Construction**			
4.1	Casing	ASTM A CF 8M		
4.2	Impeller	ASTM A CF 8M		

S. No.	DESCRIPTION	DM CYCLE MAKE-UP PUMPS	BOILER FILL/ DEAERATOR FILL PUMPS	EMERGENCY HOTWELL MAKE-UP PUMPS
4.3	Wearing rings (if applicable)	SS - 316		
4.4	Shaft	SS - 410		
4.5	Shaft sleeves	SS - 410		
4.6	Bolts & nuts	Stainless steel for those coming in contact with water and for others, material shall be high tension carbon steel.		
4.7	Base plate	Carbon steel (Epoxy painted)		
4.8	Stuffing box packing	Asbestos free		
4.9	Flexible coupling	SS		
5.0	Accessories to be provided with each pump	a) Companion flanges with nuts, bolts and gaskets, Internal piping with valves filters & Instruments for sealing/ cooling/ lubrication system upto and including isolating valve etc. b) Coupling guards, Eye bolts, lifting etc.		

NOTE:

The capacity/capacities specified herein are the minimum requirements and any increase in the capacity/capacities during detail engineering shall be taken care of by the bidder without any price implication.

CHAPTER – 11

EFFLUENT TREATMENT PLANT

CONTENTS

CHAPTER – 11

EFFLUENT TREATMENT PLANT

11.1 GENERAL

The Waste Water management scheme shall be based on 100% recycle of treated effluent for a zero Discharge concept. Each identified effluent stream shall be subjected to required treatment and then shall be equalized in the central monitoring basin. The central monitoring basin shall have two compartments of similar capacity. The treatment facilities will be such that the quality of outlet from each treatment facility and the outlet of Central monitoring basin shall individually meet the applicable standards.

The effluent treatment system shall fully comply to meet all the requirements and limits specified in

- Environmental (Protection) Rulers, 1986 alongwith all latest amendments.
- Requirements and stipulations of Central pollution control Board (CPCB).
- Ministry of Environment & Forests(MOEF)
- State Pollution Control Board(SPCB)

And any other central or local statutory requirements regarding environmental pollution and its abatement.

The waste water streams from different sources of thermal power stations shall be collected, treated and released to the maximum extent possible within the plant boundaries.

11.2 Sources of waste

The various waste water generated from different sources to be handled for reuse otherwise disposal are described therein:

11.2.1 Oil Handling Area Effluent & Service Oil Waste:

Basis of Treatment System (For Oily Waste):

Parameter	Unit	Inlet	Outlet
Oil Concentration	ppm	1000	10
Suspended Solids	ppm	300	20

The oily water runoff during rains, regular washing/cleaning, leakage and draining from LDO day tank area/pump house shall be collected in a LDO day tank area pit and shall be transferred to the oil water separator (OWS) of API design through 2 Nos. of fuel Oil transfer pumps for removal of oil. The upper layer of oil in the OWS shall be removed using oil skimmer and collected in slop oil tank and disposed off. The treated effluent may contain oil beyond 10 ppm and the effluent shall be collected in Fuel oil waste sump and shall be transferred to TPI separator for removal of balance oil to meet standards of discharge.

- One(1) sump in LDO day tank area complete with all accessories

- Two (2) LDO day tank area waste transfer screw type pumps each complete with electrical drive motors to API separator
- One (1) API Seperator of capacity 25 M3/hr complete with all accessories.
- One (1) FOOWS sump complete with all accessories
- Two (2) Fuel Oil waste transfer pumps each complete with electrical drive motors.

11.2.2 Effluent from Power House Area

The effluent generated from the turbine area & Boiler area i.e leakages from pumps, Bearing Cooling systems, hydraulic couplings, Oil burners shall contain suspended solids, oil & grease.The effluent from these areas shall be channelised and collected in Turbine Area & Boiler Area oily waste pits respectively. The oily waste from these pits shall be transferered by trolley mounted pumps to the common oily waste pit and further transferred to the TPI separator for removal of suspended solids at the bottom and oil/grease at the top, this shall be collected in the slop oil tank. The clean water from the TPI shall be led to treated water sump. The treated waste shall be led to ash water sump for ash handling system.The sludge generated from the API & TPI seperators shall be disposed to the environment in sludge trolleys meeting the environmental norms.

- One (1) Sump for oily waste generated from Turbine Area complete with all accessories.
- Four (4) (3W+1S) Trolley mounted screw pumps to transfer waste to Common Oily waste Sump.
- One (1) Boiler Area Oily waste Sump complete with all accessories.
- One (1) TPI Seperator of capacity 50 M3/hr complete with all accessories.
- One (1) Treated Water Sump complete with all accessories
- Two (2) Treated water transfer pumps each complete with electrical drive motors.

11.2.3 Effluent from Switchyard/Transformer Yard Area

The oily effluent generated in the transformer yard and switchyard area generated during exigency i.e bursting of transformer/fire etc., shall be retreived by special means.

Major effluent from the transformer/switchyard area generated during periods of rainfall wherein the rainfall entering the transformer pits containing small amounts oil & suspended solids shall be led to the oil pit and further transferred to the common collection sump and pumped to the TPI separator for removal of oil & suspended solids. The Treated water shall be stored in treated water tank and shall be finally transferred to ash water sump.

- One (1) Sump for oily effluent from Switchyard Area complete with all accessories.
- One (1) Common Oily Sump for oily effluent complete with all accessories
- Two (2) Common Oily waste transfer pumps each complete with electrical drive motors.

11.2.4 DM Plant/ CPU Plant Regeneration Waste

The DM Plant/CPU regeneration waste is generated due to regeneration of resin beds by acid or alkali. The waste contains high amount of dissolved solids and acidic/alkaline nature based on the regeneration requirements. The effluent shall be collected in the Neutralising pit after pH correction and pumped to the central monitoring basin for further treatment.

11.2.5 Cooling Tower Blow Down

CT blowdown is done to maintain the level of dissolved solids in the Circulating Cooling water. This effluent will contain dissolved solids and chemicals/biocides used for prevention of scale formation/corrosion/biofouling. Cooling tower blow down shall be used for ash slurry disposal system and excess blow down shall be taken to CMB for further utilization.

11.2.6 Boiler Area Waste Water

Boiler area floor wash drains mainly consisting of suspended solids along boiler blow down shall be diverted to boiler area sump and shall be pumped to CMB.

- One (1) Boiler Area Sump complete with all accessories.
- Two (2) Boiler waste transfer pumps complete with electrical drive motors.

11.2.7 CHP Dust Suppression/Coal Pile Run Off Area

Rainfall cum normal run off from coal piles shall be collected by a drainage system around the coal pile and led by gravity to a coal particle settling basin. The settling basin shall have two chambers one operating and one standby. Each chamber shall be sized to treat maximum rainfall water run off from the coal pile. The rain intensity for one (1) hour peak rainfall shall be considered. Decanted water shall be collected in decanted water sump and thereafter pumped to CMB.

Basis of Treatment System

Parameter	Unit	Inlet	Outlet
Specific Gravity of coal particle	-	1.2	1.2
Particle Density	kg/M^3	750	750
Suspended Solids	ppm	1000	50
Particle size to be Settled	microns	50	-
Coal Pile Run off quantity	M^3/hr	60	

- One (1) Settling Pond in two compartments complete with all accessories for transfer of waste from CHP dust Suppresson and Coal pile area.
- Two (2) Settling pond transfer pumps

11.2.8 Clariflocculator Sludge

The clariflocculator sludge collected in sludge sump shall be taken to sludge treatment system consisting of thickner and centrifuge. Sludge shall be disposed in the form of dry cakes and the clear water shall be led to the inlet of stilling chamber.

11.2.9 Condensate Waste Water

The waste water generated from the condenser containing dissolved solids shall be taken to the condenser waste water pit and shall be pumped to the CMB.

- One (1) Condenser waste water sump complete with all accessories.
- Two (2) Condenser waste water transfer pumps each complete with electrical drive motors.

11.2.10 TG Area Waste Water

The waste water generated from TG Wash contains dissolved solids which shall be diverted to the TG wash water sump and shall be pumped to the CMB.

- One (1) TG wash water sump complete with all accessories.
- Two (2) TG Wash water transfer pumps complete with electrical drive motors.

11.2.11 ESP Area Wash Water

ESP Area floor wash drains mainly consisting of high TSS. This effluent shall be led to sump cum Pre-settling pit. Overflow from the Pre-settling pit shall be led to a sump. Pumps will be installed to transfer this effluent to Ash water sump.

- One (1) Pre-Settling Pit complete with all accessories for collection of ESP Area Waste Water.
- Two (2) ESP Area waste transfer pumps from Pre settling pit to Ash Water Sump complete with electrical drive motors.

11.2.12 Ash Silo Area Waste Water

The waste water generated due to dust suppression and floor cleaning in ash silo area shall be collected in a drain sump located in the ash silo area. Drain Pumps shall be installed to transfer the ash rich effluent to ash clarifier adjacent to ash water sump.

11.3 Central Monitoring Basin

All liquid effluents after the required treatment will be led to CMB, which acts as an equalization basin. CMB also take care of the shock loads/Mal-functioning/failure of any treatment equipment /process.

CMB shall have two compartments. CMB shall have atleast 8 hours detention period which shall be calculated based on the average hourly flow of total effeluents (i.e., 4 hours for each compartment). To meet the HSPCB/CPCB norms pH correction at CMB is necessary. Acid/alkali tanks with gravity dosing shall be

installed. To monitor the quality of effluent to zero dischare ETP (ZDETP) from CMB on line analysers shall be provided.

Zero Discharge ETP shall mainly consist of the following:

- One (1) Central Monitoring Basin in 2 compartments each of capacity 2000 M^3.
- One (1) each acid/ alkali dosing tanks complete with all accessories.

Equalised waste water from CMB will be treated in clarification plant.

11.4 Scope of Supply

11.4.1 One (1) High rate solid contact clarifier complete with flash mixer & all accessories i.e. rake mechanism, flocculator continuous/intermittent timer operated sludge disposal system, sludge sump and sludge pump.

11.4.2 One (1) clarified water sump with level switch, indicator.

11.4.3 Three (3) clarified water pumps to pump the clarified water to DMF.

11.4.4 Three (3) Dual Media Fillers with all accessories.

11.4.5 Two (2) UF skid with chemical cleaning system, fast flushing, backwash arrangement.

11.4.6 One (1) filler water tank, with level switch, indicator.

11.4.7 Three (3) (2W +1S) RO feed pumps.

11.4.8 Three (2) (2W + 1S) nos. Micron Cartage Filler.

11.4.9 Three (2) (2W + 1S) nos. HP Feed Pumps.

11.4.10 Two (2) RO streams.

11.4.11 One (1) Degasser system including one (1) tower, two (2) (1W+1S) air blower, one (1) Degassed water sump (RO Permeate) alongwith level gauge, switch etc.

11.4.12 Three (3) (2W+1S) RO permeate transfer pumps.

11.4.13 Clarifier/RO reject shall be collected in sump and send back to Ash Water Sump.

11.4.14 RO treated water shall be collected in separate tank (two (2) hours holding capacity) and then transfered for CW makeup or DM plant feed.

11.4.14 Necessary instruments, pipes, valves, fitting as per system requirement shall be provided.

11.4.15 RO module shall be designed for max. 2000 ppm TDS.

11.4.16 Bidder shall provide all the consumable including chemicals till the handing over the plant and additional chemicals of two (2) months requirement.

11.5 Control Philosophy

Main ETP CMB sump pumps along with UF/RO module shall be controlled from Plant water system PLC. For all the local sumps located at different locations in the plant, local control panels with PLC based hardwired logic shall be provided.

The bidder shall include all the required field instruments, flow elements, analyzers etc. for safe operation of Effluent Treatment Plant.

For detailing, bidder shall refer Volume V.

DATA SHEETS

EFFLUENT TREATMENT PLANT

S. No.	Description	Units	Parameter
1.00.00	**FUEL OIL HANDLING AREA EFFLUENT**		
1.01.00	**Waste Water from LDO day tank area**		
1.01.01	Sump pit	Nos.	1
i)	Type		Underground rectangular with flat bottom
ii)	Effective capacity	M3	5 M^3
iii)	Material of Const.		RCC
1.01.02	**LDO day tank area waste Transfer Pumps**		
i)	Numbers Required	Nos.	2 (1W+1S)
ii)	Type		Vertical Screw Pumps
iii)	Location		Outdoor in Sump
iv)	Type of Fluid		Fuel Oil & Water Mixture
v)	Rated Flow	M3/hr	25
vi)	Head	MWC	As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		
	Casing		2% Ni.- CI to IS 210 FG 260
	Rotor		SS-316
	Stator		Nitrile/EPDM
	Shaft		SS-316
1.01.03	**API Seperator**		
i)	Numbers Required	Nos.	1
ii)	Type		Plate or tube with counter flow/cross flow
iii)	Effective capacity	M3/hr	25
iv)	Design Criteria		As per API 412
v)	Channel Width		As per API 412
vi)	Channel Depth		As per API 412
vii)	Depth to width Ratio		0.3 to 0.5
viii)	Material of Construction		
ix)	Body		Carbon steel

S. No.	Description	Units	Parameter
1.01.04	**Sludge disposal System**		By gravity, along with sludge Trolley
i)	Slop Oil Tank- API Seperator		1 No. HDPE of 5m3 Capacity
1.01.05	**Treated water Sump**	Nos.	1
i)	Type		Underground rectangular
ii)	Effective capacity	M3	50
iii)	Material of Const.		RCC
1.01.06	**Treated Water Disposal Pumps**		Two (2)(1w+1s)
i)	Capacity and Head	M3/hr, MWC	50, As per Process requirements
ii)	Type		Horizontal, Centrifugal
iii)	Lubrication		Grease
iv)	Noise Level		85 DBA
v)	Suction condition		Flooded
vi)	Material of Construction		
	Casing		2.5% Ni Cast Iron IS 210 Gr. FG 260
	Base Plate		Carbon Steel IS:2062
	Impeller		Stainless Steel CF 8M
	Shaft		Stainless Steel SS 304
	Shaft coupling		Stainless Steel SS 304
	Shaft sleeve		SS 316
	Drive motor		Induction motor 415V, 3 phase 50Hz, TEFC
1.02.00	**Turbine Area Oily Waste Sump**		
i)	Numbers Required	Nos.	1
ii)	Type		Underground rectangular with flat bottom
iii)	Effective capacity	M3	25
iv)	Material of Const.		RCC
1.02.01	**Turbine Area Oily Waste Transfer Pumps**		
i)	Numbers Required	Nos.	1
ii)	Type		Trolley Mounted Horizontal Screw Pumps
iv)	Type of Fluid		Oily Waste Water

S. No.	Description	Units	Parameter
v)	Rated Flow	M3/hr	25
vi)	Head	MWC	As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		
	Casing		2% Ni.- CI to IS 210 FG 260
	Rotor		SS-316
	Stator		Nitrile/EPDM
	Shaft		SS-410
1.03.00	**Boiler Area Oily Waste Area**		
i)	Numbers	Nos.	1
ii)	Type		Underground rectangular with flat bottom
iii)	Effective capacity	M3	25
iv)	Material of Const.		RCC
1.03.01	**Boiler Area Oily Waste Transfer Pumps**		
i)	Numbers Required	Nos.	1
ii)	Type		Trolley Mounted Horizontal Screw Pump
iii)	Location		Outdoor
iv)	Type of Fluid		Oily waste water
v)	Rated Flow	M3/hr	25
vi)	Head	MWC	As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		
	Casing		2% Ni- CI to IS 210 FG 260
	Rotor		SS-316
	Stator		Nitrile/ EPDM
	Shaft		SS-316
1.04.00	**Switch Yard Area Oily Waste**		
1.04.01	**Sump pit**	Nos.	1
i)	Type		Underground rectangular with flat bottom
ii)	Effective capacity	M3	25
iii)	Material of Const.		RCC

S. No.	Description	Units	Parameter
1.04.02	**Switch Yard Area Oily Waste Transfer Pumps**		
i)	Numbers Required	Nos.	1
ii)	Type		Trolley Mounted Horizontal Screw Pumps
iii)	Location		Outdoor
iv)	Type of Fluid		Switchyard area oily waste water
v)	Rated Flow	M3/hr	25
vi)	Head		As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		
	Casing		2% Ni-CI to IS 210 FG 260
	Rotor		SS-316
	Stator		Nitrile/ EPDM
	Shaft		SS-410
1.04.03	**Common Oily Waste Water Sump**		
i)	Numbers Required	Nos.	1
ii)	Type		Underground rectangular with flat bottom
iii)	Effective capacity	M3	50
iv)	Material of Const.		RCC
1.04.04	**Common Oily Waste Water Transfer Pumps**		
i)	Numbers Required	Nos.	2 (1W+1S)
ii)	Type		Vertical Screw Pumps
iii)	Location		Outdoor
iv)	Type of Fluid		Waste from Switchyard , Transformer Area & Turbine Area
v)	Rated Flow	M3/hr	25
vi)	Head	MLC	As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		

S. No.	Description	Units	Parameter
	Casing		2% Ni-CI to IS 210 FG 260
	Rotor		SS-316
	Stator		Nitrile/ EPDM
	Shaft		SS-316
1.04.05	**TPI Oil Water Seperators**		
i)	Numbers Required	Nos.	1
ii)	Type		Plate or tube with counter/ cross flow
iii)	Effective capacity	M3/hr	50
iv)	Treated Water Quality		Free oil content not to exceed 10 ppm with inlet oil conc. of 1000 ppm in feed water. Suspended soplids not to exceed 20 ppm with 300 ppm at feed water inlet
v)	Design Criteria		
	Angle of inclination		60 Degree
	Rise Rate		Suitable to maintain an outlet oil concentration 10 ppm max in treated effluent
vi)	Material of Construction		
	Body		Carbon steel
	Plates or tubes		UV inhibited virgin PVC
	Oil skimmer System		To be provided
	Sludge disposal System		By gravity, along with Sludge Trolley
1.04.06	Slop Oil Tank-TPI Seperator		1 No. HDPE of 5m3 Capacity
2.00.00	**Boiler Area Sump**		
i)	Numbers Required	Nos.	1
ii)	Type		Underground rectangular with flat bottom
iii)	Effective capacity	M3	50
iv)	Material of Const.		RCC
2.01.02	**Boiler Area Transfer Pumps**		
i)	Number of pumps	Nos.	2 (1W+1S)
ii)	Type of Pumps		Vertical Turbine
iii)	Capacity of each pump	M3/hr	50
iv)	Head	MWC	As per Process Requirements

S. No.	Description	Units	Parameter
v)	Material of Construction		
	Casing		2.5% Ni-CI , IS 210 FG 260
	Column Pipe		ERW to IS: 3589
	Impeller		SS-CF8M
	Shaft		SS 304
	Shaft Sleeve		SS 316
	Discharge Pipe & Flanges		Fabricated Steel as per IS:2062 with epoxy painting outside and glass coating or cement mortar coating inside
vi)	Electric Supply		415 V, 3 Phase, 50 Hz
vii)	Enclosure		TEFC, out door type, class 'B' IPW-55
viii)	Speed of Pump & motor		1450 rpm
3.00.00	**Effluent from CHP Dust Suppression & Coal Pile Area**		
3.01.01 a)	Coal Settling Ponds	Nos.	1 in two compartments
i)	Type		Underground
ii)	Type of fluid handled		Rainfall Run off
iii)	Effective capacity	M3	500 (Each Compartment)
iv)	Material of Const.		RCC
v)	Inlet Arrangement		Inlet Chamber with Gate
b)	Overflow sump		
i.	Number	Nos.	One (1)
ii.	Type of fluid handled		Clear overflow water
iii.	Effective capacity	M3	120
iv.	Material of Const.		RCC
3.01.02	**Settling Ponds Transfer Pumps**		
i)	Number of pumps	Nos.	2 (1W+1S)
ii)	Type of Pumps		Vertical Turbine
iii)	Capacity of each pump	M3/hr	60
iv)	Head	MWC	As per Process Requirements
v)	Material of Construction		
	Casing		2.5% Ni–CI IS 210 FG 260
	Column Pipe		ERW to IS: 3589
	Impeller		SS-CF8M

S. No.	Description	Units	Parameter
	Shaft		SS 410
	Shaft Sleeve		SS 316
	Discharge Pipe & Flanges		Fabricated Steel as per IS:2062 with epoxy painting outside
vi)	Electric Supply		415 V, 3 Phase, 50 Hz.
vii)	Enclosure		TEFC, out door type, class 'B' IPW-55
viii)	Speed of Pump & motor		1450 rpm
3.01.03 a)	**Central Monitoring Basin**		
i)	Numbers	Nos.	1 in two compartments
ii)	Type		Underground
iii)	MOC		RCC
iv)	Minimum Effective capacity (Each Compartment)	M3	2000
v)	Inlet Arrangement		Inlet Chamber with Gate
b)	Overflow sump		
i.	Number	Nos.	One (1)
ii.	Type of fluid handled		Clear overflow water
iii.	Effective capacity	M3	250
iv.	Material of Const.		RCC
3.01.04	**CMB Effluent Transfer Pumps**		
i)	Number of pumps	Nos.	2 (1W+1S)
ii)	Type of Pumps		Vertical Turbine
iii)	Capacity of each pump	M3/hr	450
iv)	Head	MWC	Bidder to decide
v)	Material of Construction		
	Casing		2.5% Ni cast Iron IS 210 FG 260
	Column Pipe		ERW to IS: 3589
	Impeller		SS-CF8M
	Shaft		SS 410
	Shaft Sleeve		SS 316
	Discharge Pipe & Flanges		Fabricated Steel as per IS:2062 with epoxy painting outside and glass coating or cement mortar coating inside

S. No.	Description	Units	Parameter	
vi)	Electric Supply		415 V, 3 Phase, 50 Hz	
vii)	Enclosure		TEFC, out door type, class 'B' IPW-55	
viii)	Speed of Pump & motor		1450 rpm	
3.01.05	**Measuring Tanks**		Acid	Alkali
i)	Type		Vertical	
ii)	Quantity		2 each	
iii)	Useful capacity of each tank		1.0 M^3	
iv)	Material of Construction		Carbon Steel with 4.5 mm thick rubber lining inside in 3 layers	
v)	External protection		Chlorinated rubber paint DFT 300 microns with two coats of primer.	
vi)	Vent, overflow, Drain connection		Required, all pipe, flange & valves MOC-CPVC	
vii)	Agitator		One (1) per tank SS slow speed agitator with reduction gear & motor.	
viii)	MOC for Shaft & Impeller		ASME SA 479 Gr. 316	
ix)	Dissolving baskets No. & MOC		One (1) per tank having MOC ASME SA 479 Gr. 316	
4.00.00	**Condenser Waste Water Pit**	Nos.	1	
i)	Type		Underground rectangular with flat bottom	
ii)	Effective capacity	M3	Adequate to hold 1 day effluent with 20% margin. Approx	
iii)	Material of Const.		RCC	
4.01.01	**Condenser Waste Transfer Pumps**			
i)	Number of pumps	Nos.	2 (1W+1S)	
ii)	Type of Pumps		Submersible	
iii)	Capacity of each pump	M3/hr	20 (min.)	
iv)	Head	MWC	As per process requirement	
v)	Material of Construction			
vi)	Casing		2.5% Ni – CI to IS 210 FG 260	
vii)	Impeller		SS-CF8M	
viii)	Shaft		SS 304	
ix)	Shaft Sleeve		SS 316	

S. No.	Description	Units	Parameter
x)	Electric Supply		415 V, 3 Phase, 50 Hr
xi)	Enclosure		TEFC, out door type, class 'B' IPW-55
xii)	Speed of Pump & motor		1450 rpm
4.01.02	**TG Wash Water Sump**	Nos.	1
i)	Type		Underground
ii)	Effective capacity	M3	50
iii)	Material of Const.		RCC
4.01.03	**TG Wash Water Transfer Pumps**		
i)	Number of pumps	Nos.	2 (1W+1S)
ii)	Type of Pumps		Submersible
iii)	Capacity of each pump	M3/hr	50
iv)	Head	MWC	As per process requirement
v)	Material of Construction		
	Casing		2.5% Ni cast Iron IS 210 FG 260
	Impeller		SS-CF8M
	Shaft		SS 304
	Shaft Sleeve		SS 316
	Electric Supply		415 V, 3 Phase, 50 Hz
vi)	Enclosure		TEFC, out door type, class 'B' IPW-55
vii)	Speed of Pump & motor		1450 rpm
5.00.00	**ESP Area Wash Water Sump & Pre- Settling Pits**	Nos.	1
i)	Type		Underground
ii)	Effective capacity	M3	50
iii)	Material of Const.		RCC
5.01.01	**Presettling Pit**		
i)	Numbers Required	Nos.	1
ii)	Type		Underground
iii)	Effective capacity	M3	15
iv)	Material of Const.		RCC
5.01.02	**Presettling Pit Transfer Pumps**		
i)	Number of pumps	Nos.	2 (1W+1S)

S. No.	Description	Units	Parameter
ii)	Type of Pumps		Vertical Turbine
iii)	Capacity of each pump	M3/hr	15
iv)	Head	MWC	As per process requirement
v)	Material of Construction		
	Casing		2.5% Ni- Cast Iron IS 210 FG 260
	Column Pipe		ERW to IS: 3589
	Impeller		SS-CF8M
	Shaft		SS 304
	Shaft Sleeve		SS 316
	Discharge Pipe & Flanges		Fabricated Steel as per IS:2062 with epoxy painting outside and glass coating or cement mortar coating inside
vi)	Electric Supply		415 V, 3 Phase, 50 Hz
vii)	Enclosure		TEFC, out door type, class 'B' IPW-55
viii)	Speed of Pump & motor		1450 rpm
6.00.00	**Ash Silo Area Water Sump**	Nos.	1
i)	Type		Underground
ii)	Effective capacity	M3	30
iii)	Material of Const.		RCC
6.01.01	**Ash Silo Area Wash Water Transfer Pumps**		
i)	Number of pumps	Nos.	2 (1W+1S)
ii)	Type of Pumps		Vertical Turbine
iii)	Capacity of each pump	M3/hr	10
iv)	Head	MWC	As per process requirements
v)	Material of Construction		
	Casing		2.5% Ni Cast Iron IS 210 FG 260
	Column Pipe		ERW to IS: 3589
	Impeller		SS-CF8M
	Shaft		SS 304
	Shaft Sleeve		SS 316
	Discharge Pipe & Flanges		Fabricated Steel as per IS:2062 with epoxy painting outside.
vi)	Electric Supply		415 V, 3 Phase, 50 Hz
vii)	Enclosure		TEFC, out door type, class 'B'

S. No.	Description	Units	Parameter
			IPW-55
viii)	Speed of Pump & motor		1450 rpm
7.00.00	**Flash mixer**		
7.01.01	Number required	No.	One (1)
7.01.02	Construction		Radial, RCC
7.01.03	Detention time (approx.)	Sec.	Sixty (60)
7.01.04	Agitator		Turbine type ac electric motor operated thru reduction gear, SS-316 material of construction.
7.01.05	Protective cover of GI construction for motors and gear drives.		Required – protection for motors – IPW-55 (outdoor duty)
8.00.00	**Reactor Clarifier**		
	a. MOC of inlet pipe		M.S. ERW pipe for 10 Kg/cm2 (g) Pressure Class
	b. Number required	No.	One (1)
	c. Type & Construction		Radial, RCC
	d. Rated Effluent Capacity	Cum/hr	450
	e. Effluent quality	NTU	<15
	f. Detention period:	minutes	150
	g. Rise rate	Cu.M/hr/m^2	1.5
	h. Rake bridge		
	i. Material		MS IS: 2062 Epoxy painted
	ii. Other features		Suitably braced to provide rigidity. Gear boxes for bridge drive shall be either oil-free type or suitable arrangement for collecting leak oil shall be provided.
	Sludge blow-off:		
	i. Continuous		By gravity through telescopic stand pipe for continuous discharge.
	ii. Intermittent		Through timer operated blow-off valve
	k. Flocculation Agitator		Vertical Slow speed motor driven thru reduction gear
9.00.00	**Chemical House**		
9.01.01	Number	No	One (1)

S. No.	Description	Units	Parameter	
9.01.02	Type		Two (2) storied building	
9.01.03	Ground Floor		Chemical storage for effluent-treatment Plant	
9.01.04	First Floor		Location of Chemical Tanks EL Approx. 5.0m.	
9.01.05	Handling Facility		Mono-rail with chain pulley block capacity 1.0 MT	
10.00.00	**Dosing System**		**Alum**	**Lime**
10.01.01	Numbers required	Nos.	One (1)	One (1)
10.01.02	MOC		MS/RL	MS/EP
10.01.03	Minimum Capacity (effective)	Cu.m	5	3
10.01.04	Capacity of each pump	LPH	100	50
11.00.00	**Sludge Sump**			
11..01.01	No. of sludge sump	No.	One (1) Cap. 100 cum/hr	
11.01.02	Construction		RCC; outdoor location with 5 mm thick coal tar epoxy screed lining	
11..01.03	Sludge disposal pumps a) Number b) Type	No.	2(1w+1s) Vertical (non-clog / submersible)	
12.00.00	**Dual Media Filters**	Nos.	Three (3) (2W+1S)	
12.01.01	Design Flow per unit (net)	m^3 / hr	150	
12.01.02	Design Surface Flow Rate	m^3 /m^2 /hr	10	
12.01.03	Free Board Space	%	75 min.	
12.01.04	Fill Material		Anthracite and Sand	
12.01.05	Media Trap	No.	One (1) per unit. At service outlet of filter.	
12.01.06	Design code for Shell & Dish		IS:2825, IS:2062 for Shell and IS:2002, Gr I/SA515 Gr. 70 for Dish.	
12.01.07	Material of Construction for Vessel Internals		Epoxy coated carbon steel	
12.01.08	Internal painting		Two (2) coats of high built epoxy zinc phosphate DFT 150 microns	
12.01.09	External painting		Three (3) coats of chlorinated rubber paint DFT 150 microns	
12.01.10	Manhole	No. mm	One (1) No. dia 500 mm	
12.01.11	Sight windows.	No.	One (1)	
12.01.12	Filter Material depth	mm	1200	

S. No.	Description	Units	Parameter
13.00.00	**Ultra-Filtration (U.F.) Module**		
13.01.01	No. of Skid	Nos.	Two (2) 2 x 60%
13.01.02	Feed flow rate	cu.m/hr	175
13.01.03	Permeate flow rate	cu.m/hr	160 (after considering water for backwash and fast flush)
13.01.04	Recovery	%	90 % (min.)
13.01.05	Membrane Material		PVDF
13.01.06	a) Molecular Wt. Cut off value		10000 MWCO Daltons
13.01.07	b) Pore Size		Bidder to furnish (micron)
13.01.08	Average life of membrane	Years	5 years
13.01.09	Membrane flow mode/ configuration		From outside to inside
13.01.10	Frontal pipes, valves, manifolds		SS 316
13.01.11	Chlorine Resistance	-	Yes - pH 10.5
13.01.12	Feed water temperature range considered for the guaranteed outlet water quality	^{o}C	25 deg. C
14.00.00	**Ultra Filter Water Sump**		
14.01.01	Number	No.	One (1) (in two sections)
14.01.02	MOC		RCC with lining
14.01.03	Type of tank		Above ground, fully covered, RCC tank.
14.01.04	Level Indicator		Electro – mechanical
14.01.05	Inside protection		Shall be coated with Acrylic reinforced cementitous, flexible water proof coating conforming to BS 1881 Pt5 1983
15.00.00	**RO Feed Pumps**		
15.01.01	Numbers	Nos.	Two (2) (1W+1S)
15.01.02	Type		Horizontal
15.01.03	Head/Capacity	MWC/m^3/hr	As per process requirement
15.01.04	Type of lubrication		Self-lubrication
15.01.05	Speed of pump	RPM	1450 rpm
15.01.06	Material of Construction		
	i. Casing		2.0% Ni-Cast iron IS210 FG260
	ii. Impeller		SS-CF 8M
	iii. Shaft		SS-410
16.00.00	Chemical Measuring/Solution Preparation Tanks		

S. No.	Description	Units	Parameter			
			SMBS	Anti-scalant	Acid	Chemical Cleaning Skid
16.01.01		No.	One (1) Each			
16.01.02	Type		Vertical cylindrical with dished end bottom			
16.01.03	Effective capacity	Cum.	One (1)			
16.01.04	Tank – M.O.C.		SS-316			
16.01.05	Agitator – Type		Slow speed			
16.01.06	Agitator - M.O.C.		SS-316 / Alloy 20			
17.00.00	**Metering Pumps**					
17.01.01	Number	Nos.	Two (2) (1W + 1S) for each tank			
17.01.02	Type	-	Positive displacement, constant speed, variable stroke, diaphragm operated reciprocating type			
17.01.03	Duty	-	Continuous	Intermittent		
17.01.04	Suction condition	-	Flooded			
17.01.05	Head	MWC	As per Process requirement			
17.01.06	Pump speed	rpm	1450			
17.01.07	Pump - M.O.C.	-	All Wetted parts in SS-316 /Alloy20			
18.00.00	**Micron Cartridge Filter**		**R.O.Module**	**C.I.P.**		
18.01.01	Number	Nos.	Two (2)	One (1)		
18.01.02	Vessel – M.O.C.	-	SS-316			
18.01.03	Filter Element - M.O.C.	-	Synthetic non-degradable material (PP)			
18.01.04	Efficiency of the Filter Element	% minimum	90			
18.01.05	Pore size	micron	5			
19.00.00	**High Pressure Pumps**					
19.01.01	Number	Nos.	Two (2) (1W+1S)			
19.01.02	Head/Capacity	MWC/m³/hr	As per Process requirement			
19.01.03	Speed	rpm	2900			
19.01.04	M.O.C.					
19.01.05	Casing	-	SS-316			
19.01.06	Impeller	-	SS-316			
19.01.07	Shaft	-	ASTM A276, type SS-317 or equivalent			

S. No.	Description	Units	Parameter
19.01.08	Efficiency	%	80 minimum
20.00.00	**Reverse Osmosis System**		
20.01.01	No. of Modules	Nos.	Two (2) (2 x 60%)
20.01.02	Type of Membrane	-	Spiral wound, Thin film composite polyamide
20.01.03	Make of Membrane	-	DOW / Hydronautics / KOCH / Toray / Trisep/ Osmonics
20.01.04	Membrane Life	Years	3 minimum
20.01.05	Recovery rate	%	80
20.01.06	Permeate capacity/Stream	m^3/hr	100
20.01.07	Permeate – TDS	ppm	< 200
21.00.00	**Degasser System**		
21.01.01	Number	Nos.	One (1) Tower
21.01.02	Type	-	Forced draft type (Vertical Cylindrical)
21.01.03	Packing Rings (Fill) Material	-	Polypropylene or equivalent
21.01.04	External painting	micron	Three (3) coats of chlorinated rubber paint DFT 150 microns.
21.01.05	Shell material	-	MSRL
21.01.06	Rubber lining	mm	4.5 thick in three layers
21.01.07	Internal Distributors	-	Non clogging, Non corrosive type.
21.01.08	All internal fittings, water distribution tray and hand-holes for loading and removal of packing rings etc	-	To be provided
22.00.00	**Degassed Water Storage Tank**		
22.01.01	Number	Nos.	One (1)
22.01.02	Capacity	Cum	300
22.01.03	Type & Material of construction	-	Rectangular, RCC with epoxy painting of DFT 500 microns
23.00.00	**Degasser Air Blowers**		
23.01.01	Numbers required	Nos.	Two (2 x 100%) (1W + 1S)
23.01.02	Type	-	Centrifugal
23.01.03	Location	-	Outdoor on degasser tank
23.01.04	Drive motor type	-	Induction motor, 415V, 3ϕ, 50 HZ.
24.00.00	**Pump RO Permeate Transfer**		
24.01.01	Number	Nos.	Three (3) (2W+1S) 50%

S. No.	Description	Units	Parameter
24.01.02	Type		Horizontal Centrifugal
24.01.03	Operation		Continuous
24.01.04	Suction condition		Flooded
24.01.05	Material of Construction		
	- Casing		Stainless Steel CF 8M
	- Base plate		Carbon steel IS:2062
	- Impeller		Stainless Steel CF 8M
	- Shaft		Stainless steel SS 316
	- Shaft coupling		Stainless Steel SS 304
	- Shaft sleeve		SS 316
24.01.06	Vibration		As per HIS
24.01.07	Lubrication		Grease
24.01.08	Noise Level		85 DBA
24.01.09	RPM		1450
24.01.10	Drive motor		Induction Motor 415 V, 3 Phase, 50 Hz, TEFC.

CHAPTER – 12

SEWAGE TREATMENT PLANT

CONTENTS

CHAPTER – 12

SEWAGE TREATMENT PLANT

12.1 General

The sanitary waste streams from different buildings of the plant shall be collected by gravity into the respective manholes. The sewage shall flow from the manholes to the nearest collection chambers by gravity. The collected sewage in the collection chambers shall flow through sewer lines and flow to the common collection sump. From the common collection sump, the sewage shall be pumped to the equalization Tank located in the STP Area.

The sewage treatment plant shall be designed as per guidelines of CPHEEO Manual. The anticipated no. of users shall be 1000 persons. The sewage treatment plant shall be designed to handle a flow of 40 KLD considering average per capita consumption of 45 LCPD with 80% of used water generated as sewage. The Sewage Treatment Plant shall be modular type based on FAB/MBBR technology followed by disinfection by Hypo and necessary tertiary treatment prior to reuse in horticulture purpose.

The finally treated sewage shall meet the norms of environment protection rules 1986 and its amendments and the rules of State Pollution Control Board.

The major areas as sources of sanitary waste water shall be:

- STG Building
- Service Building
- Transformer Yard
- Switch Yard
- Compressed Air Building/ DG Room
- ESP Control Room
- Ash Water & Slurry Pumphouse,
- ESP area
- CW & ACW Pump House
- DM plant, CPU Regeneration & N.Pit
- Fuel Oil Pump House & Tank Area
- Crusher House
- CHP Control Room
- Raw Water Pump House

S.NO.	Source of Waste water	No. of persons	Qty of waste Generated (m3/day) Tentative	Disposal to
A.	**FROM PLANT BUILDINGS**			
1	STG Building	150	5.4	Main Sewer line
2	Service Building	50	3.5	Main Sewer line
3	Transformer Yard	20		
4	DG Room Building	10		
5	Switch yard room and switchyard control room	15		
6	CW & ACW Pump House	25	10	Main Sewer line
7	DM plant , CPU Regn & N.pit Area	20	1.6	Main Sewer line
8				
9	ESP Control Room	20	3.0	Main Sewer line
10	Ash Water & Slurry Pump House	40		
11	Clarifier Ash water Recovery	10		
12	Ash blower house	10		
13	Pre Treatment Plant	60	2.2	
B.	**FROM ISOLATED LOCATIONS**			
1.	CHP control Room	75	1.0	Septic Tank (ST-I)
2.	Raw Water pump House	15	0.5	Septic Tank (ST-II)

The quantum of sewage generated at the isolated locations of the plant being minimal shall be collected in the respective manholes and finally flow to the septic tanks by gravity wherein the partial treatment shall be provided, and partially treated sewage shall be treated with online hypo dosing prior to being reused in the nearby areas for horticulture.

All the sewer lines shall be designed such that the self cleaning velocity is maintained and the materials to be used for sewer lines shall be RCC NP3 pipe. The manholes shall be located at intersections along the sewer line at every change in direction and the maximum spacing of 30 meters in straight stretches to facilitate the mantainence of sewer lines.Sewer lines shall be designed considering peak factor as per guidelines of CPHEEO manual and shall run at 0.5 full at ultimate peak flow.

12.2 Scope of Work

The Sewage treatment plants shall consist of following treatment components:

- ❖ Preliminary Treatment:
  - Coarse Screens for screening incoming serwage
  - Oil & Grease Trap
  - Equalization cum holding tank
- ❖ Aeration System:
  - Aerobic Biological treatment in the FAB Tank with fine bubble diffused aeration
  - Transfer of treated partially treated sewage to the Clarfication system.
- ❖ Clarfication System:
  - Settling of digested sludge in the Tube Settler
  - Transfer & storage of clarified water to the Hypo Contact Cum Filter Feed Tank
  - Dosing of Sodium Hypochlorite in the Hypo contact Cum Filter Feed Tank
- ❖ Sludge Handling Sytem:
  - Transfer of sludge to the sludge sump from the aeration tank & clarifier
  - Transfer of sludge to filter press/centrifuge
  - Transfer of centrate or filtrate to the equalization tank.
  - Disposal of sludge as cakes by sludge trolley.
- ❖ Tertiary Treatment:
  - Polishing of treated sewage by DMF& ACF.
  - Transfer of Polished sewage water for horticulture.
  - Disinfection by Sodium Hypochlorite Dosing in the treated water tank.
- ❖ Bidder shall provide all the consumable including chemicals till the handing over the plant and additional chemicals of two (2) months requirement.

INLET/OUTLET PARAMETERS FOR STP

S. No.	Parameters	Unit	Inlet Parameters	Guaranteed Parameters
1.	pH		7.0 - 8.0	6.5 - 8.0
2.	BOD	ppm	300	<20
3.	COD	ppm	600	<100
4.	Oil & Grease	ppm	<50	-
5.	Coliform	MPN /1000ml	10^6-10^7	100 MPN/100ml
6.	Suspended Solids	ppm	300	<20

TECHNICAL DATA SHEETS FOR SEWAGE TREATMENT PLANT

S. No.	Description	Units	Parameter
1.0	**Common Collection Sump**		
i)	Numbers Required	Nos.	One
ii)	Capacity	M3	4
iii)	MOC:		RCC
1.01	**Common Collection Sump Pumps**		
i)	Numbers Required	Nos.	2
ii)	Type		Non clog sump Pumps
ii)	Flow	M3/hr	2
iii)	Head	MWC	As per process requirements
iv)	Particle Size		Upto 20 mm
v)	MOC		CI-Casing, Impeller-SS-316, Shaft: SS 410
1.02.	**Screen Chamber**		
i)	Numbers Required	Nos.	1(1w+0s)
ii)	Type		Perforated Sheet
ii)	Cleaning		Manual
iii)	Angle of inclination		60^0
iv)	Bar MOC		SS-304 fitted with MS frame
v)	Velocity	m/s	<1.0
vi)	Spacing of Bar	mm	10
1.03	**Oil & Grease Trap**		
i)	Numbers Required	Nos.	One
ii)	Flow	M3/hr	2
iii)	MOC:		RCC with baffle arrangements
1.04	**Equalization Tank**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2.0
iii)	Detention Time	Hrs	8
iv)	MOC of Tank		RCC
v)	Depth	M	2.5-4.0
vi)	Type of Aeration		Coarse Bubble Diffused Aeration

S. No.	Description	Units	Parameter
			Type
vii)	Type of Diffusers		Coarse bubble diffusers with retrievable arrangement
viii)	No. of Diffusers		As per requirement
1.05	**Air Blowers for Equalization Tank/ Sludge Sump**		
i)	Numbers Required	Nos.	2
ii)	Type of Blower		Twin lobe
iii)	Flow	M3/hr	To cater Air requirement for Equalization tank & Sludge Sump.
iv)	Head	Mtrs	As per process requirements
iv)	MOC		CI
v)	Accessories		NRV, Pressure Guage,Safety valves, Silencer., PRV, Filter, etc.
1.06	**FAB Feed Pumps**		
i)	Numbers Required	Nos.	2
ii)	Type		Vertical Submersible Pumps
ii)	Flow	M3/hr	2
iii)	Head	MWC	As per process requirements
iv)	MOC		CI
v)	Particle Size		Upto 20 mm
1.07	**FAB Reactor**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2.0
iii)	F/M Ratio	Kg BOD/ kg/ MLSS	0.1-0.15
iv)	MLSS	mg/l	3000-6000
iv)	MOC of Tank		MSRL
v)	Depth	M	Min 4-5 Mtrs
vi)	Type of Aeration		Fine Bubble diffused Aeration Type
vii)	Type of Diffusers		Silicon based fine bubble diffusers retrievable arrangement

S. No.	Description	Units	Parameter
viii)	No. of Diffusers		As per requirement
ix)	Fab Media		PVC
x)	Media Qty		As per requirement
xi)	Free Board	mm	500
xii)	Volume	M3	As per Process Requirements
1.08	**Air Blowers for FAB Tank**		
i)	Numbers Required	Nos.	2
ii)	Type of Blower		Twin lobe
iii)	Flow	M3/hr	To cater Air requirement for Aeration Tank.
iv)	Head	Mtrs	As per Process Requirements
v)	MOC		CI
vi)	Accessories		NRV, Pressure Guage,Safety valves Silencer., PRV, Filter, etc.
1.09	**Secondary Settler**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2.0
iii)	Surface Flow Rate	M3/m2/ hr	2
iii)	MOC of Settler		MSRL
iv)	Qty of Tube settler Media	M3	As per Process Requirements
v)	MOC of Media		PVC
vi)	Free Board	mm	500
1.10	**Hypo Contact Cum Filter Feed Tank**		
i)	Numbers Required	Nos.	1
ii)	MOC		PVC
iii)	Make		Sintex
1.11	**Hypo Dosing System**		
1.11.1	**Hypo Dosing Tank**		
i)	Quantity		01 Nos.
ii)	Capacity		100 ltrs
iii)	MOC		PVC
v)	Make		Sintex

S. No.	Description	Units	Parameter
1.11.2	**Hypo Dosing Pumps**		
i)	Quantity		01 Nos.
ii)	Capacity		0 -6 lph
iii)	Type		Metering
iv)	Make		Std.
1.12	**Filter Feed Pumps**	Nos.	Two (2) (1W+1S) 100%
i)	Type & Operation		Horizontal, Centrifugal, Continuous
ii)	Suction condition		Flooded.
iii)	Capacity & Head	M3/hr, MWC	Approx 2, as per process requirement
iv)	Material of Construction		
	• Casing		Cast Iron IS:210 Gr FG 260
	• Impeller		Stainless steel CF 8M
	• Shaft & Shaft sleeve material		Stainless steel SS Gr. 410 & SS316
	• Packing seal		Mechanical type
	• Drive motor		Induction motor, 415V, 3 Φ, 50 Hz, TEFC.
	• Common base plate		Carbon steel IS:2062
v)	Noise level		85 DBA
vi)	Vibration		As per HIS
vii)	RPM		1500
viii)	Drive motor		Induction Motor 415V, 3 Phase, 50 Hz, TEFC
ix)	Interconnecting Piping Material		Carbon Steel with Rubber lining.
1.13	**Dual Media Filter**		
i)	Quantity	Nos.	1
ii)	Capacity	M3/hr	2
iii)	Surface Flow Rate	M3/hr/ m^2	12
iv)	Size		As per Process Requirements
v)	Design Pressure	Kg/cm2	6

S. No.	Description	Units	Parameter
vi)	MOC		FRP
vii)	Media		Graded quartz sand free from carbonates and other foreign material and anthracite.
viii)	Rising Space		100%
ix)	Make		Standard
1.14	**Activated Carbon Filter**		
i)	Quantity	Nos.	1
ii)	Capacity	M3/hr	2
iii)	Surface Flow Rate	M3/hr/m2	15
iv)	Size		As per Process Requirements
v)	Design Pressure	Kg/cm2	6
vi)	Media		Activated Carbon
vii)	Supporting Media		Graded Gravel
viii)	Minimum Bed Depth	mm	1200
ix)	Rising Space		100%
x)	Shell & Dish Material		FRP
1.15	**Treated Water Tank**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2
iii)	Detention Time	Hrs	8
iv)	MOC of Tank		RCC
v)	Depth	M	2.5-4.0
1.16	**Treated Water Pumps**	Nos.	Two (2) (1W+1S) 100%
i)	Type & Operation		Horizontal, Centrifugal, Continuous
ii)	Suction condition		Flooded.
iii)	Material of Construction		
iv)	Casing		Cast Iron IS:210 Gr FG 260
v)	Impeller		Stainless steel CF 8M
vi)	Shaft & Shaft sleeve material		Stainless steel SS Gr. 410 & SS316

S. No.	Description	Units	Parameter
vii)	Packing seal		Mechanical type
viii)	Drive motor		Induction motor, 415V, 3 Φ, 50 Hz, TEFC.
ix)	Common base plate		Carbon steel IS:2062
x)	Noise level		85 DBA
xi)	Vibration		As per HIS
xii)	RPM		1480
xiii)	Drive motor		Induction Motor 415V, 3 Phase, 50 Hz, TEFC
xiv)	Interconnecting Piping Material		Carbon Steel with Rubber lining.
1.17	**Sludge Sump (Waste Pit)**		
i)	Number	No.	One (1)
ii)	MOC & Type		RCC, Under ground, Outdoor location
iii)	Capacity	Cu.m	As per Process Requirements
iv)	Instruments		Level switch with indication on panel
v)	Inside Protection		5 mm thick coal tar epoxy screened lining
1.18	**Sludge Transfer Pumps**	Nos.	Two (2) (1W+1S) 100%
i)	Numbers Required	Nos.	2
ii)	Type		Horizontal Screw Pumps
iii)	Location		Outdoor
iv)	Type of Fluid		Sludge From clarifier
v)	Rated Flow	M3/hr	As per process requirements (approx 2)
vi)	Head		As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		
	• Casing		2% Ni.- CI to IS 210 FG 260
	• Rotor		SS-316
	• Stator		Nitrile/EPDM
	• Shaft		SS-410

S. No.	Description	Units	Parameter
1.19	**Centrifuge**	Nos.	One(1)
i)	Type		Decanter
ii)	Inlet Concentration		2%
iii)	Outlet Concentration		20%(Min.)
iv)	Capacity		As per Process Requirements
v)	Liquid Handled		Secondary Sludge
vi)	Material of Construction		Wetted Parts-SS-304 Other parts – MSEP/CI
vii)	Motor		IP55 with outdoor installation, 3 phase, 415V, TEFC Type Squirrel cage induction Motor,Rating as per requirement.
viii)	Base Frame		MS Fabricated
ix)	Acessories		Suitable piping, valves pressure guage at delivery Pulley, V Belt Drive , foundation Bolts etc.
1.20	**PE Dosing System**		
i)	**Dosing Tank**	Nos.	1
ii)	Capacity of Tank	lts	100
iii)	MOC Of Tank		PVC
iv)	Dosing Pumps	Nos.	2
v)	Dosing Pump Capacity	lph	0-6
vi)	Type		Metering
vii)	MOC		

CHAPTER – 13

RAIN WATER HARVESTING SYSTEM

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CHAPTER – 13

RAIN WATER HARVESTING SYSTEM

13.0 DESIGN BASIS & SCOPE

13.1 Rain Water harvesting is the process of collecting, conveying and storing water from an area that has been treated to increase the runoff of rainfall.The potential of Rain water harvesting can by illustrated by pointing out that 1 millimeter of rain equals 10,000 litre of water per hectare. A small area of impermeable surface can collect a relatively large volume of water.The most important components, which need to be evaluated for designing the rain water harvesting structure, etc:

a) Hydrogeology of the plant area including nature and extent of aquifer, soil cover, topography, depth of water levels and chemical availability of ground water.

b) Area contributing for runoff i.e. how much area and land use pattern, wither plant area, colony area or green belts and general built up pattern of the area.

c) Hydro – metrological characters like rainfall duration, general pattern and intensity of rainfall.

13.2 The systems conceived here is directing the rainfall runoff that are not contaminated i.e. non-contact rainwater to a collection pond termed as Rain Water Harvesting Pond (RWHP) where the entire year's partial rainwater runoff will be collected and stored.

13.3 Water from the RWHP shall be 100% recycled in the raw water reservoir in dry season.The pond shall be located at the lowest contour of the plant as far as feasible so that it can effectively collect all the rain water by gravity.

13.4 The following portions shall be excluded from the rainwater catchment area, as rainfall in these areas are either do not come out that can be dealt with or rainfall comes out as inefficient and these are dealt separately.

a) Cooling Tower
b) Clarifier / CMB / RWHP areas
c) Coal Stock Pile Area
d) Boiler / ESP area
e) Fuel oil handling and storage area

13.5 The size of rain water harvesting pond shall be calculated based on the total rain fall runoff (approx. 20 days) and the pond so designed shall be constructed within the existing rain water holding area and shall be provided with HDPE lining. Boulders lying in the existing CHP area shall be explored for side walls and bottom floor pitching. All the storm water drains in the plant boundary shall be led to the rain water harvesting pond.

13.6 From the outlet of this pond, water shall be pumped to the existing raw water reservoir for use as supplement to raw water with two (2) (1W+1S) pumps each of capacity 200 M^3/hr with suitable head and piping routed raw water reservoir.

CHAPTER – 14

LABORATORY EQUIPMENT

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CHAPTER – 14

LABORATORY EQUIPMENT

14.0 LABORATORY EQUIPMENT

Laboratory equipment, furniture, chemicals, reagent grade, chemicals & glasswares shall be provided as given below for Water Treatment Plant water testing analysis at different stages of the process for which an adequately sized office area in the DM building shall be provided.

14.1 LABORATORY SIZE & FURNITURE

14.1.1 The covered finish floor space for the water chemistry laboratory including the laboratory chemical storage room and an office area shall be not less than 500 M^2. The laboratory area shall be air conditioned in addition to providing exhaust system with fume hoods for applicable equipment located in the building.

14.1.2 The laboratory shall be provided with concealed pipework for compressed air, demineralised water and potable water all along the lab furniture equipment with valves and fixtures at specific locations

a. Base cabinets

The steel base units with prime quality, welded steel cabinets shall be furnished for the following sizes in flexible modular design to install easily; and to rearrange later as per needs.

The doors and drawers shall be easy to remove for cleaning decontamination or repair; drawer should glide effortlessly [even when heavily loaded] on nylon ball bearing rollers thus providing smooth quiet operation with lock arrangement.

	Size (inches)	Qty. (Nos.)	Type
i)	28 H x 22 D x 18 W	Four (4)	Single door
ii)	28 H x 22 D x 22 W	Four (4)	Single door
iii)	28 H x 22 D x 35 W	Four (4)	Double door
iv)	28 H x 22 D x 47 W	Four (4)	Double door

b. Chemical storage cabinets

Floor cases in heavy gauge steel construction shall be furnished in the following sizes with sliding glass doors. Each of the case shall be provided with six (6) shelves; three (3) point bolting mechanism for secured fastening of both doors with lock arrangements:

Size (inches)	Qty. (Nos.)
35 D x 84 H x 16 W	Four (4)

c. Office desk and executive chairs:

Description	Size (inches)	Qty. (Nos.)
Desk	65 L x 28 H x 40 W	Four (4)
Chairs	Executive	Four (4)

d. Fume hoods

One (1) fume hood in fiberglass material for use with corrosive & organic material. The hood shall be provided with counter balanced for inspection and maintenance. Fume chamber shall be equipped with exhaust fan & ducting.

Sizes (Inches)	Qty. (Nos.)
70 W x 59 H x 32 D	One (1)

e. Wall cabinets

Wall cabinets shall be furnished in steel construction wall mounted; open on front side. The cabinets shall be furnished in shell white enamel sliding door in glass type with lock arrangement.

Sizes (Inches)	Qty. (Nos.)
35 D x 30 H x 12 W	Six (6)
47 D x 30 H x 12 W	Six (6)

The above details given furniture are Minimum; Bidder shall consider the required furniture for supplied material as per their experience for complete laboratory installation.

14.2 LABORATORY EQUIPMENT – WATER ANALYSIS

S. No.	Item	Qty.	Make
1.	pH meter (Bench Top)	Two (2)	METROHM/DKK/Pi
	pH meter(Portable)	One (1)	
2.	Conductivity meter (Bench Top)	Two (2)	METROHM/DKK/Pi
	Conductivity meter (Portable)	One (1)	
3.	UV visable Spectro Photometer	One (1)	PERKIN ELMER/MN/ ANALYTICAL-JENA.
	Visible Spectro Photometer	One (1)	
4.	Dissolved Oxygen meter	Two (2)	SWAN/DKK/VZOR
5.	Turbidity Meter	Two (2)	HACH/ SINCHE/WTW

S. No.	Item	Qty.	Make
6.	Balances	Four (4)	SARTORIUS / SHIMADZU/ACZET
7.	Flame photometer	One (1)	BUCK SCIENTIFIC PFP-7 / COLEPARMER
8.	Selective Ion-Analyser	One (1)	HORIBA/ KENT/ DKK
9.	Oil Content Analyser	One (1)	OCMA-2000 HORIBA INSTRUMENTS / TURNER DESIGN, USA
10.	Water Purification System	One (1)	MILLIPORE/VENCHAL
11.	Magnetic Stirrer cum Hot Plate	Two (2)	SHIVAM/VTS/SUN SHINE
12.	Water Bath	One (1)	SHIVAM/VTS/SUN SHINE
13.	Refrigerator	One (1)	LG / SAMSUNG/GODREJ
14.	Vacuum Pump	One (1)	SHIVAM/VTS/SUN SHINE
15.	Residual Chlorine Meter	One (1)	DKK /MN/SUNSHINE
16.	Jar Test Apparatus	One (1)	SHIVAM/VTS/SUN SHINE
17.	Potable Water Quality Checker	Two (2)	HORIBA INSTRUMENTS/ DKK/INS
18.	Incubator	One (1)	SHIVAM/VTS/SUN SHINE
19	Gas Chromatograph	One (1)	THERMO ELECTRON / CENTURY/NUCON
20	Atomic Absorption Spectrophotometer	One (1)	THERMOELECTRON / AGILENT/ ANLYTICAL-JENA
21	TOC Analyser	Two (2)	SHIMADZU / TELEDYENE/ OI-ANALYTICAL
22	B.O.D. Analyser System	Two (2)	DKK/VTS/SUN SHINE
23	C.O.D Analyser System	Two (2)	MERCK/MN/SUNSHINE
24	TSS meter	Three (3)	MERCK/MN/SUNSHINE
25	COMPARATORS	One (1)	MN/SUNSHINE/SIPL
26	DEPOSITION & CORROSION METER	One (1)	SUNSHINE/SIPL
27	MEMBRANE FILTER HOLDER ASSEMBLY	One (1)	SUNSHINE/SIPL

14.2.1 **pH-meter**

Bench Top pH Meter

pH meter with Automatic read function with easy calibration and user interface and Calibration timer.

Range	:	pH:-6.00 to 20.00
Accuracy	:	± 0.01 pH
mV Range	:	± 2000.0 mV
Accuracy	:	± 0.05% full scale
Temperature	:	-10.0 to 120.00 □C
Accuracy	:	± 0.5 0C

Accessories :

a) Single combination electrode with inbuilt temp. sensor
b) Calibration buffers
c) Spare pH combination electrode
d) Electrode holding stand

Portable pH Meter

Portable pH meter with 3 point calibration

Range	:	pH-2.00 to 16.00;
Accuracy	:	± 0.01 pH
mV	:	± 1999 mV;
Accuracy	:	± 0.1% full scale
Temperature	:	-5.0 to 125.00 □C;
Accuracy	:	± 0.50C

Accessories :

a) Single combination electrode with inbuilt temp. sensor
b) Calibration buffers
c) Electrode holding stand
d) Spare pH combination electrode

14.2.2 **Conductivity Meter**

Bench Top Conductivity Meter

Bench top conductivity meter should determine conductivity

Working Range	:	0.01µS to 200 mS/cm,
Accuracy	:	± 0.5%
TDS	:	0.01 ppm to 100 ppt
Temperature	:	-10 to 1200□C,
Resolution	:	0.10C

Accessories:

a) Conductivity cell
b) Cell stand
c) Conductivity standards
d) Spare conductivity cell

One instrument should be supplied with K=0.1 cm-1 for low conductivity measurement and other instrument should be supplied with K=1 cm-1 conductivity cell.

Portable Conductivity Meter

Portable conductivity meter should be used to measure conductivity, Salinity, TDS and temperature simultaneously. Should have the facility of automatic range selection

Measuring Range

Conductivity	:	0.01 µS to 200 mS/cm,
Accuracy	:	±0.5%
Resolution	:	0.01 µS/cm
Salinity	:	0 to 70.0 ppt

Accessories:

a) Conductivity cell k = 1 cm-1
b) Electrode holder
c) Conductivity standard
d) Spare Conductivity cell

14.2.3 **Spectro Photometer**

Single beam spectrophotometer: UV-VIS single beam instrument of wave length range 320 to 1100 nm with essential accessories:

Band Width	: 4nm ± 1nm
Wave length Accuracy	: ± 1nm
Wave length Resolution	: 1nm
Photometric Range	: 0 to 3.0 Abs
Stray Light	: < 0.3% T @ 400nm
Wave Length Calibration	: Automatic
Read out Mode	: Transmittance, Absorbance, Concentration

UV-VIS double beam instrument of wave length range 190 to 1000 nm, spectral width 2 nm with large cell compartment to accommodate cells of path length upto 100 nm with essential accessories.

Wave length range	:	190-1100 nm
Spectral Band width	:	2 nm or better
Wave length display	:	0.1 nm increments

Wave length accuracy	:	± 0.3 nm
Wave length repeatability	:	± 0.1 nm

Accessories:

Multicell holder

100 mm quartz cell (matched)

Standard silica solution

14.2.4 Dissolved Oxygen Meter

Dissolved oxygen meter shall be capable of ppb level DO measurement in boiler feed water and other water with flow through assembly. Sensor should be insensitive against changing flow rates.

Range	:	1 ppb to 20 ppm
Saturation	:	0.0 to 200.0 %
Partial pressure	:	0.0 to 400 hPa
Operation temperature	:	0.0 to 50.00C ±0.20C
Accuracy	:	± 1.5% in air saturated water 200C

Scope of supply should be DO meter, DO sensor, Panel with instrument holder, chain and shackle, armor SM Pro, Flow through vessel, tube, and tube adapter.

14.2.5 Turbidity Meter

The Turbidity meter shall be water proof. IP67 protected and works on Nephelometric principle (900 scattered light).

The Turbidity meter should work with infrared light source IR-LED (860 nm) to minimize the sample color problems.

It shall measure turbidity over the range 0 to 1100 NTU, Auto Range with a detection limit of 0.01 NTU in accordance with ISO 7027/DIN/EN 27027

Resolution of 0.01NTU from 0-9.99, 0.1NTU from 10-99.9 and 1 NTU from 100-1100 NTU

Accuracy of ± 2% of result or ±0.01

Reproducibility of <±1% of result or ±0.01 NTU

Automatic 3-point calibration feature to make the calibration easy.

Response time of 6-16 seconds

Operating Temperature of 0-50^0 C

The Turbidity meter should have Approval of CE/TUV/GS

The Turbidity meter should be supplied along with Turbidity standards (0.02, 100, 1000 NTU), 4 AAA alkaline-manganese batteries, two 25 mm test vials and carrying case.

14.2.6 Balances

Analytical balance (Electronic type) - 2 Nos.

Capacity	:	230 gm
Accuracy	:	0.1 mg
Type of display	:	backlit LCD

'Balance' shall be supplied with breeze shield

Table top balance	:	2 Nos.
Capacity	:	500 gm/1000 gm
Accuracy	:	0.1 gm

14.2.7 Flame Photometer

Electrically operated Flame Photometer alongwith all filters. The instrument shall be capable of measuring low ranges sodium, calcium, Potassium, Barium, Lithium. The Flame photometer shall have the following features.

Read out	:	3 ½ Digit LED
Range	:	0-199.9
Reproducibility	:	1% Cu for 20 consecutive samples
Accuracy	:	± 1%

14.2.8 Selective Ion-Analyser

The system shall be capable of analyzing the following elements like sodium, potassium, calcium, magnesium, chlorides, sulfates and nitrates. The equipment shall have data displaying and retrieval, pH auto-calibration, concentration calibration state.

The accuracy of the instrument shall be ± 0.25% F.S. The equipment shall be supplied with relative test kits as required to be installed in the laboratory.

14.2.9 Oil Content Analyzer

The analyzer should measure the hydrocarbons present in the samples of water in the form of oils, fats, grease or waxes; by solvent extraction, non-dispersive infra-red analyzer with photoelectric sensor and automatic calibration.

Measuring Range	-	0 to 200 ppm
Resolution	-	0.1 mg/l for 0-100 mg/l & 1.0 mg/l for 100-200 mg/l
Repeatability	-	± 0.2 mg/l
Display	-	3 ½ digits LCD with back-light.

14.2.10 Water Purification System

Water purification system should be used for generation of High purity water for conducting lab analysis.

It should be transforms tap water into ultrapure water in one compact and fully automatic system.

Output water properties:

Resistivity at 250C	:	18.2 MΩ-cm
Total Organic CarbonL	:	1-5 ppb
Bacteria	:	< 1 CFU/mL
Feed Water Pressure	:	30-100 psig, 2-6.9 bar
Inlet Water Temperature	:	4-40 ^{0} C
Voltage	:	100-240 VAC
Flow Rate	:	0.8 L/min.

Overall Dimensions 12 x 17.1 x 19 inches

14.2.11 Magnetic Stirring cum hot plate

Plate surface area	:	7x7 inch (approx.)
Stirring speed	:	60 to 1000 rpm
Temperature range	:	50^0 C to 500^0 C, accuracy within +30^0C
Plate material	:	Stainless steel

Accessories:

Spare element
TFE coated stirrer
Temperature sensor

14.2.12 Water Bath

Electrically heated concentric ring water bath of 8 holes with support frame, capacity 15 litre (approx.). Rings shall be of flanged formed stainless steel. Water shall be heated by a copper clad immersion heater controlled with 3 position heater switch. Maximum temperature 100^0C. The water bath shall be equipped with arrangement for fixing mercury thermometer, constant water level device & over flow arrangement.

General purpose water bath, upper housing of stainless steel, exterior enameled complete with power switch, thermostat dial, thermometer and thermometer holder. Capacity 30 litres without cover & racks

14.2.13 Refrigerator

Electrically operated refrigerator of capacity 350 liters complete with freezer, chill trays, crispators and provided with magnetic door latch, pilot bulb, thermostat temperature control, automatic voltage stabilizer, leads, plugs etc.

14.2.14 Vacuum Pump

This shall be used for calibration of draft gauges, vacuum gauges transmitters and compound gauges. The equipment shall have an accuracy of 0.025% F.S. The equipment shall be supplied with the following accessories.

Bleeder valves in inlet and outlet lines

50 mm dial pressure gauge of range 0 to 2.0 kg/cm2.
50 mm dial vacuum gauge of range 0 to 760 mm of mercury

Lubricator exhaust trap, hose nipples, intake filters and any others as required shall be provided.

14.2.15 Residual Chlorine Meter

Range	:	0-10 ppm
Accuracy	:	0.01 ppm
Resolution	:	0.01 ppm for 0-6 ppm
	:	0.1ppm for 6-10 ppm

Instrument shall be supplied with 4 Nos. measuring cells, free chlorine reagents for 1000 tests.

14.2.16 Jar Test Apparatus

The Jar test apparatus shall be furnished to evaluate condition required to remove suspended colloidal & non settable matter from industrial/raw water by chemical coagulation/flocculation followed by gravity separation. The assembly should consist of a programmable six paddle stirrer with continuous speed variation from 5 to 100 rpm. The stirring paddles should be of light gauge corrosion resistance material. The apparatus shall be supplied with jars of same size & shape preferably 1000 ml capacity; and reagents rack for introducing reagents to all jars simultaneously, with standard accessories & necessary spares.

14.2.17 Portable Water Quality Checker

The Multiparameter water quality instrument supply should include control unit, sensor probe, pH sensor, ORP sensor, Reference electrode, DO sensor, Turbidity sensor, pH4 standard solution 500 ml, pH reference internal solution 250 ml, DO sensor internal solution set – (internal solution 50 ml, sandpaper, syringe), DO Membrane spare parts set, spanner for DO sensor, cleaning brush, calibration cup (transparent calibration cup and black calibration cup), Back pack, Strap, Alkaline batteries 4 Nos., silicon grease and instruction manual.

pH

Two-point calibration
Automatic temperature

Measurement principle	:	Glass electrode method
Range	:	pH0 to 14
Resolution	:	0.01pH
Repeatability	:	± 0.05pH
Accuracy	:	±0.1pH

Oxidation Reduction Potential (ORP)

Measuring Principle	:	Platinum electrode method
Range	:	-2000 mV to +2000 mV
Resolution	:	1 mV
Repeatability	:	±5 mV
Accuracy	:	±15 mV

Dissolved Oxygen (DO)

Salinity conversion (0 to 70 PPT/automatic)
Automatic temperature Compensation

Measuring Principle	:	Three electrode Polarographic method
Measuring Range	:	0 to 50.0 mg/L
Resolution	:	0.01 mg/L
Repeatability	:	± 0.1 mg/L
Accuracy	:	0 to 20mg/L: ± 0.2mg/L, 20 to 50mg/L : ± 0.5 mg/L

Conductivity (COND)

Auto range
Automatic temperature conversion (25 deg. C)

Measuring Principle	:	4 AC electrode method
Measuring Range	:	0 to 10 S/m (0 to 100 mS/cm)
Resolution	:	0.000 to 0.999 mS/cm : 0.001 1.00 to 9.99 mS/cm : 0.001 10.0 to 99.9 mS/cm : 0.1 0.0 to 99.9 mS/m : 0.1 0.100 to 0.999 S/m : 0.001 1.00 to 9.99 S/m : 0.01
Repeatability	:	±0.05% F.S.
Accuracy	:	*±1% F.S. (Median of two-point calibration)

Salinity

Measuring Principle	:	Conductivity conversion
Measuring range	:	0 to 70 PPT
Resolution	:	0.1 PPT
Repeatability	:	±1 PPT
Accuracy	:	±3 PPT

Total Dissolved Solid (TDS)

Conversion factor setting

Measuring Principle	:	Conductivity conversion
Measuring range	:	0 to 100 g/L
Resolution	:	0.1% F.S.
Repeatability	:	±2 g/L
Accuracy	:	±5 g/L

Temperature

Measuring Principle	:	Platinum temperature method
Measuring Range	:	-10 to 55^0 C
Resolution	:	0.01^0 C
Repeatability	:	$\pm 0.10^0$ C (at calibration point)
Accuracy	:	JIS class B platinum thermometer sensor (±0.3 + 0.005)

Instrument shall deliver along with pH, ORP, conductivity, Dissolved Oxygen and temperature sensors

Turbidity (TURB)

Measurement principle	:	LED forward 30^0 transmission/ scattering method
Range	:	0 to 800 NTU
Resolution	:	0.1 NTU
Repeatability	:	±5% (reading) or ±1 NTU whichever is greater

Water Depth

Measurement principle	:	Pressure method
Range	:	0 to 30 m
Resolution	:	0.5 m
Repeatability	:	±1% F.S.
Accuracy	:	±0.3 m

14.2.18 **Incubator**

The incubator should be for general purpose incubation and BOD/COD tests with auto as well as manual control and interior illumination.

It should have full view inner glass door to allow inspection of samples without disturbing the temperature of Working Chamber. Compressor should be hermetically sealed and permanently lubricated. Door gasket should be impregnated with magnets to provide positive seal.It should be supplied with a voltage regulator.Plastic drip pan an dial thermometer range 0 to 1000C.It should be compete with 3-pin plug and cord for 240 V 50 Hz, single phase AC supply.

Other Specifications

Temp. range	-	5 to 50^0C
No. of shelves	-	2
Storage Capacity	-	6-7 cft (0.16-019 M^3)
Storage area	-	0.7 M^2 (approx.)
Control accuracy	-	+ 0.5^0C

It shall be supplied with instruction manual (including maintenance).

14.2.19 **Gas Chromatograph**

Computer controlled Gas Chromatograph with Digital pressure and flow control for carrier gas, alongwith Auto leak check facility in the digital measurement through hardware. The chromatograph shall be equipped with, column oven, sample injection unit, carrier gas flow controller, Flame Thermonic Detector (FTD) for both capillary & packed column. The instrument shall have the following parameters

Column Oven

Temp range	:	Ambient- 400^{0}C
Oven capacity	:	15.8 lts
Temp. accuracy	:	± 1%
Temp deviation	:	2^{o}C max.
Linear Heating rate	:	30^{o}C/min upto 150^{o}C 20^{o}C/min upto 250^{o}C 10^{o}C/min upto 380^{o}C 7^{o}C/min upto 400^{o}C
Cooling rate	:	300^{0}C to 50^{0}C in 6 minutes

Sample injection unit

Temp. range	:	upto 400^{o}C
Heating settings	:	1^{o}C steps
Number of units that can be installed	:	Three
Type	:	Dual packed, single packed split/spentless

Carrier Gas flow controller

Range	:	0-100 m^2/min
Steps	:	7

Flame Thermonic Detector

(FTD)	:	400^0 C

14.2.20 **Atomic Absorption Spectrophotometer**

Double beam Atomic Absorption Spectrophotometer with full multi-element capability controlled by data workstation running under windows and having manual overridewith local controls. It should be easily usable with all applications like flame absorption / emission, graphite furnace, hydride vapour or mercury cold vapour absorption modes andshould have automatic background correction. Having digital display of linear absorbance & concentration, it should preferably have parallel mounting of both flame and flameless (graphite furnace) assemblies.

Flame

This part should consist of air cooled burners with good flame stability and low carbon buildup for acetylene / hydrogen, acetylene / nitrous oxide flames and standard 100 mm burner for air / acetylene flame. It should have provision for automatic ignition and extinction of flame with a safety in-lock features to prevent flashback by pressure monitoring and safe gas handling in case the

flame goes out.The system should do safe automatic shutdown in case of power failure or in case the pressure of any gas falls below the safe limit.Vertical, horizontal and rotational adjustments of the burner head should be possible. It should be provided with rotameter flow control valves and pressure gauges and a pressure control valve incorporated for both of fuel and support gases. All controls should be achievable through software commands.

Graphite furnace

Flameless water-cooled graphite furnace assembly should come with pyrolytic graphite coated furnace tube as well as boats. It should be circulating water cooled complete with water reservoir tank, pump and necessary tube and valve connections. Data station controlled with provision of local controls.

Hollow cathode lamps

Instrument should have a minimum of 4 lamp connections with two lamps on at a time. The lamp alignment and energy optimization should be computer controlled. Lamps compatible with the instrument for the following elements should be supplied.

AI, As, B, Ba,Ca, Cd, Co, Cr, Cu, Fe, Ga, Hg, K, Li, Mg, Mn, Mo, Na, N, Pb, Sb, Se, Si, Sn, Sr, Ti, V, W and Zn.

Monochromator

Echelle / Ebert or Czerny – Turner monochromator employing a grating of 1800 lines / mm.

Computers and Printer Software

Window based software for the system function including control of major accessories with single or multi element capacity for flame / furnace with the required inter locking for safe operation.

Technical data

Wavelength Range	:	190 nm – 900 nm
Digital meter	:	4 – digit LED
Slit width	:	0.2, 0.5 & 1.0 nm
Wavelength display	:	3 digit digital counter

Accessories

i) Air compressor, oil free, capable of continuous operation providing the required quantity of air at the prescribed, constant pressure.

ii) Suction hood with exhaust fan of required capacity to maintain a stable flame.

ii) Pressure Regulators for use with the gases such as Acetylene, hydrogen & nitrous oxide, and for gases used in the graphite furnace. 2 Nos. each.

iv) Voltage Stabilizer (For use at 240 VAC 50 Hz single phase supply) – One (1) no.

Reference Standards

Certified reference standard solutions (1 ml = 1 mg) for all the elements mentioned above should be provided with the equipment.

Complete with all essential accessories for the tests of all metals in ppm as well as in ppb level, along with Operation and Maintenance Manual, Methods of determination of metals by Atomic Absorption Spectroscopy, electrical circuit diagrams and trouble shooting guide.

The equipment should be procured along with Mandatory spare parts for three years' trouble free operation and after sales services in India.

14.2.21 **TOC Analyser**

Total organic carbon (TOC) is the amount of carbon bound in an organic compound and is often used as a non-specific indicator of water quality or cleaniness of pharmaceutical manufacturing equipments.

A typical analysis for TOC measures both the total carbon present and the so-called 'inorganic carbon' (IC), the latter representing the content of dissolved carbon dioxide and carbonic acid salts.Subtracting the inorganic carbon from the total carbon yields TOC. Another common variant of TOC analysis involves removing the IC portion first and then measuring the leftover carbon. This method involves purging an acidified sample with carbon-free air or nitrogen prior to measurement and so is more accurately called non-purgeable organic carbon (NPOC).

14.2.22 **B.O.D. Analyser System**

The BOD analysis equipment should use pressure sensor technology. The equipment should do the mercury free respirometric BOD measurement using pressure sensor technology with a range of 0 – 3000 ppm BOD as O_2. The sensor should measure the oxygen depletion with LCD display and should have features like automatic initiation of the measurement, five days data storage memory and battery operation.

The equipment should consist of complete unit containing electro manometer and inductive stirring unit and six sensors and standard accessories like magnetic stirring rod, gasket, over flow measuring flasks, etc. and required thermostatically controlled cabinet for the incubation of the measurement samples. With standard spares and accessories along with operation an maintenance manual including detailed theory and procedure for the measurement of BOD, diaphragm pad, potassium hydroxide solution and nitrification inhibitor. All electrically operated parts should be usable at 230 V, 50Hz single phase AC supply.

14.2.23 **C.O.D. Analyser System**

This system is for the measurement of Micro COD using spectrophotometric procedure as per ASTM D 1252. It shall consist of the following parts:

1. Heating oven/block heater capable of maintaining a temperature of 150 ± 2^{0}C throughout. It shall have thermostatically controlled temperature settings and automatic cut-off timer.

2. 16 mm diameter borosilicate glass vials with Teflon lined screw caps to withstand the oven temperature and solution pressure. Standard vials supplied should be capable of measuring COD in the ranges of 0-150 ppm and 0-1500 ppm as O_2.

3. Spectrophotometer suitable for measurement at 600 nm and 420 nm using the vials. It should be capable of measuring COD from 0 to 1500 ppm.

The system should be supplied with all necessary spares and accessories and instruction and service manual. All electrical equipments should be suitable for 230 V, 50 Hz single phase AC supply.

14.2.24 Comparators

It should be Lovibond Comparator or equivalent for routine chemical analysis by direct reading of results using standard discs complete with pair of 13.5 mm & 40 mm cells along with each comparator. The comparator shall have the provision for two cells, one for the sample and other behind the disc to contain same depth of samples without indicator for comparison. It should have provision of compensation for turbid samples as well as daylight bench-top illumination system.

Accessories

a. Nessler attachment for determining the difference between pale colours: 2Nos.

b. Nessler Tube (Pair) of 113 mm for the above nesseleriser attachment: 2 doz.

c. Nessler Tube (Pair) of 250 mm for the above nesseleriser attachment: 2 doz.

d. Special Glass Cylinders AF 315: 1 dozen

e. Tablets:

DPD tablets (bottles of 100 tab) : 12 Nos.
Indigo-Carmine tablets (bottles of 100 tab) : 3 Nos.

Comparator Discs

All the discs shall have standard 9 or 10 permanent unfading guaranteed colour standards pre-calibrated against original laboratory standards mounted permanently in durable plastic wheels. The discs shall be interchangeable and should be used in the above Comparator.

Technical method sheets describing complete chemical data shall be supplied along with every individual disc.

S. No.	Test	Disc No.	Range covered	Qty reqd
1	Ammonia	NAA	0.02 to 0.16 ppm	2
2		NAB	0.2 to 0.52 ppm	2
3		NAC	0.56 to 1.2 ppm	2
4	Chlorine (in water) Palin method using DPD tablets	3/40A	0.1 to 1 ppm	2

S. No.	Test	Disc No.	Range covered	Qty reqd
		NDPB	0.05 to 0.5 ppm	2
5	Oxygen	NOE	O to 01.12 ml/L	2

14.2.25 **Deposition & Corrosion Meter**

Deposition & Corrosion Meter is meant for monitoring bio fouling, scaling and corrosion of cooling water systems. The test material shall be SS 304, Cupronickle 90:10, Cupro-nickel 95:05 and brass.

Bio fouling monitor

1. Sample tube material – as mentioned above.
2. Water flow indicator – Rotameter
3. Flow control valve – manual / automatic control
4. Differential pressure guage – Diaphragm dial type range 0-250 mm W.C
5. Inlet and outlet water pressure tapping.
6. By pass line of SS / copper tube for differential pressure gauges.
7. Mounted on panel

Scaling Monitor

1. Sample tubes (3 no. each) – material as mentioned above
2. Outside jacket tube – Acrylic
3. Metal temperature sensor – 20-100^{O}C; accuracy 1^{O}C
4. Inlet and outlet water temperature sensor and digital indicator – 10-70^{O}C; accuracy – 1^{O}C
5. Water flow sensor digital indicator – 200 to 1000 litres accuracy 5%
6. Water flow indicator – Rotameter or digital indicator
7. Heater – 1000 to 1500 watts 220 ±10 V AC
8. Heat input controller – Selector switch.
9. Power input – 220±10 V AC
10. Heater protection relay – 50 to 100^{O}C operating valve
11. Heater and water flow relay – Automatic on/off switch for heater with water flow stopper.
12. Display – Digital.
13. Water flow regulator – valve.
14. Complete with all fittings and fixtures for attachment of equipment.

Corrosion Test Racks

1. Corrosion test rack equipment – 12 no.
2. Corrosion test coupons size 13 mm×76 mm×1.6 mm as per ASTM-D-2688- 92 – Mild steel, SS 304, Cupronickel 90:10, Cupronickel 95:05, Brass – 100 no. each
3. Complete with all fittings and fixtures for attachment of equipment

14.2.26 **Membrane Filter Holder Assembly**

Stainless Steel Filter Holder

This assembly shall have stainless steel barrel, base, filter support screen, top cap and tubing adapter with anodized aluminium locking ring, PTFE "O" rings and silicon stopper. It shall come with 9.5 mm inlet hose connecter for applied air or gas pressure.

Capacity	100 ml
Filter dia	47 mm
Dimensions (approx.)	70 mm dia., 292 mm height.

Stainless Steel Filter Holder

This assembly shallhave stainless steel funnel, base and filter support screen with anodized aluminium locking ring, nylon lock wheels, PTFE gaskets and silicon stopper and suitable 1 litre borosilicate glass filtering flask.

Capacity	650 ml.
Filter dia.	47 mm
Dimensions (approx)	114 mm dia., 229 mm height.

Glass Filter Holder:

These are for the analysis of suspended solids in water. Consisting of borosilicate glass funnel and base, anodized aluminium spring clamp, coarse frit glass filter support and silicon stopper; for mounting on standard 1litre filtering flask.

Capacity	300 ml.
Filter dia	47 mm
Dimensions (appxtly.)	76 mm dia., 229 mm height.

It shall come complete with 1 litre borosilicate filtration flask.

14.3 LABORATORY EQUIPMENT – COAL ANALYSIS

S. No.	Item	Qty.	Make
1.	Coal Analyser	One (1)	LECO TGA/NAVAS/ORBIT/CKIC
2.	Automatic Oxygen Bomb Calorimeter	Two (2)	LECO AC-500/PARR/CKIC
3.	Carbon & Sulphur Analyser	Two (2)	LECO/NCT/CKIC/ANALYTICAL-JENA/ORBIT
4.	Ash fusion Furnace	Two (2)	LECO/ORBIT/SYLAB/CKIC
5.	Muffle Furnace	Two (2)	SHIVAM/SUNSHINE/VTS
6.	Oven	Two (2)	SHIVAM/SUNSHINE/VTS

S. No.	Item	Qty.	Make
7.	Lab Pulverizer	Two (2)	SHIVAM/SUNSHINE/VTS
8.	Sieve set with nine (9) sieves	Two (2)	SHIVAM/SUNSHINE/VTS
9.	HGI measuring equipment	One (1)	SHIVAM/SUNSHINE/VTS
10.	Riffle Sampler	One (1)	SHIVAM/SUNSHINE/VTS
11.	Sieve Shaker	One (1)	SHIVAM/SUNSHINE/VTS
12.	Jaw Crusher and Double Roll Crusher	Two (2)	SHIVAM/SUNSHINE/VTS
13.	Raymond Minimill	One (1)	SHIVAM/SUNSHINE/VTS

14.3.1 **Coal Analyser**

Thermo gravimetric Analyzer shall analyze 19 samples of coal, coke at a time. The Thermo gravimetric Analyzer shall have the following specifications:

Shall be analyze 1 to 19 samples unattended (19 samples + 1 reference)

Determination of moisture, volatiles, fixed carbon, ash, LOI

Temperature Range	:	$50 – 1000^0$ C
Sample Size	:	0.1 – 10 gms
Standard Deviation	:	±0.0002 gm
Weight Loss / Gain Range	:	0-100% etc.
Temperature stability	:	±1 0C at 105-1070C and ±20C at all other ranges
Selectable atomospheres	:	N_2, O_2 or Air
All heated parts metallic	:	carousels, crucibles, pedestal, covers

Ceramics optional: Ceramic crucibles can be used for analyzing corrosive materials

Instrument shall automatically restart after power failure; Mains power failure support, only 300 watts.

Balance: Sartorius 120 gr 0.1 mg and the balance has display for easy service.

Eurotherm temperature Controller

The temperature controller has 2 displays: 1 for the set point and other for the present temperature.

All sensors are magnetic not affected by dust.

Rotation by stepper motor

All parts are standard, easy to repair by anybody – so need to depend on the manufacturer for spares

Compressed air assisted cooling for faster cool down

Data transmission from LIMS to PC, Powerful Open Database Connectivity (ODBC) data base included

Windows software with 8 editable programs, 50 correction factors and linearization for each slope and each program, non-linearregression and curves fitting for all slopes using linear, least squares and quadratic formulas

Selectable configurations : ISO, ASTM, DIN

Single furnace or dual furnace controlled by one single PC

Programmable ramp rates 25^0 C to 107^0 C 5 ~ 30^0 C/min, 104^0 C to 1000^0 C 5 ~ 50^0C / min. can be upgraded to Automatic model.

Instrument shall be supplied with Metallic crucibles, Softwares and user manual.

14.3.2 **Automatic Oxygen Bomb Calorimeter {Quantity: Two (2)}**

Instrument shall be automatic microprocessor controlled calorimeter with Touch screen display.

Measurement Range: 1,000 K Cal/Kg to 10,000 Kcal/Kg for 1 gm of Sample with a provision to extend up to 12,000 Kcal/Kg for 1 gm of sample without reducing the sample size as per standards with optional bomb.

Precision	:	0.1% RSD or better
Resolution	:	0.0001 Cal/gm
Analysis Mode	:	Isoperibolic mode / Dynamic mode or any other mode
Temp.Measuring Resolution	:	0.0001 ^{0} C
Display	:	Color touch screen with graphical user Interface
Correction	:	Spiking, Ash / Nitrogen or Acid, Fuse wire, Sulphur and Hydrogen
Memory Capacity	:	Minimum 1,000 tests results or more
Computer/Printer/ Balance Connection	:	RS 232 Interface
Sample Crucible Capacity:		0.5 gm – 1.5 gm

Measurement Precision (Repeatability/Reproducibility): As per BIS 1350, ASTM D-5865/04 & DIN 51900 Methods.

Oxygen bomb	:	The oxygen combustion bomb shall be made with special stabilized stainless steel to resist the mixed nitric acid and sulphuric acid produced in combustion. It shall have 342 ml capacity with standing a hydrostatic pressure of 3000 – PSI max and working pressure of 1500 PSI.
Network connection	:	Ethernet
Smart Block Concept	:	Provision for variety of bombs for measurement of different ranges 25 K Cal/Kg to 12,000 Kcal / Kg) with the same system. The Variety of Bomb can be simplify plug in / Plug out inside the system.

14.3.3 **Carbon and Sulfur Analyzer {Quantity: Two (2)}**

The Instrument shall be used for measuring carbon and sulfur in coal, coke and other solid samples.

Sample Digestion: The catalyst-free high temperature digestion in oxygen streams at up to a combustion temperature of 1500^0 C (1800^0 C) allows the digestion of thermally very stable samples / compounds.

Digestion temperature: Up to 1500^0 C (1800^0 C with additional aggregates).

Instrument should be high temperature ceromic technology allows the analysis more aggressive.

Detection: A special wide-range NDIR detector enables the simultaneous analysis of carbon and sulfur in a dynamic measurement range of ppm to percentage with high linearity. Effective NDIR signal evaluation with the assistance of well-known VITA methods ensures precise and matrix-independent measurement results.

Measurement Range	:	0-100% C at 500 mg sample weight 0-20% S at 40 mg sample weight
Detection Limit	:	10 µg total C or 3 ppm at 3000 mg sample weight 15 µg total S or 5ppm at 3000 mg sample weight
Precision (reproducibility)	:	Better 2% RSD at 12% C Better 2% RSD at 2% S
Analysis time	:	2 – 3 min.

The instrument should be supplied with all the accessories required Carbon and Sulfur analysis.

14.3.4 **Ash Fusion Furnace {Quantity: Two (2)}**

Material of construction	:	Outer should be made of double walled thick PCRC Sheet duly powder coated painted insulation with high temperature ceramic fiber wool, Heating element should be made of Kanthal wire in coil form wrapped on the muffle are embedded in high grade temperature refractory cement. And backed by high density ceramic fiber blanket to avoid loss of heat, temperature is controlled by digital temperature indicator cum controller,
Maximum Temperature	:	1400^0 C
Working Temperature	:	1300^0 C
Chamber size	:	100x100x225 mm

14.3.5 Muffle Furnace

Electrically heated muffle furnace for general use and coal analysis upto a maximum temperature of 1200^0C having good air circulation shall be complete with

(a) Digital display of temperature.
(b) Electronic temperature controller with red and green pilot light.
(c) Heating elements of Chromel 'A' (Cr 20%, Nickel 80%)/Kanthel A-1 grade resistant to oxidation and sulphur, mounted on ground ceramic plates.
(d) Removable ceramic sample tray and
(e) Other required accessories.

The furnace shall be insulated on all sides including top and bottom with fire brick. The door shall be double sealed and provided with safety latch. The exterior of the furnace shall be polished mild steel finished with black hammerton spray or as per manufacturer's standard. The inner dimensions of the muffle furnace shall be approximately 450x225x225 mm.

Accessories:

i. Two (2) numbers each of stainless steel tongs of sizes 9 and 20 inch size
ii. One (1) Spare heating element.

14.3.6 Oven

Electrically operated, double walled type drying oven, with digital display of temperature and electronic temperature controller suitable for a maximum temperature of degrees centigrade (accuracy plus minus 1oC) shall be furnished in steel cabinet of size 900x600x600 mm (approx.) with air circulation by fan baked on enamel paint. The cabinet shall have adjustable levelling feet; stainless steel chamber with 25 mm thick layer of impregnated fibre glass on all sides; shell brackets spaced vertically on all sides 25 mm apart with 3 stainless steel shelves; side mounted controls with 0 to 12 hour timer that shut off automatically at set time with over temperature protection power heat and safety indicators lights.

Accessories:

Two (2) Mercury thermometer, range 40^0 C to 250°C
Twelve (12) Protection crucibles of 50 ml capacity with aluminium covers
Temperature sensor
Heating element

14.3.7 Lab Pulverizer {Quantity: Two (2)}

Pulverizer should be a disc type grinder and shall be supplied with Motor (reputed make), a 'V' belt pulley drive and mounting and the brief specification are:

Motor capacity	:	3 H.P
Disc Diameter	:	175 mm
Maximum Feed size	:	8 mm (approx.)
Size of finished product	:	100 mesh to 150 mesh

14.3.8 **Sieve set with nine (9) sieves**

Electrically operated Ro-Tap sieve shaker will be furnished to accommodate eight (8) 50 mm high x 200 mm diameter standard test sieves.The shaker will produce both circular and tapping motion to provide uniform mechanical action ensuring accurate and dependable test result.The shaker will be provided with a timer switch so that the test is automatically terminated after the present time.

Standard sieve shall be of brass/steel frame 200mm diameter and 50mm high above the wire cloth and drawn from one piece without a seam.

Accessories:

a) Two (2) polished brass lid and pan for the above 200mm diameter

b) Two (2) perforated steel frame complete with lid and cover to accommodate eleven sieves; 850 microns, 710 microns, 600 microns, 500 microns, 400 microns, 325 microns, 250 microns, 212 microns,200 microns, 100 microns and 50 microns.

14.3.9 **Hard Groove Grindability Equipment**

Purpose : The equipment is required to determine the hard grove grindability index of coal as per IS 4433.

Description : The machine will be supplied fitted with automatic revolution control switch, weights and built-in gear reduction motor.

Accessories : Sieves of various sizes

14.3.10 **Riffle Sampler**

Riffle Sampler shall be with adjacent slots to deliver coal to opposite side and to divide it into two identical halves. Slots shall be of 25 mm size and number of total slots should be 36. The sampler shall be provided with legs and removable containers.The material of construction of the equipment shall be mild steel, painted with gray hammertone paint. Qty – 1 No.

Riffle Sampler shall be with adjacent slots to deliver coal to opposite side and to divide it into two identical halves. Slots shall be of 12.5 mm size and number of total slots should be 24. The sampler shall be provided with legs and removable containers.The material of construction of the equipment shall be mild steel, painted with gray hammertone paint. Qty – 1 No.

14.3.11 **Sieve Shaker**

Electrically operated Ro-Tap sieve shaker shall be furnished to accommodate eight (8) nos. 50 mm high x 200 mm dia standard test sieves. The shaker shall produce both circular and tapping motion to provide uniform mechanical action ensuring accurate and dependable test results. The shaker shall be provided with a timer switch so that the test is automatically terminated after the preset time.

Accessories:

Standard sieve shall be of brass frame 200 mm dia & 50 mm high above the wire cloth; and drawn from one piece without a seam. The wire cloth shall be soldered to the frame of stainless steel 18/8 quality as per IS: 460-1942.

Two (2) polished brass lid and pen for the above test sieves of 200 mm dia.

Two (2) perforated steel frame complete with lid and cover to accommodate eight sieves.

Test sieves: one (1) of each size 250 microns

710 microns
600 microns
500 microns
405 microns
355 microns250 microns
212 microns

14.3.12 **Jaw Crusher and Double Roll Crusher {Quantity: Two (2)}**

Jaw Crusher

Suitable jaw crusher for the preparation of coal samples shall have the following specifications:

Feed size	250 mm
Product size	50 mm
Capacity	0.5 to 1.0 Ton/hr

Motor 415 V operated 1400 rpm, 5 to 7 HP with belt, starter and required accessories.

Double Roll Crusher

Suitable roll crusher for the preparation of coal samples should have the following specifications:

Feed size	50 mm
Product size	6 mm
Capacity	0.5 Ton/hr

Motor 415 V operated 1400 rpm, 5 HP with belt, starter and required accessories.

Double Roll Crusher

Suitable roll crusher for the preparation of coal samples should have the following specifications:

Feed size	13 mm
Product size	3 mm
Capacity	0.25 Ton/hr

Motor 415 V operated 1400 rpm, 2 to 5 HP with belt, starter and required accessories complete with base frames, foundation, etc.

14.3.13 Raymond Minimill

Raymond Minimill - swing hammer pulveriser shall be of high speed type fitted with a continuous rated motor of 0.5 HP (Synchronous speed 3000 rpm) for small scale production of 212 micron coal fine powder from inlet size of 3.35 mm of coal of approximate HGI of 50. It shall be fabricated steel construction fitted with forged steel hammers and complete with feed hopper, integral hand operated screw type feeder, product container with lid and cloth Product Delivery Tube. It shall be complete with the pair of screens of above size (i.e. 3.35 mm and 212 micron). It should be suitable for operation on 220/230 volts single phase 50 Hz AC Supply. It shall be suitable for bench mounting with replaceable fittings.

Spares

1. 1 Set of hammer
2. 6 sets of screen 3.35 mm & 212 micron

14.4 LABORATORY EQUIPMENT – OIL ANALYSIS

S. No.	Item	Qty.	Make
1.	Red Wood Viscometer	One (1)	SHIVAM/SUNSHINE/SIPL
2.	Automatic Flash Point Apparatus	One (1)	SHIVAM/SUNSHINE/SIPL
3.	Dean & Stark Moisture Determination Apparatus	Two (2)	SHIVAM/SUNSHINE/SIPL
4.	Flash Shaker	One (1)	SHIVAM/SUNSHINE/SIPL
5.	Centrifuge	One (1)	SHIVAM/SUNSHINE/SIPL
6.	Automatic K-F (Karl-Fisher) Titrimeter	One (1)	METROHM/ SI ANALYTICS/ METTLER
7.	Portable Purge Gas Analyser	One (1)	NEVCO/TESTO/KANE
8.	Multi-Gas Detector	One (1)	NEVCO/TESTO/KANE/ NOVA
9.	Orsat Gas Analyser	Three (3)	SHIVAM/SUNSHINE/SIPL
10	Heating Mantle	Three (3)	SHIVAM/SUNSHINE/SIPL
11	NAS Value Analyzer	One (1)	SHIVAM/SUNSHINE/SIPL

14.4.1 Red Wood Viscometer

Electrically operated Redwood visometer conforming to IP 70/62 with heat control and voltage variator for measuring the viscosity of petroleum products whose redwood viscosity does not exceed 2000 seconds. The measurement shall be the time flow in seconds of 50 millilitres of liquid through an agate jet having standard hole at the bottom of brass cups. The cup should rest in a copper bath on a cast aluminium stand. The bath and the stand shall have silver grey hammertone stove enamelled finish or equal; and furnished with spirit level and teakwood carrying case

Accessories

Pair of thermometers to IP: 8C, 9C and 10C having temperature range of 0^0 C to 44^0 C; 37.8^0 C to 82^0 C; and 76^0 C to 122^0 C respectively

Uniform temperature water bath

An auto regulating transformer

Flask receiver encased in teak wood case

14.4.2 Automatic Flash Point Apparatus

The apparatus shall be microprocessor controlled fully automatic Pensky's Martin Flash point equipment conforming to ASTM D 96 [A&B] – IP 34, ISO 2719, EN 22719 to determine the closed cup flash point ensuring accurate and repeatable measurement. Automatic correction of flash point per actual barometric pressure should have electric and gas igniters, search mode and users defined programme, storage of test data, built in RS 232 interface for connecting printer and computer.

Temperature range	:	+ 40^0 C to +3700^0 C
Accuracy	:	± 0.5^0 C

Accessories:

Oil cup/Test vessel, Detector Electrodes Temp. Measuring probes

14.4.3 Dean & Stark Moisture Determination Apparatus

The apparatus shall consist of receiver 10 ml graduated, with 19/26 outer joint and 24/29 inner joint, round bottom flask 1000 ml with 24/29 outer joint and lie big condenser 200 mm with 19/26 joint.

14.4.4 Flash Shaker

The flask shaker shall be an electrically operated apparatus for shaking flasks, bottles & similar containers. The shaker should accommodate four (4) 1000 ml flasks or twelve (12) 125 ml flasks. It shall be used on 230 volt ac alongwith standard accessories & spares.

14.4.5 Centrifuge

Centrifuge should be Brushless AC induction motor with frequency inverter practically maintenance free Pre setting of speed Digital speed indicator & digital timer Safety lid interlock to prevent cover opening during centrifugation imbalance detector with cut off Dynamic brake for quick deceleration With CE Mark

Technical Spec.:

Max. Speed	:	5250 RPM
Max. RCF	:	3900 g
Max. Capacity	:	400 ml
Appx. Size	:	365 W x 415 D x 305 H (mm)

14.4.6 **Automatic K-FTitrimeter**

The Karl fisher titrator should be the dedicated instrument for determining the microgram level water content in transformer oil and other petroleum products.

Principle of operation : Coulometric

The Coulometric Titrator should have large high contrast liquid crystal display and the display should show the actual status even during the operation sequence. The methods for sample titrations and the collection of blank values should be pre-assigned to start the titration directly after installation.

Generator electrode	:	Diaphragm type
Measuring Range	:	10µg to 100 mg / 1 ppm to 5%
Sensitivity	:	0.1 µg
Accuracy Precision	:	0.3% at 1 mg water
Automatic drift compensation		
Number of methods	:	10
Measuring speed	:	Max.2 mg/min

Automatic background correction

GLP compliance

Automatic selection of the correct calculation formula

Facility to connect with balance, printers and PC

Pump shall have following specifications:

Free volume flow – air -	:	flow rate 2.25 l / min
Delivery pressure max.	:	1.5 bar
Flow rate liquid medium ca.	:	0.8 l / min
Stirring speed	:	50 to 1000 U/min
CE-Mark	:	EMV – compatibility according to Council Directive 89/336/EWG; Transient emissions according to norm EN 50 081, part 1 Interference resistance according to norm EN 50 082, part 1 and 2 Low voltage directive according to Council Directive 73/23/EWG, Last amended by Council Directive 93/68/EWG, Test criteria EN 61 010, part 1 Power supply : Multiple range power supply 100-240 V; 50/60 Hz, power input : 30 VA

Operating Conditions

Ambient temperature	:	+ 10 to 40 ^{0}C for operation and storage
Humidity according to EN 61 010, part 1	:	Maximum relative humidity 0% for temperatures up to 310C

Linearly decreasing up to 50% relative humidity with a temperature of 400 C

Instrument shall be delivered along with:

One generator electrode with frit
One Indicator electrode it shall be dual platinum electrode

Accessories

KF reagents
Water standards
Instructions Manual
Measuring range shall be 10µg to 100 mg (or) 1 ppm to 5%
Instrument shall accept local KF reagents.

14.4.7 Portable Purge Gas Analyser

It shall be a thermal conductivity detector based analyzer for themonitoring of hydrogen purity in turbine generators.The instrument shall be capable of measuring the gas compositions air-in carbondioxide and hydrogen-in-carbondioxide during maintenance purging as well as the hydrogen purity during normal generator operation by selection of range in the instrument. It shall be intrinsically safe for operation in hydrogen – air atmosphere.

Ranges (switch selectable)

0-100%	hydrogen-in-carbon dioxide
0-100%	air-in-carbon dioxide
90-100%	hydrogen-in-air
Zero drift	<1% per day
Accuracy	+ 5% of full scale or better
Response time	90% in 50 seconds or better
Signal Output	0-1 V DC, with mV DC output option
Operating temperature	0-52^{o}C
Electrical requirement	220 V, 50 Hz, single phase AC

It shall be supplied with all necessary spares and accessories including spare fuses for three years trouble free operation and O&M manual giving detailed procedure for operation, trouble shooting and calibration.

14.4.8 Multi-Gas Detector

Instruments should measure NO_2, SO_2, CO, NO, O_2 in flue gas

Parameters	Gas Sensor	Range	Resolution
NO_2	Electrochemical	0-100 PPM	1 PPM
NO	Electrochemical	0-4000 PPM	1 PPM
SO_2	Electrochemical	0-1000 PPM	1 PPM
CO	Electrochemical	0-1000 PPM	1 PPM
O_2	Electrochemical	0-25 %	0.1

Accuracy	:	± 2%
Response	:	20 sec. for 90% attenuation
Display	:	Digital – Backlit LCD
Calibration Span	:	Auto Zero for all gases & auto span for Oxygen. cal. With stand. Cal gas.
Alarms ILO-bat	:	Audio-visual for Two level (adjustable) Fault &
Sampling	:	Automatic thru built in pump.
Power	:	Rech battery with 220 VAC Charger

14.4.9 **Orsat Gas Analyser {Quantity: Three (3)}**

Portable Orsat gas analyzer for the determination of CO_2, CO & O_2 in flue gas samples should consist of the following pars, made of borosilicate glass:

Two absorption pipettes filled with thin walled glass tubing and one with copper spirals, and three rubber expansion bags.

Manifold made of 2-3 mm ID and length approximately 35 mm, capillary tubing, with four stop-cocks; one three – way horizontal and three vertical and a U-tube drying facility at I/L to the manifold.

100 ml measuring burette Class A, with water jacket.The lower portion of burette should be graduated in 0.1 ml, up to 30 ml and the remaining 70 ml in 5 ml divisions.

Leveling bottle 250 ml capacity.

$CaCl_2$ tubes with rubber cork-1

The assembly should be nearly fitted with supports, clamps in a portable polished wooden case with removable front and back covers.

Spares

1.	Absorption pipettes with 2-3 mm ID capillary tube	-	12 Nos.
2.	Absorption pipettes copper spirals	-	6 Nos.
3.	Measuring burette with water jacket	-	6 Nos.
4.	Leveling bottle	-	6 Nos.
5.	Manifold	-	12 Nos.

14.4.10 **Heating Mantle {Quantity: Three (3)}**

Mantle should fit snugly against spherical/flat bottom flasks upto 2000 ml capacity. It should heat up to 350^0C through flexible, knitted, glass wool fabric with coiled heating elements, supported in solid aluminium housing.

14.4.11 **NAS Value Analyzer**

Accuracy : ± ½ ISO Code

Partricle Sizes : 4µ, 6µ, 14µ, 21µ

Real time analysys for fluid cleanliness : Yes

Live Screen Readouts: NAS1638, SAE749, ISO4406

Output : RS 232

Software : Windows Compliant Latest version)

14.5 LABORATORY EQUIPMENT – METEOROLOGICAL & POLLUTION

S. No.	Item description	Qty.	Make
1.	Weather monitoring station	One (1)	ENVIROTECH / DAVID/VEC
2.	Dew Point Meter	Two(2)	SHAWAL/EXTECH/SIPL
3.	Mercury Barometer	One (1)	SHIVAM/SUNSHINE/SIPL
4.	Maximum & Minimum Thermometer	Two (2)	SHIVAM/SUNSHINE/SIPL
5.	Dry & Wet Bulb Thermometer	Two (2)	SHIVAM/SUNSHINE/SIPL
6.	High Volume Sampler	One (1)	ENVIROTECH / VAYUBODHAN
7.	Stack Monitoring Kit	One (1)	ENVIROTECH / VAYUBODHAN
8.	Portable Gas Analyser	One (1)	ENVIROTECH / VAYUBODHAN /NOVA/KANE
9.	Stop Watch	Two (2)	RACER / SUNSHINE/SIPL
10.	Assman Psychrometer	Two (2)	EXTECH/ SUNSHINE/SIPL

All laboratory equipment shall be of latest models of the above makes.

14.5.1 Electrical Anemograph

3 cup generator anemometer and electrical wind vane mounted on a supporting mass assembly. It shall be electrically connected by means of cables to the wind speed/wind direction indicator & wind speed/wind direction, and temperature two channel recorder with spares for start-up & 3 years operation.

Range : 0 to 100 knots 0o to 360o(N-E-S-W)
Resolution : 1 knot ±5o
Accuracy : ±2% of span, ±5o
Chart Speed : 15 and 60 mm/hr by manual gear change
Chart Length : Minimum for 15 days

A software system into compatible computer with windows operating system for long terms storage and processing recorded information.

14.5.2 Dew Point Meter {Quantity: Two (2)}

Portable dew point meter with below specification

Humidity	:	10% to 95% RH
Temperature	:	0 to 50 ^{0}C
Temp. unit	:	^{0}C, ^{0}F internal adjustment

Humidity measurement with fast response time
All in one, pen type, easy carry out
Hold function to freeze display value
Build in reverse display button
DC 1.5V battery (UM-4, AAA) x 4 catridge and necessary accessories

14.5.3 Rain Gauge

Recording type rain gauge receiving vessel on protective case, measuring vessel with float and siphoning device, 8 times magnification of the rain fall in measuring vessel, recording by means of hand wound drum recorder; protective case made of rust proof materials.

Maximum recordable precipitation:approx. 200 mm/hr intensity.

14.5.4 Mercury Barometer

For atmospheric pressure measurement (FORTIN TYPE). Tube of uniformbore 6.4 mm in metal casing, on hard wood panel (9x107 cm)approximately mercury level; and zero point clearly visible in glass cistern; double scale reads 647 to 800 mm (0.1 mm div); thermometer in doublescale deg.C & deg.F. It shall be calibrated to National Bureau of Standards

14.5.5 Maximum & Minimum Thermometer

The thermometer shall register both maximum and minimum temperature range (–) 43^{0}C to (+) 55^{o}C U shaped. High temperature at top of one side, low at top of other side metal floats rise with mercury column.

Range	:	660 to 800 mm Hg
Accuracy	:	0.33% of full scale.
Communication compatible to System	:	Interface connector RS 2328 IEEE 488 or
Sensitivity	:	0.2% of full scale
Scale length	:	16 Inches through 1 pointer revolution
Dial Diameter	:	6 Inches
Dial Calibration	:	Mm Hg. And Inches Hg.
Minimum Graduation	:	0.5 mm or 0.02 inches

14.5.6 Dry & Wet bulb Thermometer

This is shall be mercury filled wet and dry Bulb thermometers mounted on scales with amended graduations in 2^0 C intervals. Nominal range 10º C to 50º C.Hand blown glass cistern.Overall dimensions 108 mm width x 225 mm high, with holes for wall mounting alongwith wick and booklet of relative humidity tables.

14.5.7 High Volume Sampler

High Volume Sampler to monitor Ambient Air Quantity i.e. Suspended particulate matter (SPM), Sulphur dioxide, Oxides of nitrogen, Carbon monoxide etc. High Volume sampler having a continuous duty blower with brushless motor, with low noise level, a light and compact model for field use.

Flow rate	:	0.8 to 1.7 m3/min
Particle Size	:	Down to 1.6 micron
Blower	:	Continuous duty with brushless motor
Sampling time Record	:	Time totalizer recorder for running time in hours
Automatic Sampling	:	24 Hr programmable timer.
Power requirement	:	220 Volts, Single phase AC

Accessories

Orifice flowmeter, "Time Totalizer", "Programmable Timer", "Instrument Cabinet", Filter Holder assembly, "Gas Manifold with 4 impingers etc."

14.5.8 Stack Monitoring Kit

Measures total quantity / volume of emissions. Determines velocity of gases Stack temperature Range

Ambient to 600^0 C read on a Digital Pyrometer

Stack velocity range	:	3 to 60 m/sec
Particulate sampling	:	2 to 30 lpm collection on thimble type filter upto 0.3 micron rating
Gaseous sampling	:	0.2 to 3 lpm collection in a set of borosilicate glass impingers.
Filter Holder	:	Fabricated from SS 304 tube suitable to hold either cellulose filtration thimble (Size28 mm IDx 100mm long) or glass micro fiber thimble (Size 19mm IDx90mm long) Probe set and set of interconnection hose pipes. Vacuum pump assembly

14.5.9 Portable Gas Analyser

Application	:	For field determination of the individual quantities of carbon monoxide, oxygen, NO, NO_2, SO_2 and hydro carbons from flue gas samples.	
Accuracy	:	O_2	- better than+ 1%
		$CO/SO_2/NO/NO_2$	- better than + 4%

14.5.10 Stop Watch

The stopwatch shall be compatible with the environment of operation.The stopwatch shall be adequate for the application and the mode of working.

Specifications:

Range stopwatch>59 minutes
Range count down 59 minutes
Resolution 0.1 s
Accuracy 0.1 s over 1 hour
Stopwatch modes lap time, split time
Display LCD, good visibility in daylight
Enclosure water resistant
Power supply standard button cell(s)
Battery lifetime >1 year
Instrument life time >5 years of operation
Temperature range 0 to 500C

Robustness: The instrument shall survive several drops on concrete housing splash waterproof

14.5.11 Assmann Psychrometer

This should be senior model with long stem and battery driven or mechanical driven fan, dry & wet bulb thermometer, having range of 300C to 500C with a least count of 0.050C.It should be provided with psychometric chart. O&M manual and leather carrying case.

14.6 LABORATORY EQUIPMENT – MISCELLANEOUS

S. No.	Description	Quantity	Make
1.	Personal computer	Three (3)	HP/DELL/LENOVO
2.	Sample cooler	One (1)	SHIVAM/SUNSHINE/SIPL
3.	Density Hydrometer	Five (5)	SHIVAM/SUNSHINE/SIPL
4.	Hot Air Dryer	One (1)	SHIVAM/SUNSHINE/SIPL
5.	Hydrometers	Five (5)	SHIVAM/SUNSHINE/SIPL
6.	Heating Mantel	One (1)	SHIVAM/SUNSHINE/SIPL
7.	Stainless Steel Filter Holder	One (1)	SHIVAM/SUNSHINE/SIPL
8.	Hygrometer	One (1)	SHIVAM/SUNSHINE/SIPL

14.6.1 Personal Computer

Operator Station (Personal Computer) for Gas chromatography & UV visible spectrometer shall have minimum 64 bit computers (on WINDOWS-11), 8 GB RAM, 1TB Hard Disk. All the peripherals such as DCV ROM, IJ Printer etc shall be provided for operator stations. There shall be VGA graphics cards. 32 inch size LED monitors shall have HD resolution with latest graphics mode with flash rate of 60 Hz.The keyboard shall be with minimum of 101 keys and shall have the latest proven technology.

14.6.2 Sample cooler

Sample cooler shall be efficient counter-flow heat exchange designed for the cooling of high temperature, high pressure fluid samples, e.g. Boiler Water, Steam Feed Water, etc. for tests at atmospheric pressures and temperatures.The pressure rating on the coil should be 420 kg/cm2 at 400^0 C. Rugged, coil within shell construction should ensure trouble-free service.Inner

coil should be of Inconel seamless tubing and outer shell of Type 304 SS seamless tubing. Internal cooler baffling should be arranged for maximum rate of heat transfer and low coolant pressure loss.The cooler should be conveniently attachable with any piping system.Mounting is to be facilitated by clamp type brackets, but the unit should be suitable for mounting " in the piping".

Terminal connections should be clearly marked, showing cooling water and sample inlets and outlets.Coolant connections should be ½" NPT.A metal name plate showing flow should be permanently attached.

The sample cooler should be suitable for sampling Boiler Water, Steam having initial conditions corresponding to all present power stations, maximum conditions, providing the cooling water is flowing.Each unit should be hydrostatically tested at room temperature to 630 kg/cm2 on the inner coil and 26 kg/cm^2 on the outer shell.

Max. operating pressure	:	420 kg/cm2
Max. operating temperature	:	400^0 C.
Sample connections	:	½" NPT
Net weight	:	Approx. 3.5 kgs.
Shell maximum WP	:	-
Pressure Drop – Shell	:	0.2 kg/cm^2 at 700 lit. per hour (water flow)
Coil	:	3.88 kg/cm^2 at 115 kg/hr (water flow)

14.6.3 **Density Hydrometer**

Hydrometer shall be made of glass graduated in units of Density conforming to ASTM-Specification E-100 and calibrated at 150C.Suitable for determination of density of hydrocarbons:-

S. No.	Range	Subdivisions	Quantity
1.	0.70 to 0.75	0.001	2 Nos.
2.	0.75 to 0.80	0.001	2 Nos.
3.	0.80 to 0.85	0.001	2 Nos.
4.	0.85 to 0.90	0.001	2 Nos.
5.	0.90 to 0.95	0.001	2 Nos.
6.	0.95 to 1.00	0.001	2 Nos.

14.6.4 **Hot Air Dryer**

Electrically operated and portable type hot air dryer for general drying purpose. It shall comprise of electric motor and about 500 W heater enclosed in light weight, but high impact thermoplastic. It should be provided with 3-way switch (Off, Cool, Hot).

Maximum air flow temperature: 70^0C.

Air delivery : 3-4 cubic feet per minute.

It shall be supplied with 7 feet 3 conductor cord & 3 prong plug for use at 220V, 50 Hz AC supply.

14.6.5 **Hydrometers {Quantity: Five (5)}**

Hydrometer set is used for the measurement of specific gravity of liquids (such as Sodium Hydroxide & Hydrochloric Acid).It should have a length of 300 mm and made of Pyrex / borosilicate glass.

S. No	Range of Sp. Gravity	Division	Quantity
1.	0.800 – 1.000	0.002	3 Nos.
2.	0.950-1.250	0.002	3 Nos.
3.	1.200-1.420	0.002	3 Nos.
4.	1.420-1.620	0.002	3 Nos.

These shall be supplied with a thermometer (0 to 500C x 0.10C) in a leather case.

14.6.6 Heating Mantel

Mantle shall fit snugly against spherical/flat bottom flasks upto 2000 ml capacity. It should heat upto 450oC through flexible, knitted, glass wool fabric with coiled heating elements, supported in solid aluminium housing. The mantle shall be with built-in, continuously variable current controller, pilot lamp for heater operation and power with support bracket for 13 mm dia rod.

Note:

(i) All reagents shall be of 'AR' grade.

(ii) All Chemicals for PT/DM/ETP Operation shall be in Bidder's Scope

14.6.7 Hygrometer {Quantity: Five (5)}

Air hygrometer shall come with silver metal scale 0 to 100 x 1% RH. It shall be accurate to + 3% RH in the range of 30-90% at temperatures upto 45^0 C.The assembly should be enclosed in a chromium plated case of about 125 mm dia. It shall have provision for hanging on the wall.

14.7 LIST OF GLASS WARES & ACCESSORIES

S. No.	Description	Capacity / Size	Qty.
1	Bottles reagent plain narrow mouth with inter changeable flat head stopper	125 ml	12
		250 ml	24
		500 ml	24
		1000 ml	24
		2000 ml	12
2	Bottles reagent amber narrow mouth with interchangeable flat head stopper	125 ml	12
		250 ml	12
		500 ml	12
		1000 ml	12

S. No.	Description	Capacity / Size	Qty.
3	Bottles weighing with stopper	25 ml	6
		40 ml	6
		50 ml	6
		60 ml	6
4	Bottles dropping with 9.5 ml dropper	50 ml	6
		100 ml	6
5	Bottles dropping clear glass T.R. pattern with slotted ground glass stopper	50 ml	6
		100 ml	6
6	Bottles dropping amber glass T.R. pattern with slotted ground glass stopper	50 ml	6
		100 ml	6
7	Bottle gas washing complete with interchangeable stopper	125 ml	12
		250 ml	12
		500 ml	12
8	Bottle gas wash complete with interchangeable stopper	500 ml	6
		1000 ml	6
9	Bottles, relative density, accuracy as per IS 5717-1970 with capillary bore, interchangeable stopper	25 ml	6
		30 ml	6
10	Bottle, Aspirator with cap & outlet for tubing	200 ml	6
11	Beaker with spout	50 ml	24
		100 ml	24
		250 ml	24
		400 ml	24
		600 ml	12
		1000 ml	10
12	Buretts straight biore stop cock PTFE with capillary outlet, graduation on 0.1 ml class B of IS 4162 – 1991 with works certificate	25 ml	6
		10 ml	6
		50 ml	12
		100 ml	12
13	Pipettes volumetric with one bulb accuracy as per class B of IS 4162 with works certificate	10 ml	12
		20 ml	12
		25 ml	24
14	Pipettes (Mehr type) accuracy as per class B of IS 4162 -1967 with works certificate	1 ml	12
		1 ml	12
		2 ml	12

S. No.	Description	Capacity / Size	Qty.
		2 ml	24
		5 ml	24
		5 ml	24
		10 ml	24
15	Funnels, filtering with long stem	75 ml	24
		100 ml	24
16	Funnels, filtering with short stem	150 ml	12
		200 ml	12
17	Funnels, separating with stop cock and interchangeable stopper, globe shaps corning	250 ml	12
		500 ml	6
18	Buchner tunnel with sintered Disc	75 mm	3
19	Flasks, separating with stop cock and interchangeable stopper, globe shape	150 ml	12
		250 ml	24
		300 ml	24
		100 ml	6
20	Flasks volumetric with ground glass stopper accuracy as per class B, IS 915	50 ml	24
		100 ml	24
		250 ml	12
		500 ml	6
		1000 ml	6
		2000 ml	10
21	Cylinder with spout, graduated in 0.1 ml	25 ml	12
		50 ml	12
		100 ml	12
		250 ml	6
		500 ml	6
		1000 ml	6
22	Measuring cylinder with interchangeable stopper Class 'A' accurancy graduated in 1.0 ml	10 ml	20
		50 ml	6
		100 ml	6
23	China dish.	100 ml	12
		250 ml	12
24	Dishes (crystalising)	100x50 mm	6
		150x75 mm	6
		190x108 mm	6
25	Dishes, evaporating flat bottom with pour out	80x75 mm	12
26	Desicoator with knob, cover and porcelain plate	ID 250 mm	4
27	Distillation trap with Graham condenser,	5 ml	6

S. No.	Description	Capacity / Size	Qty.
	interchangeable stopper for determination of moisture by distiliation process as per ASTM D95 and ASTME 123	10 ml	6
		25 ml	6
28	Glass Tubing –Tube size		
	4 mm bore		5 Kg
	5 mm bore		5 Kg
	10 mm bore		5 Kg
29	Glass Rod – Rod size		
	3 mm dia		5 Kg
	5 mm dia		5 Kg
	10 mm dia		5 Kg
30	Glass cover circular swallow type with ground glass	100 mm	12
		150 mm	12
31	Iodine flasks with interchangeable stopper	250 ml	6
		500 ml	6
32	Porcelain morter with pastel. The pastel fitted with wooden handle	150 mm dia	6
33	Agati Morter and Pastel	8 mm dia	3
34	Porcelain tiles glazed size	6" x 6"	24
35	Porcelain crucibles with lid for temperature upto 1200 deg.C capacity	50 ml	12
36	Porcelain disc filtering perforated	2 mm	12
37	Polythene reagent bottles with wide mouth	100 ml	24
		250 ml	24
		500 ml	24
		1000 ml	24
38	Polythene reagent bottles with narrow mouth	100 ml	24
		250 ml	24
		500 ml	24
		1000 ml	24
39	Polythene carbuoys with washer attached lid	1.0 lt	12
		2.5 lt	24
		5.0 lt	24
		10.0 lt	12
		20.0 lt	12
40	Polythene buckets	10 lt	12
		15 it	12
41	Polythene wash bottles	1000 ml	12

S. No.	Description	Capacity / Size	Qty.
42	Polythene beakers	100 ml	12
		250 ml	12
		500 ml	12
		1000 ml	12
		2000 ml	12
43	Polythene tubing in rolls of 30 meter, size ID/OD	3/5 mm	1 roll
		5/7 mm	1 roll
		6/8 mm	2 roll
		8/10 mm	2 roll
		10/12 mm	2 roll
44	Aspirator bottles made of polythene with plastic screw in cap, handle and stop cock	500 ml	6
45	Bottle alikathene seqeeze with jet	500 ml	12
46	PVC tray rigid with handle size 450x300x15 mm		15
47	Rubber bladder	5”	24
48	Rubber tubing (pressure) in rolls of 30 meters ID/OD	5/10 mm	1 roll
		8/15 mm	1 roll
		10/15 mm	1 roll
49	Rubber tubing thickness 1 to 2 mm rolls of 30 mtrs OD	5 mm	1 roll
		6 mm	1 roll
		7 mm	1 roll
		8 mm	1 roll
50	Tubes Nessler with graduation at 25 ml & 50 ml	100 ml	36
51	Test tube Borosil glass thick walled	50 ml	24
		100 ml	24
52	Test tube holder		12
53	Test tube stand, wooden, polished with 6 holes and 6 pegs for holding test tubes		12
54	Tripod stand		6
55	Bung rubber assorted size between 5 and 20 mm dia set consisting of 10 – numbers		1 set each
56	Spatula polished and flexible with this rounded ends, length 100 mm width 15 mm		12
57	Scoop, made of SS, length 60 mm		12
58	Burettle clamp metallic base with supporting rod and spring type holders for two burettes		12
59	Funnel holder wooden, for two funnels, opening diameter 50 mm		12

S. No.	Description	Capacity / Size	Qty.
60	Pipette stand, polythene to hold 12 pipettes, 6 on either side horizontally		12
61	Tongs ss (stainless steel) with flattened and curved tip length 400 mm		12
62	Tongs blackened steel with flattened and curved tip length 400 mm		4
63	Glass cutter		1
64	Redwood viscosity flask 50 ml		4
65	Brush round form made of camel hair in quill holder		12
66	Wire gauge made of galvanized iron, square mesh, and asbestos centre net size 150 x159 mm		6
67	Cork boring machines for boring holes in cork and compressed rubber corks complete with set of nickel plated steel borers of 3 to 25 mm dia 2 nos each		1
68	Platinum crucibles with ltd – capacity 30 ml, depth 30 mm inside dia 10 mm total weight approximate 30 gms inclusive of lid		3
69	Platinum dishes with crucibles type lid capacity 100 ml depth 30 mm, inside dia 75 mm, total wt, pprox. 60 gms inclusive of lid		1
70	Stopwatch in metal body for 1 hour duration		2
71	Sprit lamp		2
72	Dean & strak apparatus for determination of moisture oil (round bottom flask capacity 500 ml, condenser & receiver 25 ml full set corning		3
73	Asbestoses gloves		6 pairs
74	Rubber Gloves Acid / alkali proof		12 pairs
75	Tissue paper	75 mm dia	100 rolls
76	Suction Bellow		12
77	Flasks volumetric with ground glass stopper as per class B, IS 915	2000 ml	10
78	Titration/Conical Flasks	100 ml	20
		250 ml	50
		500 ml	25

Note : All Glass wares shall be from Borosil

14.8 LIST OF CHEMICALS

S No.	Description	Capacity / Size	Qty.
		Unit	
1	Acetic acid glacial	2.5 lts	2.5x3
2	Acetone	2.5 lts	2.5x4
3	1-Amino-2-Naphthol-4-sulphonic acid	25 gms	25x8
4	Alkali blue indicator	100 gms	100
5	Ammonia solution about 25% pure	2.5 lts	2.5x10
6	Ammonia buffer solution	500 ml	500x40
7	Ammoniam chloride	500 gms	500x12
8	Ammoniam molybdate	1.0 kg	1x20
9	Ammoniam purporate (mureide) indicator	5 gms	5x8
10	Anhydrous calcium chloride fused	20 gms	1x20
11	Amylum soluble	500 gms	500x40
12	Aluminium for estimation of aluminium	20 gms	1x20
13	Barium chloride	500 gms	500x8
14	Benzene	2.5 lts	2.5x4
15	Bromocresol (indicator) green	5 gms	5x4
16	Bromocresol (indicator) purple	5 gms	5x2
17	Calcium Acetate	50 gms	50x10
18	Calcium chloride	500 gms	500x2
19	Carbon tetrachloride	500 gms	500x5
20	Calgon (indicator) for hardness determination	5 gms	5x4
21	Chlorotex reagent for determination of chlorine content	100 ml	100x30
22	Citric acid	1 kg	1x20
23	Concentrated nitric acid (concentration 69 to 72%)	1 lts	1x10
24	Cobaltus chloride	500 gms	500x40
25	Copper sulphate	500 gms	500x6
26	Dextrose (D glucose)	500 gms	500x8
27	Dipotassium hydrogen orthophosphate	500 gms	500x4
28	EDTA solution 0.02 N	500 ml	500x24

S No.	Description	Capacity / Size Unit	Qty.
29	Erichrome black T (solochrome black) indicator	200 gms	25x8
30	Ethylene diamine tetra acetic acid	10 gms	100x20
31	Ferric chloride anhydrous	500 gms	500x4
32	Ferrous ammoniam sulphate	500 gms	500x6
33	Fusion mixture	500 gms	500x4
34	Glycerol	2.5 lts	2.5x4
35	Hexamine	500 gms	500x2
36	Hydrochloric acid	2.5 lts	2.5x16
37	Hydrazine sulphate	500 gms	500x2
38	Hydrofluoric acid	500 ml	500x6
39	Hydrogen per oxide purified 30% W/V	500 lts	500x8
40	Hydroxyl amine hydrochloride	500 lts	500x4
41	Indigo carmine (indicator)	25 gms	25x8
42	Iodine resublimed	100 gms	100x8
43	Lead nitrate	500 gms	500x2
44	Manganous chloride	500 gms	500x2
45	Mercury	250 gms	25x12
46	Mercuric chloride	250 gms	250x8
47	Methanol	500 ml	500x60
48	Methyl orange indicator	50 gms	50x10
49	Methyl red indicator	50 gms	50x2
50	N.T. Napthyl ethylene diamine dithudrochic ride	10 gms	10x2
51	Oxalic acid grade purified	500 gms	500x6
52	Ortho Phosphoric acid	1.0 lts	1x5
53	Ortho phenanthrolein	5 gms	5x10
54	Perchloric acid	500 ml	500x8
55	Para dimethylamius benzaldehyde	100 gms	100x5
56	pH Buffer Tablets 4,7,9.2,10		5 packs each of 10 tablets
57	Potassium Bromate	100 gms	100x5

S No.	Description	Capacity / Size	Qty.
		Unit	
58	Potassium Bromide	100 gms	100x5
59	Phenolpthalein powder	50gms	50x10
60	pH indicator paper wide range in boxes of booklet range 2 to 10.5		20 boxes
61	Potassium chromate	500 gms	500x4
62	Potassium dichromate	500 gms	500x5
63	Potassium chloride puri fied	500 gms	500x6
64	Potassium hydroxide pure pellets	500 gms	500x40
65	Potassium iodide	500 gms	500x12
66	Potassium nitrate purified	500 gms	500x4
67	Potassium pemanganants purified	500 gms	500x4
68	Potassium metabisulphite	500 gms	500x20
69	Pyrogallol	100 gms	100x20
70	Silica gel indicating type	500 gms	500x4
71	Silver nitrate pure	100 gms	100x5
72	Silicone grease	100 gms	100x10
73	Sodium acetate	500 gms	500x6
74	Sodium carbonate anhydrous	500 gms	500x4
75	Sodium hydroxide pellets purified	500 gms	500x20
76	Sodium chloride crystal pure	500 gms	500x8
77	Sodium diethyl dithe carbomate	100 gms	100x5
78	Sodium nitrate	100 gms	100x5
79	Sodium Nitrite	250 gms	250x4
80	Sodium thiosulhate	500 gms	500x6
81	Sodium potassium tartarate	500 gms	500x4
82	Sodium sulphate	500 gms	500x4
83	Sulphuric acid	2.5 lts	2.5x10
84	Sulphasolicylic acid	500 gms	500x2
85	Sulphanilic acid	100 gms	100x5
86	Sulphanilenide	50 gms	50x10
87	Tin granule	250 gms	250x2

S No.	Description	Capacity / Size Unit	Qty.
88	Thorium Nitrate	250 gms	250x1
89	Toluene rectified	500 ml	500x20
90	Universal indicator	100 ml	100x110
91	Xylene rectified	2.5 lts	2.5x6
92	Xylenol orange indicator	5 gms	5x8
93	Zinc granule reagent grade	500 gms	500x2
94	Filter paper whattman make sheets, packed in boxes of 100 sheets		8 boxes
95	Filter paper whattman make		
	15 cm dia No. 40		6 boxes
	15 cm dia No. 41		6 boxes
	15 cm dia No. 42		6 boxes
96	Benzoic acid AR grade	500 gms	500x6
97	Ammonium per sulphate AR grade	500 gms	500x6
98	Mercuri thio cynate AR grade	500 gms	500x6
99	Rectified spirit AR grade	1 lts	1x10
100	Potassium thio cynate AR grade	500 gms	500x6
101	P&R (Pettern & Reader) indicator	100 gms	100x5
102	Starch	500 gms	500x2
103	Sulphanilamide AR grade	500 gms	500x2
104	Phenole sulphonic acid AR grade	500 ml	500x2
105	Stannous chloride AR grade	100 gms	100x10
106	Potassium hydrogen phthalate (PHP) AR grade	100 gms	100x10
107	Std iron as Fe 1.0 ml = 1.0 mg (1000ppm)	500 ml	500x4
108	Std silica as Si 1.0 ml = 1.0 mg (1000ppm)	500 ml	500x4
109	Std phosphate as P_2O_5 1.0 ml = 1.0 mg (1000ppm)	500 ml	500x4
110	Std hydrazine 1.0 ml = 1.0mg (1000ppm)	500 ml	500x4
111	Std chloride as Cl^- 1.0 ml = 1.0mg (1000ppm)	500 ml	500x4
112	Std nitrite as NO_3 1.0 ml = 1.0mg (1000ppm)	500 ml	500x4
113	Std magnasium as Mg 1.0 ml=1.0mg (1000ppm)	500 ml	500x4

S No.	Description	Capacity / Size Unit	Qty.
114	Weight balance 100 kg capacity (min. disply - 1 gm)	_	1 no.
115	Ampules of IN HCL		2 sets
116	N/10 N HCL,		2 sets each
117	IN NaOH		2 sets
118	N/10 NaOH		2 sets
119	N/10 Ag NO_3		2 sets
120	N/10 $KMNO_4$		2 sets
121	N/10H_2SO_4		2 sets
122	Sodium Sulphide	500 gm	2 nos
123	Sodium metabisulphite	500 gm	10 nos
124	Sodium Sulphite Anyhydrous	500 gm	4 nos
125	Triethanolamine	500 ml	6 nos
126	Ethanol	500 ml	6 nos

All Reagents shall be of AR/ER/GR Grande only from MRECK/ SDFINE CHEMICALS.

ALL THE LAB EQUIPMENT AND CHEMICALS SHALL BE HANDED OVER TO THE OWNER BY THE EPC CONTRACTOR AFTER SUCCESSFUL TRIAL OPERATION

CHAPTER – 15

CIRCULATING WATER (CW) & AUXILIARY COOLING WATER (ACW) SYSTEM

CONTENTS

CHAPTER – 15

CIRCULATING WATER (CW) & AUXILIARY COOLING WATER (ACW) SYSTEM

15.1 SYSTEM DESCRIPTION

The Circulating Water (CW) system envisaged for the unit is open re-circulating type with natural draught cooling tower using filtered water as make-up. The system shall be designed to operate at 5 cycles of concentration (CoC). The CW water shall be used to dissipate heat absorbed from condersor and dispose off to atmosphere through NDCT. Similary Auxiliary Cooling Water (ACW) system shall dessipate heat gained through the Plate Heat Exchangers (PHEs) and directly from various plant auxiliaries to atmosphere.

15.2 CODES AND STANDARDS

The design, manufacture, inspection and testing shall comply with all currently applicable standards. In particular, the equipment shall conform to the latest edition of the following standards:

1) Hydraulic Institute Standards, USA.

2) IS 1710 : Vertical wet pit turbine pumps for clear and fresh water.

3) IS 5120 : Technical Requirement of Rotodynamic Special Purpose Pumps

4) ISO 2548 : Acceptance tests for centrifugal, mixed flow and axial pumps.

5) JIS B 8301 : Testing methods for centrifugal pumps, mixed flow pumps and axial flow pumps.

6) JIS B 8302 : Measurement methods of pump capacity.

7) JIS B 8327 : Pump performance testing method using model

8) BS-3435 : Measurement of electrical power and energy in acceptance testing.

9) AWWA C504: American Water Works Association standard for Rubber seated Butterfly valve

15.3 SCOPE OF SUPPLY

"The capacity/capacities specified herein are the minimum requirements and any increase in the capacity/capacities during detailed engineering shall be taken care of by the Bidder without any price implication."

The CW & ACW System shall include, but not limited to, the following:

- Three (3) (2W+1S) – Vertical wet pit turbine pumps Circulating Water (CW) Pumps, each with associated motor drives and complete with all accessories such as base plate, sole plate, foundation bolts and nuts, anchor, sleeves, stuffing boxes (if applicable), thrust pads etc as required**.**

- Two (2) (1W+1S) – Vertical wet pit turbine pumps Auxilary Cooling Water (ACW) Pumps each with associated motor drives and complete with all accessories such as base plate, sole plate, foundation bolts and nuts, anchor, sleeves, stuffing boxes (if applicable), thrust pads etc as required.

- CW pipe from CW pump discharge to common header, common header to the Condensers, Condensers to the Cooling Tower with all associated flanges, gaskets, man-holes, instrument tapings with root valves / thermo wells, pipe supports, clamps, thrust blocks and other accessories. ACW piping from ACW pump to PHE & other auxiliaries and back to CW return header with all associated flanges, gaskets, man-holes, instrument tapings with root valves/thermo wells, pipe supports, clamps, thrust blocks and other accessories. CW pipe filling line from ACW discharge header to CW pipe with motorized isolating valve. For carrying circulating water from CW pump house to TG-area (near condenser) and from TG-area to cooling tower CW pipes (buried) shall be of MS construction. At pump discharge (i.e for interconnecting pipe with CW pump), condenser risers including header near condenser and cooling tower risers MS pipes shall be used. For MOC & further details refer chapter-27 (Low pressure piping, valves & specialties).

- Electric actuator (with integral starter) operated Butterfly valves with all accessories, counter flanges etc at the discharge of each CW & ACW pump, cooling water inlet / outlet connections to the Condensers/pipe interconnections and as decided by flow diagrams (In water service valves above 200 NB size may be butterfly valves as specified in Chapter-27).

- Rubber expansion joints and/or pressure equalising REJ at the discharge of each CW & ACW pump and at any other locations as may be required based on the layout of CW piping.Rubber expansion joint with counter flanges, accessories including control rod assemblies, bolts, nuts, washers, gaskets for each CW pump/ACW pump shall suit pump discharge pipe/divergent cone.

- Vents,ARVs along with its isolation valves and drain valves as per the system layout requirements. Surge analysis (hydraulic transient analysis of CW/ACW piping) to establish the quantity & sizing of air release valves (ARV s shall be of minimum 200 NB size).

- Stop log gates and coarse screens at up stream of CW & ACW Pumps.

- EOT crane for handling pumps, motors and other equipment in the CW pump house. Capacity selection of the crane shall be as per stipulations given in Chapter-28 (Cranes & Hoists).

- Electric hoists for handling stoplog gates and coarse screens.

- Two (2) (1W+1S) Automatic self cleaning filters in discharge header of ACW pumps as detailed below and in the corresponding datasheet.

- The protection, control and monitoring of the CW & ACW system including the CW & ACW pumps, Butterfly Valves and any other equipment in the system shall be implemented through DCS. The central control room operator shall be able to start and stop the CW & ACW pumps and its auxiliaries sequentially and should also be able to operate and control them individually from the operator stations from central control room.

- Thrust blocks for CW & ACW pipe to counter the thrust generated while the system is in operation. These thrust forces shall be calculated considering normal operation, surge generated, water hammer, vaccume generation and any other condition as can be encountered during operation.

- Model tests and Flow tests for CW & ACW pumps, CWPH in-take channel/sump for selection of optimum layout for the system.

- Condenser onloads tube cleaning system as detailed elsewhere in tender specification.

- The pump house shall also accommodate the following equipment facilities

  - All auxiliary equipment related to pump sets such as discharge piping complete with valves and specialties, electric motors etc.

  - Ventilation system for pump house.

  - Air conditioning for CW control room

  - Separate bays for unloading and maintenance.

  - Electrical equipment such as switchgears, MCCs, control panels, MLDBs etc. in Electerical switchgear rooms and control panel rooms as specified and detailed in Vol-V: Electrical works.

  - Sump pits and sump pumps as per requirement to have effective draining provision in pump house and forebay.

  - Cranes and hoists as specified in Volume III, Chapter 28.

  - Gates & screens located suitably.

  - Necessary toilets with basin & mirror and operator's cabin with drinking water facility.

  - Suitable staircases and platforms shall be provided for access and maintenance of all equipment on the pump house.

  - Other general layout criteria and guidelines as specified in Volume III.

15.4 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS FOR CW AND ACW SYSTEM

15.4.1 The CW and ACW system shall be capable of delivering satisfactory plant operation at the highest anticipated cooling water temperature and worst ambient conditions without any reduction in the rated output.

15.4.2 The CW and ACW systems shall be adequately dozed with Chlorine to arrest biological growths. The Cycle of Concentration for the above-mentioned systems shall not fall below 5 under any circumstances.

15.4.3 The temperature at outlet of the Cooling Tower for design purposes shall be 33^0 C considering cooling tower approach of 5^0 C (max) at rated conditions and design inlet air Wet Bulb Temperature to be 28^0 C. However, the same shall be substantiated by the Bidder by detailed calculations enclosed along with the Bid Proposal.

15.4.4 The required cooling water flow for the CW system shall be worked out by the bidder considering the maximum possible thermal load condition encountered in condenser and CW temperature rise. The design CW flow shall be computed by the bidder considering a minimum of five (5) % margin (i.e. 5% margin over and above the required CW flow) as computed out above and shall be substantiated by the Bidder after conducting optimization studies.

A minimum of 10% margin on frictional losses assuming C=100 on Hazen William's formula for design purposes based on respective pumping capacity as obtained above.

15.4.5 The design flow rate of Auxiliary cooling water (ACW) in ACW system for the unit shall be assessed as per the following guideline:

Qd = Q1; where Qd is the design ACW flow for the unit

Q1 = Total required ACW flow rate in all the operating PHEs for the unit + Total required ACW flow for other coolers of the unit.

The design flow rate in the filtered water (acw) side of the operating PHEs for the unit shall be considered same as the design DMCW flow rate, with the average temperature rise of ACW limited to 5.5^0 C under all circumstances. The design ACW flow rate shall be equally shared by the operating PHEs.

Capacity of ACW pump shall be fixed by taking 10% (minimum) margin on design ACW flow.

A minimum of 10% margin on frictional losses assuming C=100 on Hazen William's formula for design purposes based on respective pumping capacity as obtained above.

15.4.6 The Bidder shall carry out optimization studies on CW system encompassing CW pumps, ACW pumps, Condensers, Cooling Towers and other equipment to suit the parameters obtained after such studies.

15.4.7 The velocity of water in the CW and ACW system shall not exceed 2.0 m/sec. All interconnecting piping and equipment handling CW/ACW shall be designed to withstand a pressure not less than the shut off head of CW/ACW pump respectively.

15.4.8 Underground CW and ACW piping shall be provided with suitable protective coating/wrapping and shall be suitably stiffened to withstand soil loads and loads due to heavy vehicles at road crossings.

15.4.9 Butterfly valve design pressure and closing time shall take into account the effects of water hammering and surge.

15.4.10 The Bidder shall design the CW/ACW pump house by considering the following layout criteria as specified below:

i.) The pump house shall accommodate Three (3) CW pumps and Two (2) ACW pumps.

ii.) The CW/ACW pump house fore bay shall be sized to receive water from cold-water basin of the cooling tower. The angle of inclination of the sidewalls of this fore bay with the direction of water flow shall not exceed as specified in HIS under any circumstances.

iii.) Each individual sump in the CW Pump house shall be designed in accordance with the recommendations specified in Hydraulic Institute/British Hydraulic Research Association/equivalent international standard and its dimensions shall be finally selected after conducting necessary sump model tests by the Bidder.

iv.) Each CW pump and ACW shall be located in a separate sump.

v.) The minimum level of water for CW and ACW pumps shall be guided by the minimum submergence level required by the respective pumps and shall be obtained and informed by the Bidder.

vi.) The highest level of water in the CW pump house shall be such as to ensure around 500 mm clearance below the soffit of the lowest floor of the pump house. The dimensions of each respective sump shall be selected in such a manner that under all operating circumstances the net positive suction head available shall be sufficiently greater than the net positive suction head required, for each pump.

vii.) Adequate provision shall be made in each of the pump sump so as to facilitate insertion of isolation gates. Gates shall be fabricated from mild steel, shall be water tight type and shall preferably be of identical size/dimensions to facilitate interchange ability. Sump gates shall be accessible by the pump house overhead crane.

viii.) In addition to all the CW and ACW pumps along with their auxiliaries, the CW/ACW pump house shall accommodate the following equipment/ facilities also:

- Ventilation System.
- Gates & screens located suitably
- Separate bays for unloading and maintenance purposes.
- Electrical equipment such as switchgears, MCCs, Control Panels, MLDBs etc. in Electrical Switchgear Rooms and Control Panel Rooms as specified and detailed in Volume IV: Electrical Works of this specification.
- Overhead E.O.T. crane as specified elsewhere in this specification.
- Sump pits and Sump pumps as per requirement to have effective draining provision in pump house & forebay.
- Required number of Toilets (gents & ladies)
- Operator's cabin with drinking water facilty.
- Suitable staircases & platforms shall be provided for access and maintenance of all equipment in the pump house.
- Other general layout criteria and guidelines as specified in Volume III of this specification shall also be strictly adhered to while designing the Pump house.

15.4.12 Range of operation of the CW pumps shall be so selected that it can accommodate the following mode of operation.

The CW pumps shall be capable of delivering a flow and TDH even at minimum water level in its sump.

One (1) pump operation during half condenser in service at HHWL in the CW sump.

Two (2) pumps operation in service and LLWL in the CW sump.

15.5 INSTRUMENTATION AND CONTROL FOR CW & ACW SYSTEM

15.5.1 Circulating Water (CW) pumps, Auxiliary Cooling Water (ACW) pumps and Butterfly valves shall be controlled and operated from local panels with repeat operation from the central control room DDCMIS. The system shall be connected to DDCMIS thru necessary harware. For other details, Bidder shall refer Volume V of this specification.

15.5.2 Starting and stopping of CW and ACW pumps shall be suitably interlocked with the opening and closing of butterfly valves respectively in the discharge line of the pumps. Closed valve starting of CW and ACW pumps is preferred.

15.5.3 An interlock shall trip all running CW pumps from very low level of water in the sump of the CWPH. To achieve the above interlock, there shall be three (3) level switches, which shall operate on two (2) out of three (3) logic. Two (2) other level switches shall also be provided which shall generate alarm in case of low level in the sump.

15.5.4 Auxiliary Cooling Water (ACW) pumps shall have auto starting facility. The standby pump shall be started automatically in case of tripping of any running pump or if its discharge header pressure falls below a preset low value.

15.5.5 Each CW & ACW pump (and associated motors) shall have vibration monitoring facility. Bidder shall provide the necessary vibration transducers, monitors and suitable pads etc. Bidder shall mount the necessary mounting pad for these vibration transducers. Bidder shall also furnish necessary data/ documents of Vibration Monitoring System during detailed engineering stage.

15.5.6 CW & ACW pump motor bearing & winding temperature shall be monitored from local as well as remote.

15.5.7 The CW and ACW pumps shall be equipped with the following safety features:

(a) Thrust bearing temperature high - annunciation.
(b) Thrust bearing temperature very high - annunciation and trip.
(c) Motor winding temperature high - annunciation.
(d) Motor winding temperature very high - annunciation and trip.
(e) Pressure on pump discharge high due to accidental closure of valve - trip and annunciation.
(f) Auxiliary cooling water flow and pressure very low – annunciation and trip, if necessary.
(g) Sump level high and low - annunciation.
(h) Sump level very low - annunciation and trip.
(i) Bearing vibration high - annunciation and trip.
(j) Any other protective feature deemed necessary for safe and reliable operation.

15.5.8 Instrumentation and control detailed above is indicative minimum and Bidder shall furnish the complete interlock scheme for CW/ACW system equipment proposed by him alongwith drawings, with the Bid Proposal. However, the interlock scheme to be adopted shall be finalised in consultation with successful Bidder during detailed engineering phase of the project.

15.5.9 Necessary instrumentation as represented in relevant tender drawing enclosed and as required achieving the above operation philosophy shall be indicative minimum for the systems and shall be provided by the Bidder. For detailed hardware specification of instruments, Volume-V of this specification shall be referred to.

15.6 DESIGN CRITERIA

A. FOR CIRCULATING WATER (CW) PUMPS

a) Three (3) (2 working + 1 stand by) Circulating Water (CW) pumps shall be provided to cater the cooling water requirement of condensers of 800 MW steam turbine. These pumps shall be installed in the Circulating Water Pump House.

b) The pumps shall be vertical, constant speed, wet pit, mixed flow design, with single stage impeller, suitable for continuous heavy duty. The pump shall be directly driven by a constant speed squirrel cage induction motor. The pump shall have a flanged discharge connection.

c) Total head of the pump shall be calculated as a sum of the following:

- Static lift from minimum water level in CW sump to the highest point of cooling tower hot water distribution system.
- Discharge velocity head Friction drops in the entire CW system (including cooling tower) with 10% margin on the same and exit losses.
- Pressure drop across the condenser.
- Pressure drop due to condenser tube cleaning system.
- The bowl head of the pump shall be calculated by adding the losses through the pump column, discharge elbow and entry losses at suction to the total head of the pump as calculated above.
- The selected head of CW pump shall provide for adequate margin so that pumps are capable of supplying equipment design flow at 47.5 Hz frequency of power supply.

d) Pump shall preferably be designed with separate thrust bearings at pump and motor or as per manufacturer's standard practice. Thrust bearing shall be oil lubricated, centrally pivoted tilting pad type capable of absorbing axial thrust in both directions of rotation. The thrust bearing shall be sized for continuous operation to withstand the thrust developed when the impeller clearance is worn out up to 4 times the clearance when the pump is new and working under shut off condition. The pump shall be provided with an approved mechanical device to prevent reverse rotation on loss of drive motor power orfailure of discharge valve to close.

e) The pump & motor assembly shall be supported by two (2) floor arrangement. The lower floor will be provided below the discharge flange to provide an access to the discharge connections. The discharge head shall have a flanged discharge connection. The contractor shall provide a suitable 100% leak proof sealing joint between the lower floor and pump column to prevent water entry from below. The sealing joint shall be designed for the water pressure. Bidder must furnish the details of sealing joint along with the bid. The piping supports and pump foundation bolts shall be designed to withstand trust generated particularly under shut off condition.

f) The design, construction and speed of the pumps shall be such as to minimize cavitation and ensure a long and trouble free service. The suction specific speed required (i.e. specific speed calculated with NPSH required) of the pump shall not exceed 12,000 (US Units).

g) The system suction specific speed (i.e. specific speed calculated with NPSH available) shall not be greater than 8500 US units at minimum water level. Bidder shall note that the design suction specific speed available shall be based on actual operating experience of the bidder. Pump speed shall be based on the above suction specific speed available.

h) Suitable arrangement shall be provided to take care of the discharge hydraulic thrust. This may be achieved either by sizing pump discharge head and base plate adequately to take care of the discharge hydraulic thrust or by providing a thrust block assembly to restrain the discharge hydraulic thrust.

i) The pump shall be provided with an approved mechanical device to prevent reverse rotation on loss of drive motor power and failure of discharge valve to close. Bidder shall furnish full details of his previous experience on such non-reverse ratchets in similar installations. However, the pump and motor (complete assembly) shall be designed for withstanding the runaway speed attained with reverse rotation caused by reverse flow continuously when the other working pumps in parallel are in simultaneous operation.

B. FOR AUXILIARY COOLING WATER PUMPS

a) Two (2) (1W + 1S) Auxiliary Cooling Water (ACW) pumps shall be provided to cater the heat load of all equipments forming power plant unit. These pumps shall be installed in the Circulating Water Pump House.

b) The pumps shall be vertical, constant speed, wet pit, mixed flow design, with single/multiple stage impeller, suitable for continuous heavy duty. The pump shall be directly driven by a constant speed squirrel cage induction motor. The pump shall have a flanged discharge connection.

c) Suitable arrangement shall be provided to take care of the discharge hydraulic thrust. This may be achieved either by sizing pump discharge head and base plate adequately to take care of the discharge hydraulic thrust or by providing a thrust block assembly to restrain the discharge hydraulic thrust.

d) The pump & motor assembly shall be supported on sinlge floor arrangement. The piping supports and pump foundation bolts shall be designed to withstand trust generated particularly under shut off condition.

e) The pump shall be provided with an approved mechanical device to prevent reverse rotation on loss of drive motor power and failure of discharge valve to close. Bidder shall furnish full details of his previous experience on such non- reverse ratchets in similar installations. However, the pump and motor (complete assembly) shall be designed for withstanding the runaway speed attained with reverse rotation caused by reverse flow continuously when the other working pumps in parallel are in simultaneous operation.

f) The design, construction and speed of the pumps shall be such as to minimize cavitation and ensure a long and trouble free service. The suction specific speed required (i.e. specific speed calculated with NPSH required) of the pump shall not exceed 12,000 (US Units).

g) The system suction specific speed (i.e. specific speed calculated with NPSH available) shall not be greater than 8500 US units at minimum water level. Bidder shall note that the design suction specific speed available shall be based on actual operating experience of the bidder. Pump speed shall be based on the above suction specific speed available.

C. GENERAL DESIGN REQUIREMENT FOR VERTICAL WET PIT PUMPS (CW & ACW PUMPS)

a) The operating range of operation of pumps shall generally be 40% to 120% of rated flow for sustained period of operation. However Bidder shall guarantee satisfactory performance of the pump of any point on this operation range with the minimum submergence available.

b) The critical speed shall be well away from the operating speed i.e. critical speed shall be less than 80% of the rated speed or more than 130% of the rated speed. Also, the critical speed of the pump-motor assembly shall be more than the maximum reverse run-away speed.

c) The vibration limits of the pump set measured at motor end shall not exceed 100 microns (maximum). Contractor should clearly bring out in his proposal the location and type of vibration pick ups recommended for monitoring purposes along with the values of High/High – High vibration for alarm/ trip etc. The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1M from the equipment surface.

d) The base plate, foundation bolts, motor stool and other components shall be designed to take the full force coming on the discharge elbow under shut-off condition.

e) Water for motor cooling and thrust bearing cooling, if required, shall be tapped from the discharge of the pumps and/or fed from an over-head tank as indicated in tender drawing. All piping, valves, strainer, instruments etc. required for this purpose and line shaft bearing lubrication (if required) shall be provided by the Contractor. Hence the

coolers shall be designed to operate satisfactorily with the cooling water discharge pressure available. Cooling water if required during starting of the pumps shall be arranged by the bidder by provision of valves piping etc.

f) The pump suction bell diameter shall be such as to limit the flow velocity at the maximum flow to within 1.5 m/sec.

g) Shaft selection shall be based on maximum torque the shaft is subjected to.

h) "Net Positive Suction Head (NPSH) required" shall be less than "NPSH available" during all operating conditions including run out condition.

i) The pumps shall have stable head capacity characteristic continuously rising towards shut off conditions. Characteristics of the maximum and minimum diameter impellers, which may be fitted to the volute, shall also be indicated by the Bidder.

j) These pumps shall be directly driven by a constant speed squirrel cage induction motor. Continuous motor rating (at 50 deg C ambient) for CW pump shall be fifteen percent (15) above the demand at duty point or ten percent (10%) above the maximum load demand of the driven equipment in the complete operating range (including run out condition of pump and shut off condition in case pumps are envisaged to be started with the discharge valve closed) whichever is higher to take care of the system frequency variation. All drive motors shall be as per relevant sub-section of electrical specification.

k) The design shall ensure equal load sharing among the pumps operating in parallel. All these pumps shall be identical to one another, shall have identical characteristic curves and shall be capable of running in parallel continuously without any restrictions.

l) The pump shall operate satisfactorily in isolation and in parallel with all other working pumps without cavitation, any deleterious effects, undue vibrations and noise at all water levels, from minimum to maximum. The impeller shall be of non-over-loading type to restrict motor overloading during single pump operation. Pumps shall be able to operate satisfactorily and continuously at run-out capacity conditions as determined with the help of system resistance curve.

h) The pump and motor (complete assembly) shall be designed for withstanding the run away speed attained with reverse rotation caused by reverse flow continuously even when all the remaining pumps are in operation. Necessary speed switches to detect reverse rotation shall be provided to prevent motor switching on while rotating in reverse direction. The indication shall also be provided for this purpose.

m) The predicted performance for various operating conditions specified above shall be furnished by the Bidder by super imposing the system resistance curves (both at minimum and maximum water level conditions) over the characteristic curves of the pump. Bidder shall confirm that the NPSH and submergence requirements are satisfied and pump shall be capable of sustained running in a trouble free manner at any water level between the minimum and maximum water level.

n) The pump shall also be designed to withstand the seismic loads as informed elsewhere in the specification.

o) The length of shaft and column sections shall not exceed 3M. The column pipe shall have a wall thickness of not less than 12 mm.

p) The impeller shall be fastened to the shaft such that the connections withstand maximum torque and thrust that may occur under all operating conditions including maximum reverse rotation. The line shaft bearings shall be spaced so as to ensure smooth operation and to contain the vibration within permissible limits. The bearings shall be amply proportioned to give long and satisfactory life.

q) Suitable staircases and platforms shall be provided for access and maintenance of all equipment in the pump house.

r) Design life (minimum) of equipment supplied by contractor shall be 25 years.

15.7 DESIGN & CONSTRUCTION

15.7.1 Pump Type

Pumps shall be of vertical shaft, submerged suction, complete with bowl, column & head assembly and drive assembly. The pump design shall be of pullout / non- pullout type as per data sheet. In case of pull out type design, all the rotating elements with all wearing surfaces, diffuser and shaft enclosing tube can be withdrawn from the top without dismantling the column pipe, discharge connection and motor stool.

15.7.2 Discharge head

The pump discharge shall be of above-floor type. In certain cases of pump installation where expansion joint is located immediately at the pump discharge, the pump assembly will be subjected to the unbalanced hydraulic thrust. A thrust pad will be built in with the discharge head for transmitting the hydraulic thrust to external structures such that this hydraulic thrust is not transmitted to the foundation bolts for which they may not be designed.

15.7.3 Column Pipe

Column pipes shall be flanged complete with gaskets, nuts and bolts to permit easy diassembly. The standard lengths of the column pipes shall be dictated from consideration of ease of handling and shall not exceed 3M. Columns shall be provided with seating/lifting lugs.

15.7.4 Impeller

The impeller shall be closed, or semi-open or open. The pump shaft shall have provision for adjusting the impeller position in a vertical direction from an accessible location. The impeller adjustment mechanism must take into consideration the extension of the line shaft caused by hydraulic down thrust, the weight of the shaft and impeller. In case of open impellers the pump shall be designed to take care of additional thrust produced.

15.7.5 **Wearing Rings**

Replaceable type wearing rings shall be provided for both casing and the impeller. For open impellers replaceable casing liners shall also be provided. The difference in hardness of the casing & impeller wearing rings shall be minimum 50 BHN.

15.7.6 **Impeller & Line Shaft**

Shaft size selected on the basis of maximum combined shear stress must take into consideration the critical speed as per API - 610.

The impeller shaft shall be guided by bearings provided in each bowl. The butting faces of the shaft shall be machined square to the assembly and the shaft ends shall be machined square to the assembly and the shaft ends shall be chamfered on the edges.

The line shaft coupling shall be of muff type or approved equivalent.The length of shaft sections shall not exceed 3M.

Replaceable shaft sleeves shall be furnished, at applicable locations, under stuffing boxes/bearings and other locations as required.

Shaft sleeves shall be provided below the bearings to protect the shaft from wear.Suitable locking arrangement shall be provided for all bolted connections.

15.7.7 **Pump & Shaft Bearings - Lubrication**

Adequate number of properly designed bearings shall be furnished. All interconnected piping, valves, instruments and fittings for bearing lubrication shall be provided. The type of lubrication i.e. self-water lubrication shall be provided.

Self Water Lubrication System:

i) The line shaft bearing shall be lubricated by "carried water " (in such a case, shaft enclosing tube is not required) or lubrication water shall be tapped from CW pump discharge, passed through duplex filters and supplied through shaft enclosing tube for lubrication purpose.

ii) Pump design shall be such that line shaft bearings are below minimum water level. However in case, pump design does not permit the same, the Bidder shall use "Thordon type bearing" which are above minimum water level.

iii) Water required for cooling of pump-motor guide and thrust bearing shall be taken from main pump discharge through duplex filter. Necessary piping valves, instrumentation etc. shall be included in Bidder's scope.

iv) In case of re-circulating type CW system with cooling towers, there may be dust ingress in cooling towers. The lubricating system shall be suitably designed to prevent such dust ingress into CW system.

15.7.8 **Thrust Bearings**

Single thrust bearing at motor top or separate thrust bearings at pump and motor shall be provided to take care of hydraulic thrust and weight of the rotating assembly as per manufacturer's standard practice.

Thrust bearing shall be of oil-lubricated, centrally pivoted tilting pad type (Mitchell or Kingsbury) capable of absorbing axial thrust in both directions of rotation. Water required for cooling of thrust bearing shall be taken from main pump discharge. Hence CW pump shall be suitable for starting without cooling water for thrust bearing.

The thrust bearing shall be rated for continuous operation with thrust as developed in shut-off condition with clearance between the wearing rings in worn out condition to be at least four (4) times the clearance between the wearing rings in new condition.

15.7.9 **Pump Motor Supports, Base plate etc.**

The pump and motor shall have a common support. The necessary supporting frame, base plates, mounting plates etc. as required shall be supplied under this specification.

15.7.10 **Stuffing Box**

Gland packing shall be provided at the top of the line shaft. Shaft sleeves shall be provided at the stuffing box. The stuffing box shall be of sufficient depth to provide ample packing. The packing glands shall be split type to facilitate repackaging of the stuffing boxes. The space between motor and the stuffing box shall be sufficient to permit removal of gland packing and insertion of new gland packing without dismantling of pump.

15.7.11 **Wearing Rings**

Replaceable wearing rings/casing liners shall be provided in impeller and casing. Design of wearing rings / casing liners may be as per manufacturer's standard practice. The diametrical clearance between casing and impeller at the wearing ring(s) when the pump is new shall not be less than 1.2 mm.

15.7.12 **Coupling**

The pump shall be connected to the motor shaft by a suitable coupling. Coupling bolt and nuts shall be provided with locking devices to prevent the nut from becoming loose at normal and reverse rotation. Suitable arrangement shall be provided to adjust the vertical clearance of impeller. Bidder shall give necessary details of a proven arrangement in the offer.

15.7.13 **Base Plate**

Each pump shall be provided with a heavy structural steel base plate for pump & motor respectively. Separate heavy steel sole plates (or curb rings) shall be provided for grouting and shall be designed to permit removal of entire pump along with discharge elbow head and base plate without disturbing the sole plate or grout. The sole plates shall be blasted clean to a near white finish. Further, the design and material of foundation bolts and base plate shall be such that it can take care of all shearing forces/ stresses developed due to sudden closure of butterfly valves. The Contractor shall furnish the calculations for shearing forces and moments on foundation bolts.

15.7.14 **Assembly and Dismantling**

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouted base/sole plate or alignment.

15.7.15 **Automatic air release valves**

A suitably sized automatic air-release-cum-vacuum breaker valve(s) shall be provided on the discharge pipe of each pump. Each Air release Valve shall be provided with an Isolation Valve (Gate valve).

A suitably sized automatic air-release-cum-vacuum breaker valve(s) shall be provided on the discharge pipe of each pump. Further Air release valves shall be provided on the CW pipe based on transient analysis study. The number and size of air release valves shall be based on the transient analysis study.

All ARV shall be provided with isolation valve below the ARV to isolate the Air release valves. Air release valves shall be of automatic type as per IS: 14845. The Isolation valve of air release valve shall be Gate valve in Cast Iron or Cast steel Body with Stainless steel trim as per relevant IS code.

Details of air release valve shall be as follows:

a) The air release valves shall be double air valve/kinetic air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The Orifice contact joint with the float shall be leak tight joint.

b) The valve shall efficiently discharge the displaced air automatically from ducts/ pipes while filling them and admit air automatically into the duct/ pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/ pipes during normal working at the normal working pressure.

c) Material of construction for air release valve shall be as per IS: 14845.

15.8 **MATERIALS OF CONSTRUCTION**

Materials of construction of the pumps shall not be inferior to those specified in the enclosed pump data sheets.

15.9 **OPERATION PHILOSOPHY**

15.9.1 The Pumps shall be operated / controlled from the Distributed Digital Control, Monitoring and Information System (DDCMIS) located in the Central Control Room (CCR) in the main plant building. The start/stop commands of all associated auxiliaries/drives including all the motor operated discharge valves shall be routed through DDCMIS where all interlocks & permissives shall be implemented and start/stop signals shall be issued to MCC/Switchgear. The exact details of the same shall be finalised during detailed engineering. For local operations, operator work station shall be located in CW pump house control room.

15.9.2 A local pushbutton switch shall be used for emergency tripping of the motor.

15.9.3 The pump can be started either with pump discharge valve partially open or in closed position depending upon contractor's standard practice.

15.9.4 Pump can be started only when either at least one of the flow circuits through the respective condenser to the discharge pipe and cooling tower is established or re- circulation line to pump sump is open.

15.9.5 An interlock shall prevent the starting of pump unless bearing lubricating water flow and motor bearing cooling water flow has been established over a period of time. Low flow of either pump or motor bearing cooling water when the pump is running will give alarm(s) and trip the pump with alarm in case of sustained low value over a preset time.

15.9.6 In case of high pressure at pump discharge due to accidental closure of any of the butterfly valves in the CW system, an alarm shall be generated.

15.9.7 In case of normal stopping, when a pump control switch is turned 'OFF', the butterfly valve at its discharge first closes 25-30% before the respective pump motor is de- energized.

15.9.8 On tripping of motor due to any reason, the butterfly valve at the discharge shall close fully automatically.

15.9.9 If water level in pump sump is low, an alarm shall be initiated. Pump shall be tripped in case of very low level of water in the intake sumps and very high discharge header pressure.

15.9.10 Bidder shall provide Duplex temperature elements for bearing & simplex elements for winding temperature monitoring points. Pump shall be tripped from very high winding temperature of motor and very high metal temperature of thrust bearings. Alarm shall be provided for high motor winding temperature and high motor/ pump bearing temperature.

15.9.11 The operation philosophy as detailed above is suggestive only and bidder shall furnish the complete control and interlock scheme for System equipment proposed by him along-with the bid. The control and interlock scheme to be adopted shall be finalised in consultation with the successful bidder after award of contract and shall be subject to Employer's approval.

15.9.12 For detailed specification on instrumentation and control, refer Volume – V.

15.10 VARIOUS STUDIES FOR CW SYSTEM

A) HYDRAULIC TRANSIENT ANALYSIS

For complete CW system, Bidder shall carry out a detailed hydraulic transient analysis study by method of characteristics using a computer programme. Bidder shall decide the following based on the hydraulic transient analysis for entire CW System:

a) Pump discharge valve closing sequence and rate of closure for pump stopping and pump tripping conditions, which shall be incorporated in control system in unit control room.

b) Size, location and quantity of air release valves in the discharge pipe and CW piping.

c) Pump discharge valve opening sequence and rate of opening during pump start-up condition.

Further, study should also consider stopping/ tripping of a working CW pump and starting as an event for analysis of the system.

The report for transient analysis should consist of methodology adopted, characteristic curves/ data for various boundary conditions, complete input data used for execution of software for various events and the complete data and shall be submitted to the Employer approval.

Complete input data, methodology adopted and the results of the programme shall be submitted for approval during detailed engineering. Based on the recommendations of such a study, Bidder shall take corrective measures and provided suitable surge suppression devices in the complete CW System.

B) MODEL TEST OF CW PUMPS

a) For the offered pump, bidder should have carried out the model test. Bidder shall furnish the above test results along with the tender. The model test should have been conducted as per Japanese standard JIS-B-8327 (latest version) and specific speed of the model tested should lie within ± 5% of the specific speed of the pump offered.

b) If the bidder has not conducted such a model test for the offered pump, bidder shall conduct the test as per the procedure given below at no extra cost to the Employer.

c) A homologous model of the CW pump shall be tested at manufacturer's works in the presence of Employer's representative to predict the performance of the prototype. Model test shall include the cavitation test & Net Positive Suction Head Required (NPSHR) test. In general these tests shall be conducted as per Japanese standard JIS-B8327 (latest version).

d) The model pump head should be the same as the head of the prototype pump, and should be run at such a speed that the specific speed is the same as that of the prototype.

e) The model ratio and the procedure to be followed for model test shall be mutually discussed and agreed before conducting the test.

f) Contractor shall submit a procedure for ensuring & demonstrating the similarity of the impeller vane profile/volute profile for the model pump & the prototype.

g) All the relevant dimensions of the diffuser and impeller including clearances and profile shall be measured for model pump and prototype pump and control should be exercised to ensure repeatability of these parameters on all subsequent pumps.

C) Sump Model study

Bidder shall carry out a sump model study at a recognized Institute / Hydraulic research laboratory. Scale of the model shall be minimum 1:12. The hydraulic model study shall be conducted to study flow conditions in approach CW channel, forebay, pump bays, draft tubes for different discharges and different depths of water, different combinations of pump operations and to study velocity distribution in approach channel, forebay area, pump bays, draft tube etc. The model shall be based on Froude's law of similitude and shall be tested for following two more flow conditions, viz.

(a) At twice the prototype maximum Froude number, i.e., the Froude number of the model is two times that of the prototype.

(b) At equal velocity criterion, i.e., the velocity is same both in the model and prototype.

(c) Report of the model study incorporating the recommendations shall be submitted for Employer's approval and final copies of the same shall be submitted to the Employer. The model study shall be carried out in advance, to avoid any delay in the release of construction drawings of pumphouse, forebay and CW channel. Employer shall be intimated in advance to witness the model test.

15.11 PERFORMANCE GUARANTEE TESTS

After the manufacture, all the CW pumps shall be performance tested at the manufacturer's works to determine the power consumption and the head capacity characteristic in the presence of Employer's representative as per requirements of BS:9137, standards of the Hydraulic Institute, USA or equivalent. Performance test at design duty point shall be done keeping minimum submergence of the pump identical to that specified for the site conditions. Bidder shall submit the test procedure for Employer's approval.

Contractor shall submit details of the proposed test facilities available for testing the pumps for OWNER's approval. The details must include the capacity, head, maximum motor rating, voltage level, sanctioned load and permissible starting current.

It may be noted that during the performance tests, no negative tolerance shall be permitted on head, capacity and the pump efficiency.

Calibration of instruments to be used in the test shall be carried out by an independent agency. Calibration of instruments should be carried out prior to test. The calibration certificate of the instruments should be valid for the period of test. The following laboratories are acceptable for calibration of various instruments:

a) Indian Institute of Technology Mumbai / Chennai / Delhi / Kanpur.
b) Institute for design of electrical measuring instruments (IDEMI) Bombay.
c) Electronic Research & Testing laboratory (ERTL), New Delhi.
d) National Physical Laboratory (NPL), New Delhi.
e) National Test House (NTH).
f) Any other equivalent Government Institute / laboratory to be approved by OWNER.

For carrying out performance test at shop, actual motor shall be used. The test result will be evaluated at actual speed achieved and speed correction shall be made only if there is a supply frequency variation with respect to 50 Hz.

Shop test shall also include measurement of vibration, noise level and bearing temperature rise for reference.

Strip down examination shall be carried out to check visually mechanical damages after performance test.

Accuracy of instruments to be provided by the Contractor for testing shall be as follows:

S.No.	Parameters to be measured	Instruments	Accuracy
1	Power (motor input power)	Wattmeter	± 0.5%
		AC-Voltmeter	± 0.5%
		AC-Ammeter	± 0.5%
		Frequency meter	± 0.5%
2	Speed	Tachometer non-contact type	± 1 rpm
3	Temperature	Digital Thermometer	± 0.1 deg C
4	Vibration	IRD 308 or Equivalent	± 3%
5	Noise Level	Sound level meter	± 2 dB
6	Pressure Measurement	Bourdon type gauge/ Pressure transmitter	± 0.5 %
7	Level	Level gauge	± 0.5 %
8	Time	Stop Watch	± 0.5 %

The above list is not exhaustive. Any other instrument required for the test will be arranged by the contractor along with valid calibration certificate.

Among other tests, following shop tests shall be conducted:

1. Material tests & chemical analysis for casing/diffuser, impeller, pump shaft, line shaft of pumps & butterfly valves.
2. U.T.S. test for the casing, impeller, line shaft & pump shaft
3. Hydrostatic test for casing/impeller
4. Leakage & performance tests for butterfly valves as per AWWA-C-504.
5. Dynamic balancing of impellers of the pumps.

The test results of the CW pumps shall be evaluated and equipment should meet its rated parameters/ performance. In case the equipment does not meet the rated performance, the purchaser reserves the right to assess the deficiency in terms of equivalent amount and recover the same from the contract price or reject the equipment at his discretion and recover the payments already made.

15.12 PAINTING

All equipment shall be protected against external corrosion by providing suitable painting.

The surfaces of stainless steel, Galvanised steel, Gunmetal, brass, bronze and non- metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting etc as per the agreed procedure.

For all the steel surfaces (external) exposed to atmosphere (outdoor installation), a coat of chlorinated rubber based zinc phosphate primer of minimum thickness DFT of 50 microns followed up with undercoat of chlorinated rubber paint of minimum DFT of 50 microns shall be applied. Then, intermediate coat consisting of one coat of chlorinated rubber based paint pigmented with Titanium di-oxide with minimum DFT of 50 microns and top coat consisting of two coats of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 100 microns shall be provided. Total DFT of paint system shall not be less than 200 microns.

For all the steel surfaces (external) inside the building (indoor installation), a coat of red lead primer of minimum thickness of 50 microns followed up with undercoat of synthetic enamel paint of minimum thickness of 50 microns shall be applied. The top coat shall consist of two coats each of minimum thickness of 50 microns of synthetic enamel paint and thus total thickness shall be minimum 200 microns.

15.13 Stoplog Gates and Coarse Screens

15.13.1 Scope

i.) One (1) set of stop log gate assembly for as many identical pump bays{comprising of identical and interchangeable units of adequate size (height x width)} properly matched to withstand the water pressure and to have no leakage between connection joints, complete with seals and hooks for hoisting and lowering the unit etc as shown on the enclosed drawing for stop log gate of Circulating water sump.

ii.) One (1) sets of coarse screen assemblies per pump bay {each comprising of identical & interchangeable units of adequate size (height x width)} properly matched complete with hooks for hoisting and lowering the unit etc. generally as per details shown on enclosed drawing to be installed in circulating water sump. Screen shall be suitably strengthened so that even with 50% chokage there is no distortion of the frame.

iii.) One (1) set of lifting beam complete with automatic engaging and disengaging type hooks and counter-weights guides & guide shoes to be operated in unison with stop log gates/coarse screens as described above for handling the units with correct engagement as shown on enclosed drawings.

iv.) One (1) set of guide bar and sills for gates and screens for guiding them to operate in the center of the slot.

v.) Sets of Track-cum-side seals for the stop log gates/coarse screens for Circulating water sump shall be supplied and erected to enable smooth movement of bearing pads and seals. Proper number of pads & seals shall be provided so as to provide very smooth operation for a prolonged period.

15.13.2 Stop Log Gates

i.) The Stop log gates shall be designed in accordance with the provisions of IS: 5720, in general and in accordance with the specification indicated herein. The Stop log assembly shall be made in identical interchangeable units indicated in enclosed drawing. The gates shall be designed corresponding to the maximum water level and wave effect with full hydrostatic pressure with the downstream completely empty.

ii.) Permissible stresses in various components shall not exceed those specified in IS: 5620 for wet conditions (accessible) column and those mentioned in these specifications.

iii.) The Stop log assembly units shall normally be kept in raised condition. These shall be required to be lowered and raised in the balance condition for attending to any maintenance or repair jobs of the water bays or the associated civil structure. All the stop log assembly units shall be identical and interchangeable for each size except the bottom unit.

iv.) All the units shall have music note type side seals and bottom seal. Suitable arrangement shall be made at the top of the units for sealing the bottom seal of the unit to be placed above it. The skin plate and bottom seal clamp plate shall be suitably chamfered to prevent damage to bottom seal.

v.) Suitable drain holes shall be provided on all the horizontal girder webs and horizontal stiffeners. Each stop log unit shall be provided with three (3) guide shoes, one (1) near the top and one in middle and the other near the bottom at each end. Lifting points should be suitable for the automatic engaging and disengaging hooks provided on the lifting beam. Two (2) suitable guide rods equidistant shall also be provided on the units at the webs of the top horizontal girders to match the guide bush (pipe) provided at the bottom of the lifting beam to facilitate lowering of lifting beam correctly to engage the stop log.

vi.) The stop log assembly units are required to be lifted/lowered under balance conditions of load. The lifting operation shall be done only after the water level on both sides has equalized for which suitable filling valve shall be provided in the stop log units only under each lifting lug so that before the lifting beam lifts the stop log, water fills the dewatered portion through the filling valves and balances the water pressure on both the sides.

vii.) The stop log unit shall be required to be raised / lowered at a speed of 1 to 2 meters per minute.

viii.) In closed position, the stop log assembly units shall be completely water tight with the design water head.

ix.) The stop log assembly and its accessories shall be so designed that the stresses in the different members due to dynamic loads during closing and opening operations and static loads in the closed position do not exceed the permissible stresses specified hereunder. The frames and anchors shall be designed as per clause 6.2 of IS: 5620. The bearing plates shall be of mild steel and surface shall be machined. This shall slide on the machined structural steel track plates provided on the embedded parts.

15.13.3 Arrangement of Stop Log

i.) The stop log gate assembly shall consist of a skin plate provided on downstream side and shall be supported on horizontal girder and vertical stiffeners. Each stop log gate assembly unit shall have two (2) bearing pads, one (1) on each end supported by end vertical girders. The bearing pads shall transfer the thrust to concrete through the embedded angle. Suitable lifting attachments, guiding stems shall be provided.

ii.) The side seals shall be music note rubber seals with solid bulbs and bottom seal shall be wedge type.

iii.) Six (6) guide shoes, three (3) on each side of the unit, shall be provided to check side and lateral movement of the units and to restrain the same within specified limits.

iv.) The side and bottom seals should have perfect leak proof jointing, and the side seal bulbs should be in a true vertical plane.

v.) The end vertical girders shall have suitable inclined cut at bottom, so that only skin plate and bottom seal rest on bottom seal set.

vi.) When not in use, it should be possible to hang the stop log gate units in their grooves, to the extent possible, any provision of latches on the operating floor with corresponding locking devices in each unit shall be provided.

15.13.4 Design Criteria

i.) This stop log assembly units and guiding parts shall consist of the following component parts and shall involve the design of these components:

- Stop log unit leak consisting of skin plate, horizontal and vertical girders/ plates; end vertical girders; lifting points; guide stems; guide shoes; bearing pads.
- Seals and accessories e.g., clamp plates, nuts and bolts etc.
- Guides (Rails/tee sections)
- Track, bottom and side seal seat assemblies.

ii.) The gate leaf and its components shall be designed in accordance with clauses 6.1.1 to 6.1.2.4 of IS: 5620. The maximum deflection of stop log unit shall be limited to 1/800 of span (center to center bearing pads). The unit leaf shall also be checked for additional forces due to earthquake.

iii.) Carbon steel construction suitable bearing pads shall be provided and the bearing surface shall be machined.

15.13.5 Seals

i.) Music note type solid bulb seals for side seals and wedge type bottom seals shall be furnished complying with clause 6.3.3 of IS: 5620, except that stainless steel bolts shall be used for clamping. Seals shall be so fixed as to ensure a positive water pressure between the seal and the gate and shall bear tightly on the seal seat to prevent leakage. The side seals should be in single piece of suitable length. However, use of moulded corner seal pieces shall be preferred. Friction forces shall be computed as per IS: 5620.

ii.) The bottom rubber seal shall be so provided as not to have any leakage past the gate when the gate is in deflected position due to full water pressure. The side and bottom seals on the gate should also be joined in such a manner that there is no leakage at the seal joints when the gate is in closed position.

iii.) Track cum side seal seat assembly shall consist of rolled structural steel/plate sections which shall form the base over which stainless steel plate shall be welded/screwed to present a smooth surface to bearing pads and seals. The bearing stress in concrete should not exceed 40 kg/cm2.

iv.) Guides shall consist of structural steel plate anchored to embedded steel by bolting/welding. The guide shall be tapered at top for easy entry of unit.

15.13.6 **Construction Materials**

a.	Guides/ Anchors	:	SS 316
b.	Gate leaf & lifting beam	:	IS: 5620-1985
c.	Rubber seals	:	IS: 5620-1985

All the codes and specifications mentioned shall be of latest edition.

15.13.7 **Permissible Mono-axial Stresses for Stop log gates (Only for wet accessible condition)**

a. **Structural Steel**

i.	Direct compression and compression in bending	0.45 Y.P
ii.	Direct tension and tension bending	0.45 Y.P
iii.	Shear stress	0.35 Y.P
iv.	Combined stress	0.60 Y.P
v.	Bearing stress	0.35 Y.P

Note: Y.P = Yield Point

b. The maximum bearing pressure in concrete shall not exceed 40 kg/cm^2.

15.13.8 **Erection Tolerances**

The erection tolerances in various components of stop log assemblies, lifting beam etc shall be in accordance with IS: 5620 and other relevant Indian Standard Codes and shall conform to the best engineering practice.

15.13.9 **Lifting Beam for Stop log Gate/Coarse Screen**

15.13.9.1 The lifting beam shall be made from rolled structural steel I- beam/ channel sections or fabricated from angle iron frames. The depth of lifting beam/frame should be sufficient to prevent bending of lifting beam in between the side guides. It shall have suitable guide shoes at both ends. Two (2) guide bushes corresponding to guide stems on stop log/coarse screen units shall be provided for correct engagement with the stop log unit.

15.13.9.2 Two (2) automatic engaging and disengaging type hooks with counter-weights etc shall be provided corresponding to lifting lugs on the units, for grappling and un-grappling of stop log/coarse screen, assembly units under water.

15.13.9.3 It should be assembled in shop and its operation specially that of automatic engaging and disengaging hook shall be checked for its correct operation.

15.13.9.4 The lifting beam shall be designed to cater for the following requirements:

a. Double point lifting shall be envisaged in the design of lifting frame.

b. The depth of beam/frame shall be normally 0.6 of its length. However, this may be reduced with suitable end arrangement preventing bending of frame in the guides.

c. Counter-weights shall be provided for automatic grappling and un-grappling.

d. The hook made out of plate shall be checked for automatic grappling and un-grappling and shall be suitably designed for the load of heaviest stop log/coarse screen unit with adequate margin of impact, sticking of stop log units etc. The pin of hook shall be suitably designed for load for which hook is being designed.

e. The top pin of the lifting frame/beam shall be designed for the load of lifting frame, load of stop log/coarse screen unit with adequate margin of impact, sticking of stop log unit etc.

f. Two (2) guides on either side with their bottom chamfered shall be provided for guiding the lifting frame into the slot and clearances of guide and guide shoes shall be kept the same as adopted in the stop log units.

g. The pilot shall be provided at the bottom of lifting frame to prevent rotation of stop log/coarse screen units during handling.

h. The lifting frame shall be checked for its verticality and for satisfactory operation of grappling and un-grappling of its hook.

15.14 Coarse Screens

Coarse screens of conventional design as shown indicative in the specification drawing shall be installed at each bay of the Circulating Water sump to stop objectionable debris and floating matter from entering the CW Pumps.

15.14.1 Design Considerations & Operating Requirements

15.14.1.1 The coarse screen shall be designed for 50 percent choking condition.

15.14.1.2 Earthquake effect shall also be considered and allowed in the design in accordance with IS: 1893. The design shall be checked for additional force due to horizontal and vertical seismic coefficient. An increase of 33 percent over the normal allowable stresses may be allowed for the structural members and 25 percent for bolts and nuts etc. for earthquake condition.

15.14.1.3 The screens shall always remain in position, under water, to stop objectionable large debris and floating matter.

15.14.1.4 Screens shall be lowered and lifted only under balanced conditions of head. The lifting operation shall be only for maintenance/painting requirements or for cleaning of screen in case of excessive choking.

15.14.1.5 The screens and its components shall be so designed that the stresses in different members due to dynamic loading during closing and opening operations and static loading in the closed position do not exceed the permissible stresses.

15.14.2 **Arrangement of Screens Parts**

15.14.2.1 Each unit of coarse screen to be provided shall consist of vertical and horizontal frame. The screen shall be 12 gauge AISI-304 stainless steel crimped wire bolted on rolled structural steel frame with flat all round pitch of Clear opening of the screen shall be 10 mm x 10 mm.

15.14.2.2 As the screen units shall always remain submerged under water, a lifting beam/frame with automatic engaging and disengaging hooks shall be used for lifting and lowering purposes. The lifting frame shall also be guided in the embedded track-cum-guide.

15.14.2.3 The screen shall mainly comprise of following components:

i. Load bearing horizontal members.
ii. End frame members
iii. Screen
iv. Lifting points
v. Pilot Rods/pipe
vi. Rest pads

15.14.3 **Design Criteria for Screens**

15.14.3.1 The coarse screens shall be designed to cater for the following requirements:

i. The frame shall transmit the load uniformly to the concrete structure through bearing plate duly stiffened and welded to the horizontal members. The inclined ties shall also be provided to prevent any distortion of unit during handling. The bearing stress of concrete shall not be more than 40 kg/cm^2.

ii. 12 gauge stainless steel wire mesh having 10 mm pitch center shall be fixed on units with the help of bolts duly laced with flats all round the frame. Screens shall be designed for 50% choking condition.

iii. The depressed lifting lug shall be provided at the top of each unit for its lowering and raising in or out of guide with the help of the lifting beam/frame. If necessary the points shall be suitably stiffened without obstructing the opening area.

iv. The pilot pins and pilot rods shall be provided at suitable location to ensure correct centering of the coarse screen unit one above other in the guide. The pilot pin and pilot rod shall be so located and designed that minimum area is encroached in the opening. The location if required shall be suitably stiffened.

v. Since the welds in case of screens are susceptible to corrosion, frame shall be painted as per paint specification after welding.

15.14.4 **Material of Construction**

S. No.	Component	Materials
1.	Screen Wire	SS 304
2.	Side guide-cum-track Structural steel of Convenient shapes	IS:8500

3.	Frame	IS 2062
4.	Mechanical fasteners	SS 304 to IS 1367

All the codes and specifications mentioned shall be of latest edition.

15.14.5 **Erection Tolerances**

The tolerances and allowances for establishing the limit in sizes of mating parts shall be in accordance with the best engineering practice for the equipment of the type covered by these specifications and drawings due consideration being given to the special nature of the parts and corresponding accuracy required to secure proper operations.

15.15 **Condenser On load Tube Cleaning System**

Condenser on load tube cleaning system complete with cleaning balls, ball injector, ball collector, ball strainer, ball recirculating pumps and all other auxiliaries shall be provided for condenser cooling water system. Details of COLTCS shall be refered from Volume III, Chapter 02.

15.16 **Self Cleaning Strainer:**

Two (2) Nos. Self Cleaning Strainers (1 working + 1 standby).

Each self cleaning strainer shall be complete with following accessories and auxiliaries alongwith common local control panel for both self cleaning strainers.

a) Flushing pump with drive motor (if required) – 1 No.

b) Debris disposal pipework terminating to nearest storm water drain including non-return and motor operated flushing valves.

c) Filter body/housing vent and drain connections along with their isolating valves.

d) Matching counter flanges complete with bolts, nuts and gaskets for filter inlet/outlet including all other flanged terminal points.

e) DP measuring system with built in flushing arrangement

f) Supporting arrangement complete with foundation plates anchor bolts, nuts, sleeves, inserts etc. for complete equipment (including pipe work) supplied under this package.

g) Finish paints for touch up painting of equipment after erection at site, in sealed containers.

h) Set of special tools and tackles if required for maintenance and erection of the equipment supplied.

i) Any other accessories as required to make the self cleaning strainers a complete package.

15.16.1 **DESIGN AND CONSTRUCTION**

15.16.1.1 **Strainer Housing/Body**

- The self-cleaning strainer housing / body shall be designed and manufactured as per the applicable codes for pressure vessels. However in no case thickness of housing/body shall not be less than connecting pipe thickness or as specified in Data Sheet. It shall house the filter section / screen assembly and shall have flanged inlet, outlet, flushing/debris discharge openings and pressure measuring tappings etc.

- In design of strainer housing / body due attention shall be given for easy removal and replacement of strainer section/screen assembly.
- The strainer shall be provided with inspection hole with bolted cover.
- The strainer body / housing shall be provided with vent and drain connections with isolating valves. It shall be possible to drain unfiltered and filter water.

15.16.1.2 **Strainer Section/Screen Assembly**

- The strainer section/screen shall be designed for the maximum differential pressure across the strainer and shall be securely positioned by a supporting cage and shall be securely mounted in the housing or body.
- The perforation/mesh size of the strainer section shall not be more than that specified in Data Sheet.
- The arrangement of the strainer section shall be such that there shall be no forced accumulation of debris.

15.16.1.3 **Differential Pressure Measuring System**

- The self-cleaning strainer shall be provided with a measuring system for differential pressure across the filter section/screen, to check debris accumulation and to initiate flushing/backwashing operation. This shall consist of a separate differential pressure transmitter for normal automatic flushing operation and separate DP switch as a backup in the event of DPT failure, a differential pressure gauge for manual observation with adequate no. of tappings with isolating valves and equalizing valves.
- The contacts for differential pressure transmitter, differential pressure switch and for differential pressure gauge shall be independent so that in the event of failure of one, the other is available.
- The differential pressure measuring system shall also be equipped with built in flushing arrangement consisting of flushing pump, valves and associated piping to prevent blockage of the system with any debris. Unless otherwise specified, water required for flushing the differential pressure measuring system shall be taken from downstream side of the strainer/ screen.

15.16.1.4 **Flushing/Backwash Unit**

- The self-cleaning strainer shall be provided with suitable flushing/backwash unit and debris discharge/backwash outlet valve with associated actuator to flush out the accumulated debris/sludge.
- The flushing pump shall be provided with mechanical seals to the extent possible. If gland packing is provided it should be of good quality to prevent leakage of water from pump glands.
- The flushing backwash unit shall be either fixed type with actuator operated flushing valves or electric motor driven (through reduction gear)

backwash rotor. In case of backwash rotor, it shall be fitted with removable shoes for smooth and close running contact with the filter section/screen and to prevent the unfiltered water from bypassing to waste.

- If any water is to be injected for backwashing the strainer section/screen, water shall be taken from down-stream side of the filter section/screen with necessary pump, valves and piping for water injection supplied by the bidder.
- View glass to be provided in debris outlet pipe to monitor the flushing of debris.

15.16.1.5 **Valves**

- The flushing valves (if any) the debris discharge/backwash outlet valve, isolation, vent and drain valves shall conform to appropriate codes/standards. The debris discharge/backwash outlet valve shall be larger than the debris discharge/ backwash outlet pipe.

15.16.1.6 **Instrumentation and Control System**

- The control system for self-cleaning strainers shall be PLC based with monitoring in DCS.
- Complete instrumentation and control system for automatic flushing/ backwashing operation, protection, interlocking, indication/annunciation of high differential pressure and other malfunctions etc. shall be provided. This shall consist of adequate operational hardware, local control panel and interconnecting control and power cabling between the control panel and the self-cleaning filter and its associated electrical devices.
- The control panel shall house all necessary instruments, indicating/annunciation lamps, alarms, differential pressure indicator, timer, function selector switches, relays, protection and interlocking systems, start/stop push buttons, counter to register number of flushing operations etc. and shall be complete with internal wiring. In addition to the above, the control panel shall meet the requirements of the enclosed specification.
- All instrumentation shall be of reputed make and shall meet the requirement of the enclosed specification.

15.16.1.7 **Other Accessories**

- Counter flanges, flat faced slip on type, complete with gaskets, bolts and nuts etc., shall be supplied for the filter inlet, outlet connections and all other terminal points. Fabrication, dimensions and drilling of the flanges shall conform to the codes/standards specified in Data Sheet.
- Self-cleaning filter shall be provided with suitable lifting arrangement for handling during erection and maintenance.
- Necessary supporting arrangement (wherever applicable) complete with foundation plates, bolts, nuts etc., shall be provided.

15.16.2 **Performance Requirements**

The self-cleaning filter with all accessories shall be designed and guaranteed to meet the following requirements.

15.16.2.1 The self-cleaning filter shall perform satisfactorily and shall be capable of housing the various forms of debris/sludge i.e. suspended particles/matter, mussels, grass, leaves, wood pieces etc. The performance of the filter shall be continuous with minimum number of flushing/backwashing operations.

15.16.2.2 The self-cleaning filter shall be designed such that the pressure drop across the filter (i.e. between inlet and outlet connections) under clean conditions and partially (50%) chocked conditions shall not be more than those specified in Data Sheet.

15.16.2.3 Unless otherwise specified in Data Sheet, debris discharge/wash water flow rate during flushing/back washing operation shall be limited to 10% of the total flow rate and flushing/backwashing operation shall be completed within a period of maximum three (3) minutes. However the vendor shall recommend the flushing period for the specified system. The pressure drop across the debris filter during flushing/backwashing operation shall not be more than the pressure drop under partially (50%) chocked condition.

15.16.2.4 The coarse particles and floating matter accumulating at the filter section/ screen are flushed out of the system by the debris flushing/backwash unit such that the pressure drop across the filter after flushing/backwashing, shall not be more than the pressure drop under clean condition.

15.16.03 **Operational Requirement**

The self-cleaning filter and other accessories shall be designed for the following flushing/backwashing operation modes:

15.16.03.01 Complete automatic flushing/backwashing operation effected by the following:

(a) Differential pressure measuring system at a pre-determined differential pressure across the filter.

(b) Suitable timer with adjustable settings.

(c) Push button (for manual initiation of sequential flushing/backwashing).

15.16.03.02 Manual operation in the event of failure of control system.

15.16.03.03 Interlock for operation of standby strainer. The changeover to the stand-by strainer shall be manual based on the status/indication available in the DCS/LCP.

DATA SHEET FOR CIRCULATING WATER (CW) PUMPS

S. No.	Item	Unit	Description
1	Total no. of pumps	Nos.	3 (2 W + 1 S)
2.	Pump capacity	M^3/hr	By bidder; shall be equal to 105% of the cooling water requirement of the unit
3.	Pump total head excluding losses in the pump	mwc	By Bidder
4.	Pump speed (max.)	rpm	To limit specific speed to 6000 US units ensure adequate NPSH under all conditions
5.	Type of pump		Vertical Turbine wet pit type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Filtered water
9.	Type of line bearing lubrication		Self water lubricated
10.	Liquid for lubrication		Filtered water
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		Refer note – I
14.	Motor rating		115 % of duty point requirement or 10 % above the maximum load demand of the driven equipment in the complete operating range (including run-out condition of pump and shut-off condition in case pumps envisaged to be started with the discharge valve closed) whichever is higher to care of the system frequency variation.
15.	Voltage Level		11 KV
16.	Materials of construction		
a.	Casing, suction bell		2% Ni CI to IS 210 Gr FG 260
c.	Impeller		ASTM A 351 Gr CF8M
d.	Shaft		SS - AISI A 276 Gr 410
e.	Line shaft coupling		SS - AISI A 276 Gr 410
f.	Line shaft bearing		Cutless Rubber with bronze retainer for bearing below water level. Thordon type bearing for aboce water level
g.	Shaft coupling		SS - AISI A 276 Gr 410

S. No.	Item	Unit	Description
h.	Column pipe, discharge head		Fabricated steel as per IS 2062 / IS 3589 with minimum thickness of 8 mm with 300 micron epoxy coating inside and outside
i.	Stuffing box		2 % Ni-Cl to IS 210 FG 210
j.	Gland		2 % Ni-Cl to IS 210 FG 210
k.	Gland Packing		Impregnated Teflon
l.	All hardware		AISI 316
m.	Shaft sleeve		SS - AISI A 276 Gr 410
n.	Thrust bearing cooling system pipes and valves		SS 316
o.	Thrust Pads		Carbon steel with white metal lining
p.	Discharge Pipe & flanges		Fabricated steel as per IS:2062

Note: (i) Pumps shall be capable of operating from shut-of point to a maximum flow of 10% over the point of intersection between system resistance curve and pump H-Q curve for single pump operation.

(ii) CW fore bay and Channel design shall be as per HIS standard.

DATA SHEET FOR AUXILIARY COOLING WATER PUMPS

S. No.	Item	Unit	Description
1	Total no. of pumps	Nos.	2 (1 W + 1 S)
2.	Pump capacity	M^3/hr	By bidder; shall be equal to 105% of the cooling water requirement of the unit
3.	Pump total head excluding losses in the pump	mwc	By Bidder
4.	Pump speed (max.)	rpm	To limit specific speed to 6000 US units ensure adequate NPSH under all conditions
5.	Type of pump		Vertical Turbine wet pit type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Filtered water
9.	Type of line bearing lubrication		Self water lubricated
10.	Liquid for lubrication		Filtered water
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		Refer note – I
14.	Motor rating		115 % of duty point requirement or 10 % above the maximum load demand of the driven equipment in the complete operating range (including run-out condition of pump and shut-off condition in case pumps envisaged to be started with the discharge valve closed) whichever is higher to care of the system frequency variation.
15.	Voltage Level		11 kV
16.	Materials of construction		
a.	Casing, suction bell		2% Ni CI to IS 210 Gr FG 260
c.	Impeller		ASTM A 351 Gr CF8M
d.	Shaft		SS - AISI A 276 Gr 410
e.	Line shaft coupling		SS - AISI A 276 Gr 410
f.	Line shaft bearing		Cutless Rubber with bronze retainer for bearing below water level. Thordon type bearing for aboce water level
g.	Shaft coupling		SS - AISI A 276 Gr 410
h.	Column pipe, discharge head		Fabricated steel as per IS 2062 / IS 3589 with minimum thickness of 8 mm with 300 micron epoxy coating inside and outside
i.	Stuffing box		2 % Ni-Cl to IS 210 FG 210
j.	Gland		2 % Ni-Cl to IS 210 FG 210
k.	Gland Packing		Impregnated Teflon

S. No.	Item	Unit	Description
l.	All hardware		AISI 316
m.	Shaft sleeve		SS - AISI A 276 Gr 410
n.	Thrust bearing cooling system pipes and valves		SS 316
o.	Thrust Pads		Carbon steel with white metal lining
p.	Discharge Pipe & flanges		Fabricated steel as per IS:2062

DATA SHEET FOR RUBBER EXPANSION JOINTS

S. No.	Item	Unit	Description
1	Total no. of RE joints	Nos	Bidder to decided
2	Designation		CW & ACW system
3.	Expansion joint ID/Pipe ID	Mm	To suit selected pipe diameter
4.	Fluid handled		Filtered water
5	Vacuum	mm of Hg	700
6.	Operating temperature	Deg.C	50
7.	Movements		Max Min.
	(i) Axial Compression	Mm	25 15
	(ii) Axial elongation	Mm	13 10
	(iii) Lateral movement	Mm	13 10
8.	No. of arches		One (1)
9.	Controls unit to be provided		Yes
10.	Companion flanges		One piece or in segments. If segmentally welded, 100% radiography shall be carried out. Companion flanges shall be supplied with bolts, nuts and washers
11.	Material of construction		
	(i) Main body		High grade abrasion resistant natural or synthetic rubber compound
	(ii) Reinforcement		Copper coated steel wire or solid steel endless rings
	(iii) Retaining ring		Galvanized steel retaining rings
	(iv) Outer cover		Exposed surface shall be given 3 mm thick coating of neoprene
	(v) Bolts & nuts		IS 1367 Gr. 4.6
	(vi) Stretcher bolt plates		IS 2062

DATA SHEET FOR BUTTERFLY VALVES

S. No.	Item	Unit	Description	
1	Service		CW pump discharge, Condenser inlet/outlet	ACW pump discharge, CT blowdown and other applications as per flow diagram
2.	Valve size	mm	By bidder	
3.	Number of valves		As per Flow Diagram (min)	
4.	Supporting legs		Required	
5.	Valve opening / closing time	Secs.	120 seconds (max)	Maximum 50 seconds
6.	Frequency of valve operation		Intermittent	
7.	Location		Indoor	Indoor
8.	Type of operation		Electric	Electric
9.	Preferred face to face dimension	mm	As per AWWA C 504	
10.	Material of construction			
	(i) Body		ASTM A48, Gr. 40 with 2% Ni/ IS:210. Gr. FG-260, with 2% Ni and epoxy coated	
	(ii) Disc		ASTM A48, Gr. 40 with 2% Ni/ IS:210. Gr. FG-260, with 2% Ni and epoxy coated	
	(iii) Shaft		Stainless Steel ASTM-A-479 type 304	
	(iv) Body seat rings		Clamping ring Stainless Steel ASTM-A-479 type 304	
	(v) Disc seal rings		EPDM	
	(vi) Seal retaining rings		Stainless Steel	
	(vii) Companion flange		Carbon Steel to IS 2062 Gr B	
	(viii) Internal hardware		SS 316	
	(ix) External hardware		SS 316	
11.	Butterfly valves shall be provided with end limit switches, torque limit switches and adjustable limit switches as per the logics and interlock controls for electric valves actuated. Limit and torque switched shall be enclosed in water tight enclosures along with suitable space heaters. Refer Electrical specification (Vol-IV) for details on actuators with integral starters.			

PROOF OF DESIGN TEST (TYPE TEST) FOR BUTTERFLY VALVES:

Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual P.O.D. test shall be conducted by the bidder in the presence of Employer's representative. All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of P.O.D. test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the P.O.D test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirement of P.O.D. test of AWWA-C-504.

DATA SHEET FOR AUTOMATIC SELF CLEANING STRAINERS

S. No.	Description	Unit	Data / Particulars
1.0	**GENERAL :**		
1.1	No. of Strainers required	Nos.	2 (Two) (1W+1S)
1.2	Inlet connection	mm	By bidder
1.3	Outlet connection	mm	By bidder
1.4	Filter type / duty		On Line / Continuous
1.4a	Type of cover		Quick opening/bolted
1.5	Location		ACW Pump Discharge Header
1.6	Liquid handled		Filtered water.
2.0	**DESIGN DATA**		
2.1	Operating pressure	Kg/sq.cm	Approx. 2.0 (to be confirmed by bidder)
2.2	Design pressure	Kg/sq.cm	7.5(g)
2.3	Design temperature	Deg. C	50
2.4	Flow rate through Strainer		
	a) Normal	m^3/hr	105% of ACW pump rated flow
	b) Maximum	m^3/hr	Flow at run out condition in ACW pump
2.5	Type of suspended matter likely to enter the Strainer		Typical debris encountered in cooling tower water.
2.6	Strainer section / screen perforation size	mm	2 mm size.
2.7	Free straining area		Four times the diameter of the pipe
2.8	Screen Opening Area		6 times of the inlet pipe cross section area
2.9	DP Measurement System		DP Switch & DP Transmitter

S. No.	Description	Unit	Data / Particulars	
2.10	Max. Pressure drop in fully choked condition	MWC	6	
3.0	**GUARANTEED PERFORMANCE REQUIREMENT(AT SITE).**			
3.1	Debris discharge flow during flushing period		Not to exceed 10% of the total flow rate.	
3.3	Flushing period	Minutes	Not to exceed 3.0	
4.0	**MATERIAL OF CONSTRUCTION**			
4.1	Strainer body / Housing		IS-2062 Epoxy painted inside.	
4.2	Strainer screen / section		SS 316.	
4.3	Shaft		SS 316.	
4.4	Supporting cage		SS 316.	
4.5	Differential Measuring System		SS 316.	
4.6	Flushing / Backwashing Unit		SS 316	
4.7	Bachwash rotor shoes		Neoprene	
4.8	Any other internal hardwares / pipes, etc.		SS 316	
4.9	Pipe work (external to strainer)		As per IS 1239 / IS 3589 (heavy class)	
4.9.1	Valves		Size upto & incl. 50 NB	Size 65 NB & above.
	a) Body & Bonnet.		Gun Metal Screw ends, IS 318 Gr. 2	SS 304
	b) Trim		IS 318 Gr. 2	SS 304
	c) Seating surface & rings.		-	SS 304
	d) Stem.		-	SS 304
	e) Back seat.		-	SS 304
	e) Hinge pin for check.		-	SS 304
4.10	**COUNTER FLANGES**			
	a) Flanges		IS 2062 Gr. B	
	b) Bolts & Nuts		A 193 & A 194	
	c) Gaskets		3 mm thick, rubber	
	Drilling standard		BS 4504/AWWA or equivalent.	
	Connecting pipe size (OD & thk)	mm	711.1 & 6.0 thk	
5.0	**PAINTING**			
5.1	External surface		As per Clause No. 16.00	

S. No.	Description	Unit	Data / Particulars
	a) Surface preparation		
	b) Primer		
	c) Final paint		
5.2	Internal Surface		As per Clause No. 16.00
	a) Surface preparation		
	b) Primer		
	c) Final paint.		
6.0	Pumps : Centrifugal type (IS : 6595)		
	a) Casing		CI-IS-210 FG 260
	b) Impeller		SS CF 8M
	c) Shaft		Carbon steel Gr. 40C8 to IS:1570
7.0	**SHOP TEST**		
7.1	Hydrostatic test		
	a) Test pressure	bar (g)	1.3 times design pressure
	b) Test duration	min.	30
8.2	Leakage test		
	a) Test pressure	bar (g)	Design pressure
	b) Test duration	min.	30

NOTE:
The capacity/ capacities specified herein are the minimum requirements and any increase in the capacity/ capacities during detail engineering shall be taken care of by the bidder without any price implication

CHAPTER – 16

DEMINERALISED COOLING WATER (DMCW) SYSTEM

CONTENTS

CHAPTER – 16

DEMINERALISED COOLING WATER (DMCW) SYSTEM

16.0 SYSTEM DESCRIPTION

Two independent primary cooling circuits - one for TG Auxiliaries & BOP auxiliaries and another for cooling of Steam Generator Auxiliaries including SCR and FGD shall be provided. However, the Secondary circuit pumps shall be common for both these systems.

Quality of water

(a)	Primary circuit	-	Demineralised (DM) water
(b)	Secondary circuit	-	Clarified water

Sodium Hydroxide dosing equipment shall be provided to maintain pH around 9.5 in the D.M. water side.

The system design for DMCW system for Auxiliaries of TG System and SG System shall be as follows:

In the primary circuit, a set of demineralised cooling water (DMCW) pumps of 3 X 50% capacity shall discharge cooling water through 3 X 50% capacity plate type heat exchangers (PHE) to all TG Auxiliary coolers & BOP coolers & a set of demineralised cooling water (DMCW) pumps of 2 X 100% capacity shall discharge cooling water through 2 X 100% capacity plate type heat exchangers (PHE) to all SG Auxiliary coolers.

For the primary cooling circuit, One (1) overhead tank of minimum (normal) capacity of 10 M^3 for TG system and SG system shall be provided by the bidder.

The pH of DM water in the closed loop shall be continuously monitored and controlled at around 9.5. The control shall be achieved by dosing sodium hydroxide in DM water overhead tank. The dosing shall be done manually by operating dosing valve.

The secondary water system shall receive water from the discharge of 2 x 100% Auxiliary Cooling Water pumps through 2 x 100% self cleaning filters installed at the inlet of TG & SG plate heat excahangers. Return hot water (ACW) from the PHEs shall be discharged to CW return/Cooling tower.

(Refer P&ID for CW & ACW System (Dwg 111-12-3300)

The heat exchangers shall be designed with a (Terminal Temperature Difference) TTD of 3^0 C (max.).

Frame of each plate type heat exchanger shall have about 25 % extra capacity i.e. the frame shall be able to accommodate about 25 % extra plates.

16.1 Scope of Work

The scope of DMCW system includes, but not limited to the following:

- 3 x 50% DMCW Pumps with drive motors for TG auxiliaries & BOP

auxiliaries

- 2 x 100% DMCW Pumps with drive motors for SG auxiliaries
- 3 x 50% Plate heat exchangers for TG auxiliaries & BOP auxiliaries
- 2 x 100% Plate heat exchangers for SG auxiliaries
- One (1) DMCW Overhead tank of 10 M^3 (mim) effective capacity or as per clause # 16.2.5 below, whichever is higher.
- Manual sodium hydroxide dosing in DM water overhead tank for DM water passivation.
- Inter connecting piping, pipe supports, valves and fittings from DMCW pump discharge to SG & TG PHE's and back to DMCW Pump.
- Make up piping from DM cycle make-up/DM transfer pump discharge.
- Online measurement of pH.
- Motorized butterfly valves at DMCW pump suction & discharge
- Couplings of approved design to connect pump shaft directly with the motor shaft.
- Sets of base plates, support plates, grounding pads, lifting lugs, eye bolts, nuts etc for each pump and motor set.
- Slip-on type drilled steel flanges of proper rating for both suction and discharge connections of each pump set. All the counter-flanges shall be complete with requisite number of bolts, nuts, gaskets etc.
- Air release cocks and drain plugs for each pump set.
- Discharge line pressure gauge and suction line pressure/ vacuum gauges complete with isolating cocks for each pump set.
- All internal/integral piping with valves, fittings, and pressure gauges for lubrication, cooling and sealing, wherever applicable, shall be tapped of directly from respective pump discharge.

16.2 **Design Basis**

16.2.1 All the pumps shall have 10% margin on friction head over the actual requirement.

Capacity of pumps shall be fixed by taking 10% (minimum) margin on design DMCW flow (design DMCW flow has been detailed in the following para).

16.2.2 The required flow in this system shall be based on the requirement of each individual connected cooler in the system with respect to flow and terminal temperature rise as encountered during maximum possible thermal load conditions. Bidder shall list out the required flow and terminal temperature rise of each cooler and the number of individual equipment coolers (operating/standby) in his Bid proposal. A minimum of 20 % margin shall be considered over and above the total required heat load to compute the design heat load and subsequently the design DMCW flow for the closed circuit. In computing the design heat load and design DMCW flow in individual DMCW system Bidder shall ensure that the average temperature rise of DMCW is limited to 5.5 deg.C under all circumstances.

16.2.3 All piping and equipment coming in contact with demineralised water shall be designed to withstand a pressure not less than the shut off head of DMCW pump. All DMCW piping in the discharge of DMCW pumps shall be sized for a velocity not exceeding 2 m/sec under all circumstances.

16.2.4 The DMCW working pressure in lube oil coolers of Boiler and TG island shall be less than the oil pressure in the above coolers so that possibility of water leakage into oil is eliminated. Similarly, the water pressure shall be less than the hydrogen pressure in the hydrogen coolers.

16.2.5 The DMCW make up tank supplying make up water to the DMCW system shall be located above the highest equipment cooler in this closed circuit to ensure flooded suction of the DMCW pumps under all conditions and to prevent backflow of water in the make up tank. The capacity of the make up tank shall be adequate to provide a minimum of one (1) hour make-up water storage capacity in between the minimum and maximum operating levels based on the make up demand.

16.3 Plate Type Heat Exchangers

16.3.1 Plate Type Heat Exchangers shall be designed with the following considerations:

(a) Design temperature shall be 50^0 C.

(b) Design pressure as mentioned in the data sheet.

(c) Number of plates theoretically calculated shall be increased by adopting a minimum of five (5) % margin.

(d) Frame size of each heat exchanger shall have provision to accommodate 25% of extra plates in future.

(e) Minimum Fouling factor shall be 0.8 x 10-4 m^2-hr-0C/Kcal.

(f) The TTD shall not exceed 3^0 C.

(g) Minimum corrosion allowance for heat exchanger parts of carbon steel shall be 1.6 mm.

16.3.2 Codes & Standards

The design, manufacture and testing of the equipment under this section shall generally conform to the latest editions of the applicable standards.

IS/BS/ASME standards regarding boiler, pressure vessels & others, as necessary

IS/BS/ASTM/DIN for material specification and testing properties.

British standard BS EN 1092 – 2:1997 (and including its latest amendments) for flanges of steel & their joints, valves fittings and accessories, cast iron flanges.

16.3.3 Scope of Supply

16.3.3.1 The scope of supply shall be as below. Items not specifically mentioned but deemed necessary by the Bidder for making the system completely reliable and efficient shall also be included.

16.3.3.2 Three (3) Plate Type Heat Exchangers (PHE) for Turbine island & Balance of Plant system and Two (2) PHE's for Boiler island. Each PHE shall consist of following accessories:

(a) Suitable cleaning system complete with all equipment and accessories (viz. pumps, piping, valves etc.) for inside cleaning of the PHE's.

(b) Suitable drain and vent connections for both DMCW and ACW streams complete with isolation valves.

(c) Sampling connection with isolation valve on the outlet nozzle of demineralised water.

(d) Relief valves on both streams, as required.

(e) Local temperature and pressure devices complete with root valves, thermo wells etc. on the inlet and outlet nozzles of both the streams.

(f) Differential pressure and temperature across PHE in DMCW & ACW sides.

(g) All structural steel members e.g. plates, channels etc. for supporting the heat exchanger, support wheels, lifting lugs, eye bolts, anchor bolts, nuts, sleeves, inserts etc.

(h) Matching flanges with necessary bolts, nuts, gaskets etc. for all flanged connections.

16.3.4 **Design Criteria & Performance requirements**

16.3.4.1 The equipment shall be capable of safe, proper and continuous operation at heat loads and water flows corresponding to all operating conditions. Vibration, noise, mechanical and thermal stresses shall be kept within the allowable limits as spelt out in relevant codes and standards. In design, due attention shall be given to ease of maintenance, repair and cleaning of the equipment.

16.3.4.2 Unless otherwise necessary, manufacturer's standard models of the heat exchangers shall be supplied.

16.3.4.3 Suitable corrosion allowance shall be provided, wherever necessary. Also refer stipulation under clause no.16.3.1 (g).

16.3.4.4 The Plate Type Heat Exchangers shall be designed and guaranteed for the following conditions:

Heat Load

(a) The required heat load shall be computed by obtaining the summation of the maximum permissible heat loads encountered in the respective operating coolers of Boiler and TG Islands & BOP system which shall be cooled by DMCW system. A minimum of 20 % margin over and above the total required heat load as obtained above shall be taken into account by the Bidder to work out the design heat load rejected by DMCW system and to be picked up by ACW system for the same.

(b) The operating Plate Type Heat Exchanger shall be capable of ensuring adequate cooling in individual DMCW system when ACW temperature reaches its maximum value.

(c) The pressure drop across each operating plate heat exchanger shall be limited to eight (8.0) MWC in the DMCW circuit and eight (8.0) MWC in the ACW circuit.

(d) Plate Type Heat Exchangers shall be designed to withstand a pressure not less than the maximum espected pressure to which PHE may be subjected plus 5% additional margin. The maximum expected pressure shall not less than the Shut-off pressure of the DMCW Pump or ACW Pump, or 1.5 times the operating pressure of respective pump, whichever is higher. The hydrostatic test pressure of each Plate Type Heat Exchanger shall be minimum 1.5 times the design pressure as obtained above.

(e) Design ambient temperature for Plate Type Heat Exchanger shall be taken as 50°C.

(f) Each Plate Type Heat Exchanger shall be capable of passing a flow of at least 1.1 times the design flow rate on both DMCW and ACW sides without exceeding the pressure drop values indicated above.

(g) If backwash is necessary, it shall be clearly mentioned in the bid proposal.

(h) The number of plates theoretically calculated shall be increased by a minimum of five (5)%. Frame size of each heat exchanger shall have provision to accommodate 25% of extra plates in future. Plates shall be of stainless steel (AISI-316).

(i) The performance requirements given above are indicative minimum which are to be strictly adhered to by the Bidder.

(j) The TTD of the PHE shall not be more than 3^0 C.

16.3.5 **Design & Construction**

(a) The Plate Heat Exchangers shall be water-water type, cooling a stream of hot DM water coming from DMCW system and flowing into the heat exchangers with the help of another stream of water coming from ACW system.

(b) The design, manufacture, performance and testing of heat exchangers shall be done as per the latest applicable IS/BS/ASTM/DIN standards and shall comply with all currently applicable standards, regulations and safety codes in the locality where the equipment shall be installed.

(c) The heat exchangers shall be designed for safe, proper and continuous operation for all operating condition heat loads & fluid flows. The heat exchangers shall meet the heat transfer rates as encountered during the operating conditions.

(d) The quality, quantity, pressure and temperature of different water flowing through it shall be as guided elsewhere in this specification. Velocity in the PHE plates shall be so chosen such that sufficient turbulence should be maintained so as to prevent any deposition on the plate surface. In this regard recommendation of OEM shall be considered.

(e) Design shall be suitable for cleaning without dismantling the piping.

(f) Plates shall be packed in a frame consisting of fixed frame plates and movable pressure plates aligned at top and bottom on carrying bars of special inverted "T" section to ensure three dimensional steering and locking arrangement. Plates shall be sealed at their outer edges and around the ports by gaskets in order to prevent intermixing of hot & cold water. Thickness of pressure plates & frame plates shall conform to ASME sec. VIII Div. I.

(g) Double sealing arrangement shall be provided at outer edge and around ports to avoid intermixing of fluids. The inter space between the seals shall be vented to atmosphere in order to avoid intermixing of liquids in case of gasket failure. Locally manufactured best quality gaskets shall be offered so that there is assured future supply of spare parts.

(h) Plates shall be provided with sufficient thickness in order to impart sufficient rigidity particularly from handling considerations, restricted to a minimum of 0.6 mm. Plates shall have contact points in order to provide inter-plate supports. The plates shall be pressed from one piece. They shall be pressed in single operation. The corrugation shall be smooth, uniform & identical for every plate.

(i) In design due attention shall be given to ease of maintenance, repair and cleaning. Each plate shall be numbered in sequence. The number shall be marked by indelible ink on the plate, to permit easy reassembly.

(j) The PHE bottom frame plate and supports should have fixing lugs and cleats to keep provision for enabling the Contractor to fit a trough with outlet nozzle fitted underneath to collect and drain out water in the event of leakages.

(k) Thermal and mechanical stresses, vibration & noise shall be kept within the allowable limits as per relevant codes/standards. Corrosion allowance shall be provided as per code and shall be sufficient to take care of the corrosiveness of the liquids handled.

(l) All nozzles shall be `built-in type' and shall have a raised face.

16.4 Design Requirements for DMCW Pumps & Tanks

Pumps shall comply with criteria specified in Chapter: 34.

16.4.1 The DMCW tank shall be designed as per requirements mentioned in the data sheet for DMCW tank.

16.4.2 The Alkali dozing tank shall be designed as per requirements mentioned in the data sheet for Alkali dozing tank.

16.5 DMCW System Description

16.5.1 The DMCW pumps shall operate in closed piping system and shall pump DMCW water to respective SG, TG & BOP auxiliaries through primary side of PHE's. Refer P & ID of DMCW system (Drawing 111-12-3310) for tentative scheme. DMCW overhead tank shall serve as buffer tank and shall supply make up for the loss of water from this closed piping system.

16.6 **Instrumentation**

All instruments, such as thermo well, temperature element, flow element, pressure/DP and temperature gauge/transmitters/sensors/switches, DP switch, pH analyzer, Rotameter etc. alongwith associated devices should meet the requirement as specified in relevant portion of this Technical Specification and shall be sufficient to meet all interlock/protection & operation requirement.

Necessary instrumentation as specified for the system is indicative minimum. For detailed hardware, specification of instruments, refer to Volume - V.

16.7 **Control Operation**

16.7.1 Complete Operation and Control shall be provided as described in relevant chapters of Control & Instrumentation System.

All the DMCW pumps shall be controlled and monitored from central control room DDCMIS. All control logic shall be configured in DDCMIS. All status indication and alarms of the above pumps shall be available at unit DDCMIS for operations.

16.7.2 The pump suction valves, re-circulation valves and discharge valves shall be motor actuated type to enable remote operation. Pump suction valves shall be provided with required limit switches for interlock & control.

16.7.3 The pumps shall be designed to operate under discharge valve open as well as in close condition.

16.7.4 Suction and Discharge valves of pumps to interlock with start/stop of respective pumps.

16.7.5 Local emergency stop provision of each pump shall be kept.

16.7.6 Any of the pump shall be selectable as standby duty.DMCW pumps shall have auto starting facility. The stand-by pump shall start automatically in case of tripping of any running pump, or inadequate pressure in the discharge header.

16.7.7 All the working pumps shall be interlocked with the suction level or suction pressure condition as the case may be. Pumps operation shall be interlocked with the high discharge pressure condition so that the pump may not operate at shut-off pressure.

16.7.8 Pressure control in between supply and return header of DM cooling water circuit ensures a constant pressure at the DMCW supply header down stream of Plate Type Heat Exchangers (PHEs). A control valve shall be provided to maintain a constant pressure differential between the main supply and return headers of DM water (primary circuit of ECW system of unit auxiliaries). The valve will bypass flow to compensate for fluctuations in coolant flow to the process heat exchangers due to modulating control valves on the process coolers or if any cooler goes out of service in DM circuit.

16.7.9 Opening and closing of DMCW makeup tank inlet valve shall be suitably interlocked with tank level. Automatic inlet valve at supply line to the tank shall open and close at low-level and very high-level respectively.

16.7.10 Alarm to indicate high differential pressure across self cleaning strainers, heat exchangers, as the case may be.

16.7.11 The DMCW pumps shall be equipped with the following safety features as a minimum:

(a) Motor winding temperature high - annunciation.

(b) Motor winding temperature very high - annunciation and trip.

(c) Bearing temperature high - annunciation.

(d) Bearing temperature very high - annunciation and trip.

(e) Pressure on pump discharge high due to accidental closure of valve - trip and annunciation.

(f) Any other protective feature deemed necessary for safe and reliable operation.

16.7.12 C&I and interlocks as stated above is indicative minimum. Bidder shall furnish the detailed operation philosophy and also detailed interlock schemes based on this and as required for safe and trouble-free operation of the system. Detailed Interlock & protection logic shall be as finalised during detailed engineering.

DATA SHEET FOR DMCW PUMPS

S. No.	Item	Units	Description
1	Quantity	Nos.	3 (2W +1S) for TG & BOP auxiliaries 2 (1W + 1S) for SG auxiliaries including SCR & FGD Packages)
2.	Pump capacity	M^3/ hr	By Bidder
3.	Pump total head excluding losses in the pump	MWC	By Bidder
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Horizontal Centrifugal
6	Impeller type		Closed
7.	Location		Indoor
8.	Liquid handled		Passivated DM Water
9.	Liquid for lubrication		Pumped liquid
10.	Type of pump motor coupling		Spacer type
11.	Pump operating range		By Bidder
12.	Sealing		Mechanical Seal for primary water pumps and self water/gland for secondary side
13.	Materials of construction		
a.	Casing		ASTM A 351 CF8M
b.	Impeller		ASTM A 351 CF8M
c.	Shaft		SS 410
d.	Shaft Sleeve		SS 316
e	Wearing rings		SS 316
f.	Stuffing Box Packing		ASTM A 351 CF8M
g.	Flexible Coupling		SS
h.	Base Plate		MS IS 2062 minimum 10 mm thick
i.	Bolts & Nuts		High Tensile Steel / SS
j.	Fastners		AISI 304 / SS
	Design / Performance standard		HIS / Equivalent

DATASHEET FOR PLATE HEAT EXCHANGERS (Common for all PHE's)

DESIGN STANDARD	DESCRIPTION	
Heat Exchanger	ASME Section III & VIII/Equivalent Standard. Thickness of pressure and frame plates as per ASME sec. VIII Div. I.	
Steel Flanges	ANSI B16.5 or equivalent	
Material Specification & Testing Procedure	IS/BS/ASTM/DIN/equivalent standard	
Type	Plate type, single pass	
Design Pressure	Maximum expected pressure to which PHE may be subjected plus 5% additional margin or 10 Kg/cm^2 (g) whichever is higher. The maximum expected pressure shall not less than the Shut-off pressure of the DMCW Pump or ACW Pump or 1.5 times the operating pressure of respective pump, whichever is higher.	
Maximum differential pressure at which each plate may be subjected	Shut-off pressure of DMCW/ACW Pump, whichever is higher.	
Normal Working Pressure	Working Pressure of ACW and DMCW Pumps in respective sides. However, the equipment shall be designed as stated above.	
Heat Transfer Plate	SS-AISI-316	
Thickness of plate	By bidder. Plate thickness should be adequate to withstand all operating conditions but not less than 0.6 mm.	
Compression / Fixed plates	IS:2062	
Movable pressure plate	IS:2062	
Guide rail	IS-2062 with stainless steel cladding	
Carrying bar /Support Beam/Column	IS:2062	
Plate gasket	Nitrile rubber, 65 $\pm$ 5 % shore hardness.	
Frame plate/Pressure plate/ nozzle	CS (IS:2062)	
Nozzle Flange	CS (IS 2062), ANSI B 16.5 or equivalent	
Nozzle flange Gasket	3 mm wire inserted Red Rubber.	
Nozzle flange Bolts/ Nuts	SA 193 B7/SA 194 2 H.	
Wetted Fasteners	Stainless Steel AISI-316	
Tightening Rods	IS-1367 or equivalent	
Fouling factor (Minimum)	0.8 x 10^{-4} m^{2}hr^{o}c/kCal	
Flow (m^3/hr)	Primary (DMCW)	Secondary (ACW)
Quantity of Water per Heat Exchanger, m^3/hr	By Bidder	By Bidder
Quality of Water	Demineralised Water	Clarified Water
Inlet Temperature of water	By bidder	Inlet – 33 ^{0}C
outlet Temperature of water	BY bidder	By bidder

DATASHEET FOR DMCW OVERHEAD TANK

S. No.	Description	Tech. Particulars
1.	Quantity	One (1)
2.	Type	Horizontal Dished ends
3.	Design Standard	ASME Boiler and Pressure Vessel code Section-VIII/ IS: 2825 (Class 3). The internal surfaces of the tanks shall be epoxy coated or rubber lined in three layers with total thickness not less than 4.5 mm
4.	Material of Construction	Plates to IS: 2062 / ASTM A36. Minimum shell thickness shall be 6 mm.
5.	Location	TG Building BC Bay roof
6.	ACCESSORIES	
	a) Vent, overflow and drain	Required
	b) CO2 absorber for vent	Required
	c) Seal for overflow	Required
	d) Manhole & approach ladder/ platform	Required
	e) Level Indicator	Required
	f) Level Transmitter	Required
	g) Level Switch	Required

DATASHEET FOR ALKALI DOZING TANK

S. No.	Description	Tech. Particulars
1.	Quantity	One (1)
2.	Useful Capacity	Suitable for the system (Minimum 500 L)
3.	Material of Construction	MS Plates to IS:2062/ ASTM A36. with rubber lining of 4.5 mm thick & Minimum shell thickness shall be 6mm. OR SS plates of minimum thickness of 3mm without rubber lining.
4.	Dissolving Basket	AISI-316,
	Agitator	Propeller type agitator (shaft, propeller etc. of stainless steel 316SS construction) along with drive motor of suitable rating and protection class. (With Slow speed reduction gear unit)
5.	ACCESSORIES	
	a) Vent, overflow and drain	Required
	b) Sample Connection	Required
	c) Level indicators, level transmitters, level switches	Required

CHAPTER – 17

CHLORINE DI-OXIDE (ClO_2) GENERATION SYSTEM & CW TREATMENT SYSTEM

CONTENTS

CHAPTER – 17

CHLORINE DI-OXIDE (ClO_2) GENERATION SYSTEM & CW TREATMENT SYSTEM

1.0 CHLORINE DIOXIDE GENERATION SYSTEM

1.1 INTRODUCTION

1.1.1 Chlorine dioxide treatment is to be used for microbiological control in cooling tower circulating water, raw water and potable water.

i)	Raw Water	:	1.0 ppm continous
ii)	Potable Water	:	1.0 ppm continous
iii)	Circulating Water	:	0.6 ppm, 4 hrs/day

1.1.2 Chlorine di-oxide shall be generated from the reaction of Hydrochloric acid and sodium chlorite solution.

1.1.3 The minimum conversion efficiency of ClO_2 generator unit shall be 90 % ± 1.0 % with respect to yield.

1.1.4 Above mentioned dosing rates are to achieve free residual (ClO_2) of 0.1 to 0.2 ppm.

1.1.5 The chlorine dioxide generator system shall be designed and bidder shall submit all calculation details, catalogue for review / approval during detail engineering and shall confirm to recommendations of the chlorine institute and EPA guidance manual, international/ Indian standards/codes.

1.2 DESIGN CRITERIA

i) Cooling Water

The detail of cooling tower, cooling tower make up water quality & quantity and capacity of ClO_2 generator are as given below:

(a)	CT Type	:	NDCT
(b)	Δt	:	10^0C
(c)	CT flow	:	By bidder
(d)	CT make up	:	By bidder
(e)	Number of ClO_2 generators	:	2 (1W+1S)
(f)	Design capacity of of ClO_2 generator	:	By bidder
(g)	Make-up water	:	Filtered water

ii) Raw Water

(a)	Raw water consumption	:	By Bidder (bidder to confirm)
(b)	Source	:	Raw water
(c)	No. & capacity of ClO_2 generator	:	2 (1W+1S) ; Capacity by Bidder

iii) Potable Water

(a) Potable water flow	:	By bidder
(b) Source	:	Filtered water
(c) No. & capacity of ClO_2 generator	:	2 (1W+1S); Capacity by bidder

1.3 SCOPE OF SUPPLY & WORK

i) The ClO_2 will be used as an alternative to chlorine gas, or sodium hypochlorite plus organic / inorganic biocide. Chlorine Dioxide (ClO_2) to be used for this purpose shall be generated at site from the reaction of Hydrochloric acid and Sodium chlorite solutions.

ii) Each Chlorine dioxide generation system shall include the following:

(a) $NaClO_2$ & HCl measuring tanks

(b) Dozing pumps for $NaClO_2$ & HCl

(c) Chlorine di-oxide generators

(d) Ejectors and dozing facilties

(e) Water dilution pumps

(f) Instrumentation i.e. flow, level etc.

(g) Safety equipments.

iii) Common Bulk storage tanks for $NaClO_2$ & HCl and associated unloading pumps for Sodium chlorite, Hydrochloric acid shall be provided.

iv) The chlorine di-oxide generator shall be automatic submerged/ encapsulated type in order to avoid leakage.

v) The scope of work includes design, engineering, manufacture, shop fabrication, assembly, tests and inspection at manufacturer's works, packing, delivery to site, unloading, storage and testing, inspection, erection, commissioning and handing over. The items though not specifically mentioned but are needed to make the system complete shall also be furnished, erected and commissioned unless otherwise specifically excluded.

vi) The scheme of chlorine dioxide generation and dosing is indicated in drawing no. 111-12-3505, 111-12-3506 & 111-12-3507.

vii) Getting approval from statutory auithorities and taking License for Chlorine Dioxide Generation Unit is included in scope of bidder. All fees and coordination on this account is included in scope of the bidder

1.3.1 Raw Water Chlorine Dioxide Generator

i) 2 Nos. (1W + 1S) of automatic submerged / encapsulated chlorine – dioxide generators.

ii) 2 Nos. (1W + 1S) HCl dozing system comprising of dozing pumps of PP construction, PRV, PG, auto & manual valves etc.

iii) One Acid (1) HCL measuring tank.

iv) 2 nos. (1W + 1S) Sodium chlorite (31%) unloading pumps of PP construction with necessary piping, pressure gauge etc.

v) 2 nos. $NaClO_2$ bulk storage tanks (each tank of effective capacity of 15 days total requirement or 15 cum, whichever is higher) with nozzles, vents, level control units etc. all complete. (These tanks shall be of FRP with UV protection construction).

vi) 2 nos. (1W + 1S) $NaClO_2$ dozing system comprising of dozing pumps of PP constructions, PRV, PG, auto & manual valves etc.

vii) One (1) no. $NaClO_2$ measuring tank.

viii) 2 Nos. (1W + 1S) water dilution dozing horizontal pumps comprising of SS construction with PG, auto & manual valves etc.

ix) Suitable diffuser arrangement to be provided for ClO_2 dozing in
(a) Clarifier 1 inlet
(b) Clarifier 2 inlet

1.3.2 Cooling Tower and Potable Water Chlorine Dioxide Generator

i) 2 Nos. (1W+1S) of automatic submerged/encapsulated chlorine dioxide generators for CT dozing.

ii) 2 Nos. (1W+1S) of automatic submerged/encapsulated chlroine dioxide generator each of capacity for potable water dozing.

iii) 2 Nos. (1W + 1S) HCl dozing system comprising of dozing pumps of PP construction, PRV, PG, auto & manual valves etc. for CW ClO_2 generator.

iv) One (1) Acid (HCL) measuring tank for CW ClO_2 generator.

v) 2 Nos. (1W + 1S) HCl dozing system comprising of dozing pumps of PP construction, PRV, PG, auto & manual valves etc. for potable water ClO_2 generator.

vi) One (1) Acid (HCL) measuring tank for PW ClO_2 generator.

vii) 2 nos. (1W +1S) water dilution pumps with drive and all accessories for CW ClO_2 generator.

viii) 2 nos. (1W + 1S) $NaClO_2$ dozing system comprising of dozing pumps of PP constructions, PRV, PG, auto & manual valves etc. CW ClO_2 generator.

ix) One (1) no. $NaClO_2$ measuring tank for CW ClO_2 generator.

x) 2 nos. (1W + 1S) $NaClO_2$ dozing system comprising of dozing pumps of PP constructions, PRV, PG, auto & manual valves etc. for potable water ClO_2 generator.

xi) One (1) no. $NaClO_2$ measuring tank for potable water ClO_2 generator.

xii) 2 nos. (1W +1S) water dilution pumps with drive and all accessories for potable water ClO_2 generator.

xiii) 2 nos. (1W +1S) water dilution pumps with drive and all accessories for CW ClO_2 generator.

xiv) Suitable diffuser arrangement to be provided for ClO_2 dozing in CW sump for each pump chamber with isolation valves.

xv) Suitable diffuse arrangement to be provided for ClO_2 dozing in potable water tank.

1.3.3 **Miscellaneous**

i) Any other items(s) if required for completeness of the system, safety requirements and to make the system operational.

ii) Painting of exposed pipelines, steel structures, equipments, operating platforms, ladders, stairs, hand railing, etc. as required.

iii) Complete structural, mechanical, electrical and instrumentation works for the system.

iv) Supply of first charge of lubricating oil and all consumables including operating chemicals like acid & sodium chlorite etc. requires for entire operation of raw water, CW & service water chlorine dioxide plant till the handling over the plant and additional chemicals of two (2) months requirement.

v) For successful pre-commissioning, commissioning and performance testing requirements of spares are to be supplied including essential spares required for two (2) years operation

1.3.4 **Control & Instrument**

i) ClO_2 leak sensor with detector shall be installed at ClO_2 generator room. The least count of sensor shall be 0.1 ppm and generator shall stop automatically in the event of leakage.

ii) Generators must be equipped with systems of dosing and/or measurement for reagents and diluting water. These systems must be able to shut down the operation of the generator in case any of the supplies is cut off.

iii) All other instruments like pressure guages, pressure relief valves, level indicators, compound guages, etc require for safe & trouble free operation of the system.

iv) Pressure indicator and flow meter with controller shall be provided on water inlet pipe to generator.

v) In case of water supply to the generator stops, the chemical dozing pumps shall also stop automatically.

vi) ClO_2 generation, dozing system for $NaClo_2$ & Hcl and other dosing facilities shall be operated through dedicated PLC based control system.

1.3.5 **Piping Valves**

i) Complete piping (with diffusers) from chlorine dioxide generator to all dozing points flow control valves, drain valves, Y-strainers, vents, ejector, etc. the diffuser shall be of CPVC.

ii) Complete piping (including interconnecting), all fittings, bends, tees, reducers, valves, flanges, bolts, gaskets, specials, isolation valves, permanent strainers, etc. including piperacks and supports, jointing, etc and any other work as required for the system shall be of CPVC, P&ID, process flow diagram etc.

1.3.6 **Civil**

i) Chlorine dioxide Generator unit shall be provided as a skid mounted unit in a room.

ii) MCC & Control System shall be located in a separate room

iii) HCl/$NaClo_2$ storage, unloading pumps and dozing pump arrangement shall be located in a suitable chemical lining area with dyke and sump pit.

1.4 Safety for Chlorine Dioxide System

i) Chlorine institute approved safety equipment shall include the following:

(a) Two (2) nos. respiratory equipment (pressure demand type air masks full face for working in leak area)
(b) Two (2) nos. canister type gas mask
(c) Two (2) nos. of emergency repair kit
(d) One (1) no. weather cock provided at a suitable location on the building
(e) Two (2) nos. each of safety helmets, googles, rubber boots, gloves and coloured vests (Aprons)
(f) Display charts of PFD, safety checks, maintenance procedure, emergency action plan, etc.
(g) One (1) no. safety shower an eye wash facility at each ClO_2 genration site (located just outside the chlorine-dioxide generator room).

2.0 CW TREATMENT SYSTEM

2.1 SYSTEM DESCRIPTION

i) The schematic arrangement of Circulating Water Treatment Plant has been detailed in Flow Diagram – CW Chemical Dosing System No. 111-12-3513 enclosed in Volume - VII.

ii) The proposed plant need to have treatment systems for inhibition of micro - biological fouling control scale formation and corrosion with reference to Circulating Water.

iii) There is a fore bay after the cooling tower of the unit, for which treatment sytem has been envisaged.

2.2 C.W. CHEMICAL TREATMENT

i) Sulphuric Acid will be dosed in the CW bay to convert scale-forming calcium and magnesium carbonate into corresponding sulphate compounds having higher solubility. Based on make-up water flow, 5 cycles of concentration in CW Circuit and to maintain maximum of 150 ppm of M-alkalinity in CW Circuit, 98% Sulphuric Acid needs to be dosed.

ii) Sulphuric Acid Injection System shall comprise of two (2) nos. Sulphuric Acid unloading Pumps, Two (2) nos. Sulphuric Acid Storage Tanks, two (2) nos. Sulphuric Acid Measuring Tanks, two (2) (1W+1S) nos. Sulphuric Acid Injection Pumps and all other accessories. The Sulphuric Acid Storage and Injection System shall be located outdoor.

iii) For additional safeguard against scaling & corrosion, synthetic polymer based Antiscalant along with corrosion inhibitor will also be dosed in CW fore.

iv) The Scale Inhibitor Injection System shall consist of Two (2) no. Scale Inhibitor Tanks, two (2) (1W+1S) nos. Scale Inhibitor Injection Pumps and all other accessories.

v) The Corrosion Inhibitor Injection System shall consist of Two (2) no. Corrosion Inhibitor Tanks, two (2) (1W+1S) nos. Corrosion Inhibitor Injection Pumps and all other accessories.

vi) The Scale Inhibitor and Corrosion Inhibitor System shall be located indoor within C.W. Treatment Building.

2.2.1 **Acid Injection and Chemical Injection Systems**

2.2.2 Two (2) nos. HDPE hose with suitable flange for unloading 98% Sulphuric Acid.

2.2.3 Two (2) nos. Sulphuric Acid Unloading Pumps with drive motor & accessories.

2.2.4 Two(2) no. Bulk Sulphuric Acid Storage Tanks with acessories.

2.2.5 Two (2) nos. Sulphuric Acid Measuring Tank with acessories.

2.2.6 Two (2) nos. (1W+1S) Sulphuric Acid Dozing Pumps with drive motor & acessories.

2.2.7 Two (2) no. Scale Inhibitor Tanks along with agitator & Two (2) nos. (1W_+1S) Scale Inhibitor Injection Pumps with drive motor & acessories.

2.2.8 Two (2) No. Corrosion Inhibitor Tank along with agitator & two (2) nos. (1W+1S) Corrosion Inhibitor Injection Pumps with drive motor & acessories.

2.2.9 All integral and interconnected piping including pipe fittings, valves, stubs for instrumentations, pipe supports, specialties, etc.

2.2.10 One (1) no. Diffuser each Sulphuric acid/Scale inhibitor/ Corrosion inhibitor.

2.2.11 Complete instrumentation and control for the entire plant. The nature and extent of instrumentation and control intended to be covered under this specification have been outlined in the P&I Diagrams enclosed with this specification.

2.2.12 Supply of first charge of lubricating oil, inhibitor for oil and also adequate quantity of all consumable including operating chemicals like sulphuric acid, scale inhibitor, corrosion inhibitor etc. requires for entire operation of CW Treatment till handling over of the plant is included in scope of bidder.

2.2.13 Supply of Mandatory Spares for the entire CW Treatment system as indicated in Volume II of specification.

2.2.14 Spares required for erection and commissioning of CW Treatment system.

2.2.15 One new set of special tools and tackles, fixtures etc., as required for regular operation and maintenance of the equipment offered. Adequate means shall be provided for lifting and handling of each item of plant and equipment.

2.3 SALIENT DESIGN FEATURES

2.3.1

i)	Circulating rate	:	By BIdder
ii)	Cycle of concentration	:	5
iii)	CW make up	:	By BIdder

2.3.2 Various chemical storage, preparation and injection systems in the Circulating Water Treatment Plant needs to be designed for the dosage rates as follows:

i)	Sulphuric Acid	:	To maintain M-alkalinity in cooling water 150 ppm max.
ii)	Scale Inhibitor	:	≤ 10 ppm.
iii)	Corrosion Inhibitor	:	≤ 10 ppm.

2.3.3 Each Tank under chemical service (except for Sulphuric Acid) shall be of vertical cylindrical with dished bottom design and welded construction with bolted top flange cover& agitator. The tanks shall be provided with overflow, inlet feed funnel, discharge/outlet pipe and level gauge.

2.3.4 Each Tank under chemical service (except for Sulphuric Acid) with all integral part including all nozzle connections shall be of SS 304 construction.

2.3.5 A minimum of 300 mm freeboard shall be provided for all the units and chemical solution tanks of the Circulating Water Treatment Plant.

2.3.6 For Sulphuric Acid service, the material of construction shall be of carbon steel. The tanks shall be provided with full-length gauge glass with isolation valve and drain valves, vent along with silica gel breather as well as overflow connection Staircase shall be provided for getting access to the top of tanks.

2.3.7 For Scale Inhibitor Injection System and Corrosion Inhibitor Injection System, all associated pipe work, fittings, valves etc. shall be stainless steel type 316 construction only.

2.3.8 The chemical injection pumps shall be positive displacement, simplex, constant speed, variable stroke plunger operated reciprocating type and arranged to operate under flooded suction conditions. The pump internals coming in contact with chemical shall be SS 316 (except for Sulphuric Acid service where it shall be of Alloy 20) construction. The pumps shall be capable of varying the discharge over the entire range of operation. The pump stroke shall be capable of manual adjustment from 0 to 100% capacity and locking shall be possible while the pumps are in operation. A calibrated scale shall be provided for the above purpose. The pumps shall be capable of operation either intermittently or continuously. Necessary relief valves and discharge pressure gauges shall be provided. 'Y' type strainer shall be provided at the suction of each Injection pump.

2.3.9 All nuts, bolts etc. in submerged and corrosive application shall be of SS-316.

2.4 OPERATION AND CONTROL PHILOSOPHY

2.4.1 The operation of the Circulating Water Treatment Plant shall be from DCS. Refer Volume V of specification for operational philosophy.

2.4.2 Sulphuric acid will be unloaded from road tankers by Sulphuric Acid Unloading Pumps into over ground Sulphuric Acid Storage Tanks.

In the auto mode, the stroke shall be adjusted by sensing pH of Circulating Water. During normal operation, Sulphuric Acid Injection Pumps will operate in the auto-mode and inject sulphuric acid to maintain the pH of circulating water

at a desired level. Adjustment of stroke shall also be possible automatically as well as local manually.

Normally one (1) no. pump will be in service and one (1) no. will be as stand-by pump selection through Selector Key.

2.4.3 ON/OFF/TRIP status of all pumps, agitators and drive motors as required shall be displayed in Operating Station.

2.4.4 All drive motors shall be provided with arrangement of local starting and stopping. Local starting shall be possible through remotel local selection key in Operating Station or in MCC. Tripping of drive motors locally shall be permissible irrespective of position of remote/local selector switch. Provision for locking the local stop push buttons after tripping the motor from local push button shall be there. All drive motors, valves etc shall be connected to DCS and the functions described above shall be performed in DCS.

2.4.5 Annunciation showing tripping of different motors, level alarms from level switches shall be located in the Operating Station.

2.5 GUARANTEE PARAMETERS FOR CIRCULATING WATER TREATMENT

2.5.1 Circulating Cooling Water:

i) Corrosion rate:

(a) On MS : < 3.0 mpy

(b) OnCu : < 0.5 mpy

(c) On SS (304) : < 0.5 mpy

ii) Scaling < 15 mg/dm²/day

iii) Ni-Cr mesh should be clean when visually inspected

iv) Pitting corrosion rate on MS/Brass : < 20 mpy.

v) Micro/Bio fouling conditions

(a) Total Viable Count (TVC): < 1 x10^5 Counts/ml

(b) Sulphate reducing bacteria (SRB) : < 1 x10^5 Counts/100 ml

DATA SHEET FOR BULK STORAGE TANKS - SODIUM CHLORITE

Sl. No.	Description	Unit	
1	Number	no	Two (2)
2	Location		----------Outdoor----------
3	Nett capacity	Cum	Each tank of effective capacity of 15 days total requirement or 15 cum, whichever is higher
4	Type		Horizontal cylindrical with dished ends
5	Design code		BS : 4994 (1987
6	Design Pressure		ATM
7	Design temperature	^{0}C	50
8	Material of construction		FRP, 12 thk for shell 15 thk semi ellipsoidal dish end
9	Concentration	%	31 sodium chlorite
10	Manhole, staircase, platform, vent, overflow fume absorber		Required
11	Gasket		3 thk National Rubber

DATA SHEET FOR UNLOADING PUMPS – SODIUM CHLORITE

S. No.	Description	Unit	
1	Quantity	Nos.	02 (1W + 1S)
2	Application	%	31 sodium chlorite
3	Type of pump		Horizontal centrifugal
4	Operation		Intermittent
5	Location		Outdoor
6	Power supply		415V±10%, 3ϕ, 50 Hz ± 3-5 %
7	Fluid to be handled	%	31 $NaClo_2$
8	Specific gravity		1.2
9	Normal viscosity	cP@^{0}C	1
10	Operating temperature	^{0}C	60
11	Corrosive nature		Corrosive
12	Normal flow	M^3/hr	10
13	Nominal head at discharge	MWC	15
14	Suction condition	$NPSH_A$	Flooded
15	Range of operation	%	20 - 120
16	Type of impeller		Semi open
17	Suc/discharge flange drilling		As per ANSI B16.5 # 150
18	Method of lubrication		Oil
19	Type of coupling		Flexible
20	Material of Construction		
i)	Casing		Moulded polypropylene
ii)	Back plate		Moulded polypropylene
iii)	Impeller		Moulded polypropylene
iv)	Shaft		EN-8
v)	Shaft sleeves		High Alumina Ceramic
vi)	Shaft sealing / MOC		Mechanical seal / GFT ceramic
vii)	Bearing		Steel antifrication
viii)	Bearing housing		CI
ix)	Bolts & nuts		PP & SS
21	Pump speed	RPM	1440
22	Accessories		
i)	Base plate (MS fabricated)		Yes
ii)	Coupling		Yes
iii)	Coupling guard		Yes

DATA SHEET FOR DOSING PUMP - HYDROCHLORIC ACID

S. No.	Description	Unit	Raw Water	CW Treatment	Potable Water Water
1	Type		Electronically actuated diaphragm type		
2	Quantity		02 (1W+1S) for each area		
3	Fluid	%	33 Hcl		
4	SG of Fluid		1.165		
5	Operating flow	LPH	Bidder to indicate		
6	Operating pressure	Kg/cm^2	Bidder to indicate		
7	Max flow	LPH	Bidder to indicate		
8	Maximum pressure	Kg/cm^2	Bidder to indicate		
9	Range of operation	%	10 to 100		
10	Flow adjustment		a) By manual stroke adjustment b) By manual speed adjustment		
11	Speed range	SPM	0-100		
12	Input		230V, 1 Phase, 50 Hz AC		
13	Drive		Electrical power unit, class "F" insulation		
14	Suction pressure		Flooded		
15	Ambient temperature	^0C	50 max.		
16	Design temperature	^0C	60 max		
17	Noise level		<85 decibel up to 1 mts		
18	Material of construction				
i)	Housing		PP		
ii)	Spacer		PP		
iii)	Diaphragm		Teflon faced hypalon		
iv)	Ball		Ceramic		
v)	Liquifram shaft		Hardened steel EN-8 (BS : 970)		
vi)	Head		PP		
vii)	Valve seat		PVC		
viii)	Valve housing		PVC		
ix)	Ring seal		Teflon		
x)	Suction strainer-Y type		PP		
xi)	Nuts & Bolts		SS 316		
xii)	Pulsation dampener		PVC		
xiii)	Fixing bolt		SS 316		

DATA SHEET FOR DOSING PUMP - SODIUM CHLORITE

S. No.	Description	Unit	Raw Water	CW Treatment	Potable Water
1	Type		Electronically actuated diaphragm type		
2	Quantity		02 (1W +1S) for each area		
3	Fluid	%	31 $NaClo_2$		
4	SG of Fluid		1.2		
5	Operating flow	LPH	Bidder to indicate		
6	Operating pressure	Kg/Sqcm	Bidder to indicate		
7	Max flow	LPH	Bidder to indicate		
8	Maximum pressure	Kg/Sqcm	Bidder to indicate		
9	Range of operation	%	10 to 100		
10	Flow adjustment		a) By manual stroke adjustment b) By manual speed adjustment		
11	Speed range	SPM	0-100		
12	Input		230V, 1 Phase, 50 Hz AC		
13	Drive		Electrical power unit, class "F" insulation		
14	Suction pressure		Flooded		
15	Ambient temperature	^{0}C	50 max.		
16	Design temperature	^{0}C	60 max		
17	Noise level		<85 decibel up to 1 mts		
18	Material of construction				
i)	Housing		PP		
ii)	Spacer		PP		
iii)	Diaphragm		Teflon faced hypalon		
iv)	Ball		Ceramic		
v)	Liquifram shaft		SS-321		
vi)	Head		PP		
vii)	Valve seat		PVC		
viii)	Valve housing		PVC		
ix)	Ring seal		Teflon		
x)	Suction strainer-Y type		PP		
xi)	Nuts & Bolts		SS 316		
xii)	Pulsation dampener		PVC		
xiii)	Fixing bolt		SS 316		

DATA SHEET FOR DILUTION DOSING HORIZONTAL CENTRIFUGAL PUMP

S. No.	Description	Unit	Cooling water	Raw water	Potable water
1.	Quantity	Nos.	02 (1W+1S)	02 (1W+1S)	02 (1W+1S)
2.	Type of pump		Radially split back pullout		
3.	Location		Outdoor		
4.	Power supply		415V±10%, 3ϕ, 50Hz ±3-5%		
5.	Fluid and state		Service water		
6.	Specific gravity		1	1	1
7.	Corrosive nature		Non corrosive		
8.	Nominal flow	M^3/hr	60	15	1
9.	Head at discharge	M	As per process requirement		
10.	Suction condition		Flooded		
11.	Range of operation	%	20 – 120		
12.	Type of impeller		Closed		
13.	Suction/discharge connection		ANSI B16.5 # 150		
14.	Method of lubrication		Oil		
15.	Type of coupling		Flexible		
16.	Material of construction				
i)	Casing		SS 304		
ii)	Impeller		SS 304		
iii)	Shaft		SS 410		
iv)	Shaft sleeves		SS 304		
v)	Packing / MOC		Gland packing / VTA		
vi)	Stuffing box packing		Asbestos free graphite cotton		
vii)	Bolts & Nuts		High tensile steel		
17.	Rated speed	RPM	1440		
18.	Accessories for pump		Foundation bolts, common base plate: MS as per IS2062, coupling guard etc.		

DATA SHEET FOR CHLORINE DIOXIDE GENERATOR

S. No.	Description	Unit	Cooling Water	Raw water	Potable water
1.	Type		Automatic – submerged / Encapsulated pressure water reactor		
2.	Quantity	Nos.	2 (1W+1S)		
3.	Capacity	Kg/hr	By Bidder	By Bidder	By Bidder
4.	Material of construction		MS with internally lined vessel with PVC – FRP & PVDF internals. (for encapsulated pressure water reactor) PVDF (for submerged type)		

Datasheet for Acid Measuring Tanks

1.0	**Acid (HCL) Measuring Measuring Tanks**		**CW Chlorination**	**RW Chlorination**	**PW Chlorination**
i	Number	No.	One (1)	One (1)	One (1)
ii	Type		Vertical Cylindrical		
iii	Effective capacity (minimum)	M^3	Effective capacity of each tank shall be adequate to hold the quantity required for 12 hrs operation but effective capacity of each of the tank shall not be less than 2.5 m³		
iv	Tank – M.O.C.		FRP	FRP	FRP
v	Agitator – Type		Not Required		

Datasheet for Chlorite Measuring Tanks

1.0	**Chlorite Measuring Tanks**		**CW Chlorination**	**RW Chlorination**	**PW Chlorination**
i	Number	No.	One (1)	One (1)	One (1)
ii	Type		Vertical Cylindrical		
iii	Effective capacity (minimum)	M^3	Effective capacity of each tank shall be adequate to hold the quantity required for 12 hrs operation but effective capacity of each of the tank shall not be less than 2.5 m³		
iv	Tank – M.O.C.		FRP	FRP	FRP
v	Agitator – Type		Not Required		

DATA SHEET - CIRCULATING WATER TREATMENT SYSTEM

S. No.	Description	Unit	
1.0	**Sulphuric Acid Unloading Pumps**		
1.1	Number	No.	Two (2) (1 W + 1S)
1.2	Description for each pump		
i)	Location		Outdoor
ii)	Fluid to be handled		98% Concentrated Sulphuric Acid
iii)	Service		To unload Concentrated Sulphuric Acid from Road Tanker to Storage Tanks
iv)	Duty		Intermittent and to be suitable for parallel operation
v)	Type of Pump		Horizontal Centrifugal Non Clog type
vi)	Rated Capacity	m^3/hr	10
vii)	Range of operation	%	20 - 120
viii)	Suction Condition		Flooded
ix)	Head to be developed at rated capacity	mlc	10 minimum
x)	Material of construction		
a)	Casing		Alloy- 20
b)	Impeller		Alloy-20
c)	Shaft		EN-8 to BS- 970
d)	Mechanical Seal		Alloy-20
e)	Common Base plate		Fabricated Steel as per IS 2062
f)	Nuts and bolts		Alloy-20
xi)	Type of drive		Electrical Motor
xii)	Rated speed	RPM	1500 (Sync.)
xiii)	Voltage, Phase & Frequency (± % variation)		415 V (±10%), 3 Phase, 50 Hz
xiv)	Type of coupling between Pump & Motor		Flexible Spacer
xv)	Accessories to be provided		
a)	Suction Strainer		Required

S. No.	Description	Unit	
b)	Hoses	Nos.	Two (2) nos., 50 mm NB and 20 m long type-2 HDPE Hose as per IS-7654/1989
2.0	**Bulk Sulphuric Acid Storage Tank**		
2.1	Numbers to be provided	Nos.	Two (2)
2.2	Description for each tank		
i)	Type		Horizontal cylindrical with dished ends
ii)	Type of Fluid to be handled	%	98 Sulphuric Acid
iii)	Effective capacity		Total effective capacity of all tanks shall be adequate to hold the quantity required for 15 days operation but effective capacity of each tank shall not be less than 25 m^3
iv)	Minimum free board	mm	300
v)	Material of construction		
a)	Shell		Carbon steel as per IS 2062 or ASTM A 36
b)	Dished Ends		Carbon steel as per IS 2002 or ASTM A 515 Gr.70.
vi)	Thickness	mm	Not less than 10
vii)	Protection		
a)	Internal		Not required
b)	External		Chlorinated Rubber Paint
viii)	Manhole		One (1) No. of 500 mm NB
3.0	**Sulphuric Acid Measuring Tanks**		
3.1	Numbers to be provided	Nos.	Two (2) (1W + 1S)
3.2	Description for each tank		
i)	Type		Vertical cylindrical with dished ends,covered
ii)	Type of Fluid to be handled	%	98 w/w Sulphuric Acid
iii)	Effective capacity		Effective capacity of each tank shall be adequate to hold the quantity required for 12 hrs operation but effective capacity of each of the tank shall not be less than 2.5 m^3

S. No.	Description	Unit	
iv)	Material of construction		Carbon steel as per IS 2062 or ASTM A 36 for shell and Carbon steel as per IS 2002 or ASTM A 515 Gr 70 for dish
v)	Thickness	mm	Not less than 6.0
vi)	Protection		
a)	Internal		Not required
b)	External		Chlorinated Rubber Paint
4.0	**Sulphuric Acid Injection Pumps**		
4.1	Number	Nos.	Two (2) (1W + 1S)
4.2	Description for each pump		
i)	Type of pump		Positive displacement, constant speed, variable storke and plunger operated reciprocating type
ii)	Fluid to be handled		98% w/w Concentrated sulphuric acid
iii)	Service		To inject Concentrated sulphuric acid into CW Pump House Fore-Bay
iv)	Duty		Continuous and to be suitable for parallel operation
v)	Suction Condition		Flooded
vi)	Rated Capacity	lph	By Bidder
viii)	Facility for Capacity Adjustment		Auto on pH with local manual over ride facility through Micrometer Dial and remote manual from Control Panel
ix)	Range of Capacity Adjustment	%	0 - 100
x)	Tentative head to be developed at rated capacity		As per process requirement but not less than 10 MLC
xi)	Pump speed	RPM	1500
xii)	Material of construction		
a)	Housing		Alloy-20
b)	Pump head		Alloy-20
c)	Plunger		Alloy-20
d)	Worm		Manganese bronze / cast iron
e)	Worm wheel		Manganese Bronze / Cast Iron

S. No.	Description	Unit		
f)	Shafts (worm)		Hardened Steel (EN 19 / ASTM A 276 Gr.410)	
g)	Base plate		MS	
xiii)	Type of coupling between Pump & Motor		Flexible spacer	
xiv)	Accessories to be provided		Pulsation Dampener, Pressure Relief Valve	
5.0	**Measuring Tank**		**Scale Inhibitor**	**Corrosion Inhibitor**
5.1	Numbers	Nos.	2 (1W +1S) for each system	
5.2	Description of tank			
i)	Type		Vertical cylindrical tank with dished bottom and agitators, covered	
ii)	Effective capacity		Overall effective capacity of each type of tanks shall be adequate to hold the quantity required for 2 days with effective capacity but each tank shall not be less than 1.5 m^3 for scale & corrosion inhibitor	
iii)	Minimum free board	mm	30 0	
iv)	Material of Construction		SS – 304	
v)	Thickness	mm	Not less than 5	
vi)	Dissolving Basket			
a)	Number		←---------One (1) per tank----------→	
b)	Material of Construction		SS-316	
6.0	**Injection Pumps**		**Scale Inhibitor**	**Corrosion Inhibitor**
6.1	Number	nos.	Two (2) [1W + 1S] for each system	
6.2	Description for each pump			
i)	Type of pump		Positive displacement, constant speed, variable stroke and plunger operated reciprocating type.	
ii)	Location		Indoor	
iii)	Service		To inject Scale Inhibitor & Corrosion Inhibitor into CW pump house fore-bay	
iv)	Duty		Continuous and to be suitable for parallel operation	
v)	Suction Condition		Flooded	
vi)	Rated Capacity		To be suitable for operation of all the units at full load m^3/hr with 10% margin	

S. No.	Description	Unit	
vii)	Facility for Capacity Adjustment		Local manual through micrometer dial and remote manual from control panel
viii)	Range of Capacity Adjustment	%	0 - 100
ix)	Tentative head		As per process reqeuirement but not less than 10 MLC
x)	Material of construction		
a)	Housing		SS-316
b)	Pump head		SS-316
c)	Plunger		SS-316
d)	Worm		Manganese Bronze / Cast Iron
e)	Worm wheel		Manganese Bronze / Cast Iron
f)	Shafts (worm)		Hardened Steel (EN 19 / ASTM A 276 Gr.410)
g)	Base plate		MS
xi)	Type of coupling between Pump & Motor		Flexible spacer
xii)	Accessories to be provided		Pulsation dampener, Pressure relief valve

CHAPTER – 18

NATURAL DRAUGHT COOLING TOWER

CONTENTS

CHAPTER – 18

NATURAL DRAUGHT COOLING TOWER

18.1 CODES & STANDARDS

The design, construction, manufacture, performance, testing and commissioning of the cooling tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of Practice. The latest editions of the following standards and publications shall be followed in particular:

18.1.1 BS 4485 Water Cooling Tower (Part 1 thru' 4)

18.1.2 Cooling Tower Institute of USA, Bulletin ATC-105: "Acceptance Test Procedure for Water Cooling Tower."

18.1.3 CTC ATC-105: Acceptance Test Code for Water Cooling Towers

18.1.4 IS: 11504: Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Towers.

18.1.5 ANSI/ASME PTC-23: Performance Test Code for Atmospheric Water Cooling Equipment.

18.1.6 Cooling Technology Institute of USA, STD-136: "Polyvinyl Chloride Materials used for Film Fill, Louvers and Drift Eliminators.

18.1.7 Cooling Technology Institute of USA, STD-146: "Standard for Water Flow Measurement".

18.1.8 Cooling Technology Institute of USA, ESG-144: "CTI fastener material guidelines".

18.1.9 Cooling Technology Institute of USA, ESG-153: "Recommended guidelines for Portland Cement Concrete for Mechanical draft Cooling Towers.

18.1.10 AWWA C504: American Water Works Association standard for Rubber seated Butterfly valve.

18.1.10 AWWA C207: American Water Works Association standard for Steel Pipe Flange for Waterworks service.

18.1.11 BS: 3435: Measurement of Electrical Power and energy in acceptance testing.

18.1.12 American Society of Testing Materials.

18.1.13 Materials of various components such as PVC, plain and reinforced concrete, bars and steel wires for concrete reinforcement etc. shall be in accordance with relevant Indian Standards or else to applicable American Standards.

18.1.14 In case of any contradiction between the aforesaid Standards and stipulations as per this technical specification as specified hereinafter, the stipulations of this technical specification shall prevail.

18.1.15. Also, in case of any contradiction between this technical specification and stipulations of the enclosed "Data Specification Sheets", the stipulations of the Data Specification Sheets will prevail.

18.2 GENERAL REQUIREMENTS

18.2.1 The cooling tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature and other design parameters as enumerated in the enclosed Natural Draught Cooling Tower Data Specification Sheets.

18.2.2 The cooling tower shall be designed for continuous operation throughout the year, unless specially stated otherwise in Data Specification Sheet. The guaranteed performance (cold water temperature) shall be achieved at all wind velocities as specified.

18.2.3 The cooling tower shall also give satisfactory performance while handling the specified water during monsoon months, with the range as indicated in Data Specification Sheet.

18.2.4 For arriving at the air properties such as enthalpy, density etc., no correction for altitude shall be considered. All properties shall be taken from the data provided on CTI or BS code corresponding to sea level.

18.2.5 Bidder shall also furnish the following in support of tower design and performance, along with the bid without which the offer is liable for rejection.

18.2.6 Heat balance calculations.

18.2.7 Justification for the outlet air temperature. This could be in the form of operating experience on existing tower or laboratory test on actual fill shape, material and configuration as offered. In the case of laboratory test, Bidder shall indicate correction / scaling factor applied to predict performance of full size tower under field conditions.

18.2.8 Calculations to show the adequacy of tower height to provide the required Draught.

18.2.9 Calculations for tower duty coefficient and performance coefficient.

18.2.10 Sketch showing fill arrangement which should clearly indicate the total depth, horizontal and vertical spacing.

18.2.11 Drift loss of the cooling tower expressed in % of rated capacity shall be limited to as close to zero as possible.

18.2.12 The Bidder shall assume full responsibility in proper design and operating of each and every component of the complete cooling tower as well as the cooling tower as a whole.

18.2.13 The cooling tower shall be designed to use filtered water to reject the steam cycle heat load from the steam surface condenser as well as the auxiliary Cooling Water System directly to the atmosphere. Cycle of concentration shall be 5 (minimum) to optimize the use of inlet water. The hot water distribution pipes for counter flow type shall distribute the hot water over the Fills. The hot water cools by evaporation as it drains through the fill into the cooling tower basin.

18.2.14 **Design Criteria**

The layout of the cooling tower in the plant area and the wind rose are indicated in the plot plan drawing. The Bidder shall examine the proposed layout of the tower and accordingly determine the recirculation which must be taken into consideration for the purpose of design of the tower to ensure that the design parameters of the tower are maintained. Bidder may consider to apply a correction factor to the design wet bulb ambient temperature to accommodate the recirculation effect.

Sensible heat of evaporated water shall be taken into consideration in the thermal design of the cooling tower. The air flow requirement shall not be less than that worked out by the formula given below.

$G \times H = L (T1 - T2) + EvT2$

Where

L = Water flow rate in Kg/Hr

T1 = Water inlet temperature to the tower in deg. C

T2 = Water outlet temperature from the tower in deg. C

Ev = Evaporation loss in Kg/hr. To compute this factor, RH shall be taken as specified.

G = Air rate in Kg/hr.

H = Change in enthalpy of air in Kcal/Kg.

Calculations justifying the selected air flow and evaporation loss shall be enclosed with the bid. International / National standard table of properties of air shall be used; and a copy of the table clearly indicating the standard used shall be enclosed with the bid.

The bidder shall furnish in his bid the following:

a) Heat balance calculations and air requirements for cooling tower, Calculations justifying the selected air flow and evaporation loss.

b) Available tower characteristics (KaV/L – as a function of air & water rates, fill geometry, hot water temperature, air velocity etc.) based on field performance tests. The relationship shall be of general as per the equation below and shall include values of the constants "c" and "n". The equation shall cover range of "L/G" values from atleast 20% above to atleast 20% below design.

$KaV/L = c(L/G)^n$

The bidder shall also submit an equation and/or curve defining the demand requirement at design approach, range and wet bulb temperature. The design "L/G" value shall be identified.

c) Calculations for pumping head

d) Tower Performance curves

The Bidder should establish and prove the validity and the basis of procedures and methods used in the calculations.

18.3 **SCOPE**

The following Equipment shall be supplied under this specification.

18.3.1 **General**

- Design, manufacture, supply and delivery of plant and equipment to site, storage at site, material handling, construction/ erection including all civil & structural works and bar bending schedules, aviation lighting, lightning protection, earthing, illumination and provision for instrumentation works, final checkup, connected channel works and piping works within the battery limits, performance testing, painting and commissioning of one (1) Natural Draught RCC Cooling Tower.
- Thermal, mechanical and structural design of cooling tower including all appurtenant civil works.
- Supply at site of all materials and equipment required for construction.
- Construction of cold water basin, cold water outlet channel/ duct and basin de-sludge arrangement, including stop loggates and screens and gantry structure for lifting tackles.
- Hot water distribution piping/ducting along with spray nozzle system.
- Supply, shop testing of components and erection of all mechanical equipment, fill, Spray nozzles, etc.
- Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure/super structure in a water free condition is in the scope of work of the Bidder. Dewatering shall be planned and continued till backfilling is completed. For discharge of sub-soil water a suitable pipeline system with pumping arrangement shall be provided to the nearest drain with the prior approval of the Owner.
- Fills and their support members, precast concreting work etc.
- Water distribution system of approved design along with its support members.
- Staircases with handrails and posts, platforms, FRP access doors with all accessories, internal walkways and walkways at CT top with stainless steel pipe handrails and posts, all necessary stainless steel inserts in the concrete etc., for satisfactory maintenance of the Cooling Tower as detailed in civil tender specification.
- Water proof painting of all internal surface of the basin, shell and fill supports, structures, water distribution ducts and external surfaces of the basin and foundations.
- The drift eliminators shall limit the drift loss to 0.05% of total water in circulation. The air pressure drop across the drift eliminators shall be kept to a minimum by suitable design. The water collected in the drift eliminators shall be returned to the Tower basin and it shall not mix with the discharge air system. The bidder shall demonstrate the efficiency of the drift eliminators by means of tests as per BS 4485 Part 2.

- The drift eliminators shall be made of virgin PVC. It shall be highly resistant to deterioration and fire retardant. The make and properties of the fill shall be subject to the approval of theOwner Owner.

- Complete electrical grounding, illumination, lightning protection system and aviation warning system with necessary stainless steel inserts conduits and cabling, necessary power distribution arrangement as per technical specification for "Volume IV: Electrical Works,".

18.3.2 **Mechanical works**

a) Hot water distribution spray system of reliable & efficient design, along with its supporting arrangement.

b) Hot water duct/pipe work along with supports and anchors.

c) Motor operated with chain pulley arrangement isolation valves on hot water inlet piping before hot water distribution system to achieve basin maintenance.

d) Painting both inside and outside surfaces of steel pipes with three coats of rust and corrosion resisting paint including thorough cleaning of the surfaces.

e) Tower fill, drift eliminators including all required supporting structure and accessories, etc. as necessary.

f) Screens along with guides embedded in concrete at each of the cold water outlet channels from the cold water basin.

g) Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin.

h) Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates.

i) Cold water outlet duct/tunnel.

j) Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels.

k) Tower Fill Hot water By-Pass Nozzle connections on Hot water duct/ piping for system lines flushing during commissioning.

l) Instrument tapping provisions on hot water duct/piping and cold water duct/piping for carrying out flow and temperature measurement during PG test.

18.3.3 **Electrical Works**

Refer Volume IV.

18.3.4 **Civil Works**

Refer Volume-VI.

18.3.5 Any additional equipment, material, services which are not specifically mentioned here, but are required to make the plant/systems in the scope of the Bidder complete in every respect in accordance with the technical specification

and for safe operation and guaranteed performance, shall be deemed to be covered under the scope of this specification.

18.3.6 All accessories and hardwares.

18.3.7 The scope of this specification also includes erection, installation, site testing, commissioning, trial run, performance and guarantee tests, training of operating personnel, O&M of the plant till commencement of commercial operation and other erection services to ensure trouble free operation and commissioning of the Equipment/System.

18.4 DESIGN AND CONSTRUCTION

18.4.1 The Structure

a) The Cooling Tower shell shall be hyperboloid.

b) The shell of the Cooling Tower shall be supported by a set of diagonal columns, which shall be supported by raker piles and a peripheral pile cap and on an annular raft depending on final soil investigation report to be conducted by the bidder.

c) Hot water inlet shall be through a pair of steel pipes.

d) To control the hydraulic forces at the change of alignment of the hot water (HW) inlet pipe, at ground level near the Cooling Tower, RCC thrust block shall be provided.

e) The hot water distribution shall be by RCC main and secondary ducts finally through UPVC/HDPE/FRP pipes fitted with nozzles for uniform distribution through the fill, which shall be film type.

f) When selecting the spray equipment and its position, it shall be ensured that maximum heat transfer is achieved above the parts installed with the system chosen. Optimum cascading is to be attained using spray equipment with staggered nozzle sizes.

g) The concrete main distribution ducts shall be accessible and are to be provided with non-corroding, pressure-sealed inspection openings. Cleaning and sludge-removal openings shall be included on each run at the end of the duct in the main distributor pipes.

h) The profile of the drift eliminators shall be selected to ensure a maximum degree of precipitation and minimum air pressure loss.

i) The HW distribution arrangement shall be supported independent of the shell by internal columns finally supported on the floor of the cold water basin.

j) Access to the hot water distribution system shall be provided with two RCC stair leading to FRP door giving access to distribution system.

k) The material used for access facilities including steel components for steps, ladders, platforms, catwalks, railings, doors, base frames, mountings, etc shall be resistant to corrosion.

l) All bolted connections and attachments to concrete shall be made out of suitable stainless steel.

m) The Cooling Tower basin shall be divided into two equal parts by watertight RCC partition for cleaning and HW distribution and maintenance of one half while the other half is in service. Arrangements for the HW distribution and water drainage shall also be provided with suitable valve chamber and submersible drain pumps for each Cooling Tower.

n) The basin and cold water discharge channel shall be capable of handling 120% of design flow or the both CW pump run-out flow whichever more, without any over flow. The basin outlet shall be sized for water velocity not exceeding 1M/sec at minimum water level. The cold water from the basin shall be conducted through an opening in the cold water basin and led to the fore-bay of the CW sump. The cold water from the basin shall flow by gravity to open approach channel leading to the fore-bay. The cold water channel shall be provided with stop log gates & screens. Suitable handling arrangements with monorail and chain-operated hoists with travelling trolley shall be provided for handling of the stop log gates & screens. In front of the outlet structure, provision shall be made for de-sludging facilities, so that sediments can be withdrawn near the basin. In order to clean the Cooling Tower basin, sludge sumps for each half of basin compartment shall be provided from where the sludge can be pumped out.

o) The water collection basin, consisting of base slab and basin wall, shall also serve as a water reservoir. The basin wall shall be inside the diagonals.

p) Structural Design Concepts shall be as described in Volume VI: Civil Specification.

q) To handle stop log gates & coarse screens, mono rails shall be provided across each cold water channel. Separate Hand operated chain pulley blocks with travelling trolley of adequate capacity to handle stop log gates and coarse screens shall be provided for each Tower. The capacity of the hoist however shall in no case be less than 125 % the weight of the stop log gate / screen. Coarse screen dimensions shall be identical and interchangeable.

18.4.2 **Hot Water Distribution System**

18.4.2.1 The distribution system shall be designed for flexible and satisfactory operation at all reasonable loads.

18.4.2.2 The hot water distribution shall be suitable for handling an additional 20% flow over the design circulating water flow. The hot water distribution shall be done by two headers, each covering half of cooling tower area so that it can be operated at 50% capacity.

18.4.2.3 The hot water distribution piping and valves shall be designed for a working pressure as calculated by the Bidder.

18.4.2.4 The spray system can be either upward or downward maintaining water spray even with shutdown flows.

18.4.2.5 The nozzles shall be arranged in a uniform pattern with proper distance to produce 15% overlapping of the individual sprays. This arrangement shall provide extremely even water distribution with uniformly sized droplets entering

the fill. The spray overlapping required avoiding dry pockets in the fill due to variations expected in water head availability in main hot water duct.

18.4.2.6 The spray nozzle shall be reliable and effective in breaking the hot water jet into a spray pattern of uniformly sized droplets. It should be proven and tested design to provide maintenance free service for minimum 3 years.

18.4.2.7 The fixing arrangement of spray nozzles to hot water distribution header shall be of flanged joint type. Screwed joint shall be avoided as they are likely to get loosened due to flow induced vibrations.

18.4.2.8 The distribution of water shall be in Ducts / troughs of approved material. The entire water distribution system shall be self-draining and non-clogging type.

18.4.2.9 The distribution troughs/pipes shall be independently supported from the structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs / pipes.

18.4.2.10 The structural design of the water distribution system shall also consider the following loadings, combined as appropriate.

- Self weight.
- Hydraulic pressure during normal operations, including pressure surges.
- Hydraulic pressures due to mal-operation of tower or supply pumps.

18.4.2.11 Seismic loading on the water distribution system shall also be considered.

18.4.2.12 The water distribution system shall be provided with adequate pressure surge relief facilities to prevent pressure loadings in excess of values used in the design. If such facilities are not provided, a further increase in loading shall be considered in the design. The pressure level to be considered shall not be less than 1.5 times the design pressure.

18.4.2.13 The design of water distribution system and its supports shall be capable of accommodating all thermal stresses and movements due to changes in inlet water temperature, outlet water temperature and ambient temperature.

18.4.2.14 If open basin system of distribution is provided, the basin shall be provided with removable type covers made of pre-cast concrete.

18.4.2.15 Splash boxes in cross flow tower shall be provided at the discharge of each distribution valve to minimize splashing and to facilitate even distribution of water.

18.4.2.16 The nozzles shall be spaced to give even distribution of water over the entire space occupied by top row of fills.

18.4.2.17 The nozzles and splash bars shall be made of High Density Polyethylene UV rays stabilized.

18.4.2.18 The pipes & valves etc. used shall be designed and arranged to take care of the possible thermal stress due to temperature variation. The pipes & fittings shall have extra heavy thickness.

18.4.2.19 Ready accessibility to the different parts like isolation valves etc. shall be provided and as required necessary platform/walkway and ladder shall be provided for this purpose.

18.4.3 **Fill & Fill Supporting Arrangement**

18.4.3.1 The fill shall be of non-clogging type fills like modular splash/trickle grid/turbo splash or splash type fills like V-bar splash/splash grid and easily installable. The fills shall be adequately supported to prevent sagging and damage. The tower shall be levelled so that water will be uniformly distributed over the fills and does not cause channeling. The splash type fills shall be placed horizontally.

18.4.3.2 The non-clogging type fills shall be in modular form. These fills are to be mechanically assembled without any use of adhesives. Assembling by other proven method is also acceptable. The fill shall be freely rested, and bottom supported to prevent any sagging and damage.

18.4.3.3 The fill material shall be highly resistant to deterioration and shall be fire retardant. PVC/PP fill shall be of proven quality. The Properties of PVC/PP material for the fills shall be in line with CTI-136 2010.

18.4.3.4 The type of fill to be supplied for this package shall be of proven design. The performance of the fill should have been established for the specified/higher duty conditions.

18.4.3.5 Type Test of PVC/PP Material In addition to the routine tests specified in this Technical specifications, ultra-violet exposure for 500 hours on the PVC/PP material shall be carried out for this contract once as per ASTM-G155, Test Method 3 and Impact resistance test before and after UV exposure shall be conducted as per ASTM D-256. The above type test shall be carried out by the Contractor at reputed third-party laboratory.

Offered fills shall be tested by an independent reputed laboratory approved by Owner to validate thermal characteristic and pressure drop correlation of the offered fill. In case the bidder has their own established test facility where such tests have been conducted for other reputed clients in the past, the same is also acceptable subject to owner's approval.

Test bed shall have fill height same as the offered fill height. During testing water and air loading as well as the air velocities shall be maintained same as the duty conditions and in the range of performance guarantee conditions for which tower is designed.

18.4.3.6 The supporting of the fill shall be achieved by a series of precast RCC columns arranged in suitable grid spacing and precast beams in orthogonal directions. Loads from fills, hot water ducts, pipes including water load, wall blocks etc shall be considered for column design. To take care of horizontal loads due to seismic and thrust from hot water header, a suitable system of vertical bracings is to be designed and provided in either direction.

18.4.3.7 Concrete impermeable to water shall be used for all components, including reinforced concrete components. The composition of the concrete and the cement shall be chosen depending on the chemical analysis of the Cooling Tower water/Cooling Tower make-up water.

18.4.4 **Drift Eliminators**

18.4.4.1 Zig-Zag path type Multi pass Drift eliminators (minimum two pass) shall be provided so as to limit the drift loss to that specified earlier or as in the Data Specification Sheet.

18.4.4.2 In case the tower is provided with pre-stressed concrete or PVC fill, drift eliminators may be made up of PVC.

18.4.4.3 The eliminator frame shall be of rugged construction and shall be firmly secured to arrest vibration.

18.4.5 **Access**

18.4.5.1 Staircases shall be provided external to the cooling tower along with stairways, landings, walkways, handrails and access doors. Minimum 2 Nos. staircase 1000 mm wide and minimum landing width of 1000 mm at locations as necessary to give safe and convenient access to the top and the interior parts of the tower.

18.4.5.2 Suitable arrangement for supporting walkways inside the cooling tower shall be made and such arrangement shall be independent of the fill material.

18.4.5.3 Whether specifically mentioned in the Data Sheet or not, steel components and fittings used in walkways, handrails shall be hot dip galvanized after fabrication followed by one coat of etching primer and two coats of bituminous paint.

18.4.6 **Cooling Tower Basin & Outlet Sumps**

18.4.6.1 The hot water distribution system, basin and cold water outlet channel of the cooling tower shall be designed by considering a minimum of 20% margin over the design cooling tower flow.

18.4.6.2 Cooling tower basin, shall be supplied/constructed along with all civil parts, base plates, anchor bolts, nuts, and other accessories, pipe sleeves, inserts, etc. and as required to complete the work in all respects.

18.4.6.3 The work shall include excavation/back-filling as necessary, all concrete/steel work, cold water outlet sump & sludge pit for each basin, water-proofing and all other works.

18.4.6.4 The basin shall be partitioned into two individual chambers such that one section can be taken out for maintenance /de-sludging while the other section is in operation.

18.4.6.5 Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.

18.4.6.6 For each basin chamber, there shall be a cold water outlet sump. In the connection between basin chamber and cold water sump there shall be screen and sluice gate/Butterfly valve.

18.4.6.7 Each basin chamber shall have overflow arrangement at sludge pit end.

18.4.6.8 Basin slope towards cooling sump shall be 1 in 120.

18.4.7 **Stoplog Gates & Handling Facility**

a) Stop Log Gates shall be providsed for isolation of Cooling Tower from CW Channels. These gates shall be provided with guides and sealing arrangement. Hooks shall be provided for lifting the gates.

b) Designing, supplying, fabricating and installing in position leak tight log gates in CW channels for the maximum water head including forming grooves with stainless steel channels, providing lifting hook arrangement etc. Detailed design and drawings are to be submitted by the Bidder during detailed engineering.

c) Stop logs shall be complete with guide shoes, bearing blocks, rubber seals, lifting lugs etc. The stop log gate shall cover the clear opening of the cold water channel and effectively stop the water leakage. The minimum thickness of skin plate shall be 6 mm. The structural design of the stop log gate shall generally conform to IS: 5620-1986.

d) To handle the stop log gates, monorails at sufficient height shall be provided across each cold water channel. Hand operated chain pulley blocks with traveling trolley of adequate capacity to handle the stop log gates shall be provided for each Tower. The capacity of the hoist however shall in no case be less than 125% the weight of the stop log gate.

18.4.8 **Screens**

Design, Supplying, fabricating and installing in position wire mesh screen of stainless steel (SS316) wire mesh 12 SWG and 10 mm clear sieve opening with frame and stiffeners with MS confirming to IS 2062 (epoxy painted), guide & concrete embedment with stainless steel, fixing in position in Cooling Tower outlet with inserts/lugs, providing lifting hook arrangement etc. All bolts, nuts and washers if used shall be of stainless steel conforming to grade SS 316. Detailed design and drawings shall be furnished by the Bidder. The structural design of the coarse screen shall generally confirm to IS: 11388

i) Quantity - 6 Nos. (2 Nos. per Tower + 2 Nos. common standby).

ii) Purpose - For filtering suspended matter, if any, in circulating water.

iii) Size of mesh - 10 X10 mm

The size of the screen shall be such that it can be handled easily.

18.4.9 **Hardware**

All nails and fastening bolts, nuts & washers used in the cooling tower stainless steel, if not specified in the Data Specification Sheet.

18.4.10 **Aviation Warning Lights**

All the aviation warning lights shall be approachable. In accordance with official regulations, aviation warning lights shall be installed along the perimeter of the Cooling Tower opening as per ICAO requirement. They shall be connected to completely separate power circuits and to be monitored by relays.

The technical requirements of aviation warning lighting, lightning protection system, earthing, lighting, and cabling etc. shall be as described in Electrical volume.

18.5 TESTING AND INSPECTION

18.5.1 General

18.5.1.1 Inspection and testing of bought-out equipment shall be carried out by the Owner as per the mutually agreed QAP at the works of Bidder or his sub-Contractor during manufacturing and on final product to ensure conformity of the same with acceptable criteria of Technical Specifications, approved drawings, authenticated manufacturing drawings and reference National/ International standards.

18.5.1.2 The Bidder shall furnish Quality Assurance Plan (QAP) for respective equipments for Owner's approval at least two months prior to start of manufacturing.

18.5.2 Testing and Inspection at Manufacturer's Works

18.5.2.1 The Bidder shall conduct all tests required on various bought-out components including those specifically mentioned in the respective equipment specification sections to ensure that the system/equipment furnished shall conform to the requirements of the specification and in compliance with the requirements of applicable codes and standards.

18.5.2.2 Particulars of the proposed tests and procedures for the tests shall be submitted to the Owner in the draft QAP for approval before conducting the tests.

18.5.2.3 Stop Logs Gates and screens welding shall be done by qualified welders and Dye Penetration Test (DPT) on welds shall be carried out.

18.5.2.4 Stop logs shall be checked for confirming to relevant IS dimensional conformity in shop and smooth operation and leakage tightness at site.

18.5.2.5 Galvanized items shall be checked for thickness of coating, weight of zinc coating, adhesion test, visual examination and pierce test (uniformity of coating) as per the requirement of relevant IS codes and as directed, by the Owner.

18.5.2.6 Valves

a) Hydrostatic pressure test of the body and seat as per relevant standard for all the valves.
b) Disc strength test and life cycle test shall be conducted additionally for the butter fly valves as per the applicable standard.

18.5.2.8 Stop Log Gates (at site)

a) Total assembly alignment
b) Dimensional check
c) Seat leak test and other tests as per relevant IS

18.5.2.9 Coarse Screen

a) Total assembly alignment
b) Dimensional check and other tests as per relevant IS

18.5.2.10 Submersible pump:

a) Flow
b) Pressure
c) Auxiliary Power consumption (Power input to motor)

18.5.2.11 Chain pulley block: Tests shall be conducted as per IS: 3938.

18.5.2.12 Fills and Drift Eliminators:
The following tests shall be conducted

a) Tensile strength & elongation : ASTM D638 & ASTM D882
b) Flammability : ASTM D635
c) Tensile modulus : DIN 53457
d) Impact strength : ASTM D256

18.5.3 **Performance Guarantee Tests at Site**

18.5.3.1 Performance testing of Cooling Tower shall be carried out as per ATC-105 at a time when the atmospheric conditions are within the permissible limits of deviation from the design conditions. Correction curves shall be applied for correction of the test results for deviation of test conditions such as flow rate, cooling range and wet bulb temperature and dry bulb temperature/ relative humidity.

18.5.3.2 After construction of the Cooling Tower, the complete systems/ equipment shall be operated at site to show satisfactory performance as required by the applicable Clauses of the specification. Further all piping shall be hydraulic tested at site.

18.5.3.3 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to final trial run and commissioning of the complete system/ equipment.

18.5.3.4 To ascertain the fulfillment of guarantees, performance tests shall be carried out on all the Cooling Tower erected under this contract at site. The procedure to be followed and other conditions shall be as given below.

a) Acceptance test procedure shall cover the determination of the thermal capability and verification of all guaranteed parameters of the Cooling Tower(s) supplied for the Project.

b) The purpose of this test procedure is to describe instrumentation and procedures for the testing and performance evaluation of water Cooling Tower.

c) Latest versions of the codes and standards as per clause # 18.1, shall be applicable for conducting test unless otherwise modified to be supplemented by the following procedure and mutually agreed to, between the Owner and the Bidder:

d) Conditions of tests

i. Accredited representatives of the Bidder and the Owner along with Consultants shall conduct tests for the tower. The Bidder shall be given permission to inspect the Tower in advance and make it ready for the test. Bidder's representatives shall witness all phases of the test and record the data jointly with the Owner's representatives in the agreed formats.

ii. The responsibility for conducting the test lies with the Bidder.

iii. All test instruments required for the Performance Guarantee Test (PG Test) shall be provided by the Bidder. Calibration of test instruments shall be the responsibility of the Bidder. After PG test, special test instruments, if any, brought for the test can be taken back by the Bidder on getting clearance from the Owner.

iv. Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments shall be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments shall be valid for the period of test.

v. List of instruments to be arranged by the Bidder along with the calibration certificates of the instruments to be used, psychometric charts and tables shall be submitted to the Owner/ Consultant for approval in advance.

vi. Performance guarantee tests shall be carried out by the Bidder within one year of successful completion of trial operation of the Cooling Tower and at a time when the atmospheric conditions are within limits of permissible deviation from the design conditions as specified in this section preferably in the period from May to September.

vii. Performance Test shall be carried out based on ambient W.B.T. The performance curves of the Cooling Tower showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity, water loading of the Tower, approach, terminal temperature difference etc., required to ascertain the performance of the Tower shall be furnished along with the Tender. Performance curves applicable to 90%, 100% and 110% of the design water flow rate shall be furnished. Each set shall consist of three or more cooling range curves and at least four relative humidity curves, arranged to show the effects of wet bulb temperature, relative humidity and cooling range on outlet water temperature. The range curves shall be presented in uniform increments of 0.5^{o}C, with sufficient scope to cover approximately ± 20% of design range. The relative humidity curves shall be presented for spaced increments to cover the extent of expected conditions such as 5, 20, 40, 60 and 80% relative humidity. The design conditions shall be indicated on the set applicable to design water flow rate.

viii. The dry bulb temperature associated with the wet bulb on each fixed relative humidity graph shall be included (if applicable). All performance curves shall be based on ambient wet bulb temperature.

ix. The Bidder shall demonstrate the guaranteed performance of the Cooling Tower after evaluating the PG. Test. Should the result of the test deviate from the guaranteed values, the Bidder shall be given an opportunity to modify the fill etc. required to enable it to meet the guarantees. In such cases the P.G. Test shall be repeated within one month from the date on which the Cooling Tower is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The opportunity for repeat testing shall be given only once during the contract period.

x. In case the test cold water temperature as determined from the PG Test is higher than the predicted value (based on the performance curves), the Owner reserves the right to accept the tower after assessing the liquidated damages as per Volume II A for rise in cold water temperature.

xi. A maximum tolerance of 0.3° C in the cold water temperature of the guaranteed value shall however be allowed to take care of instrument inaccuracies. No other tolerances shall be permitted.

18.5.4 **General conditions of Cooling Tower**

a) Condition of Cooling Tower

i. At the time of the test the Tower shall be in good operating condition. Tower may be inspected and repaired, (if necessary) by the Bidder, before the test to ensure the following:

ii. Water distribution system shall be essentially clear and free of foreign materials which may impede the normal water flow. Fill shall be essentially free of foreign materials such as oil, tar, scale or algae. Water level in cold water basin shall be at normal operating elevation and shall be maintained substantially constant during the test.

b) Operating Conditions

i. Every effort shall be made to conduct the test under design conditions, or as close to design conditions as possible. The test shall be conducted within the following limitations.

ii. The following variations from design conditions shall not be exceeded:

a) Wet bulb temperature	:	± 5%
b) Dry bulb temperature	:	± 10%
c) Range	:	± 20%
d) Circulating water flow	:	± 10%
e) Heat load	:	± 20%

c) Duration of test

i. After reaching steady state conditions, the duration of the test run shall not be less than mentioned in the standards. If thermal lag

time is greater than five minutes, the time for the tests period shall be at least one hour plus thermal lag time.

ii. Readings shall be taken at regular intervals and recorded in the units and to the number of significant figures as shown in the following tabulation.

	Measurement	Minimum number each per station	Unit	Record to nearest
	Wet bulb temperature	12	Deg C	0.05
	Dry bulb temperature	12	Deg C	0.05
	Cold water temperature	12	Deg C	0.05
	Hot water temperature	12	Deg C	0.05
	Wind Velocity	6	Kmph	
	Circulating Water Flow	**		
**	Single centre point readings for comparison with full traverse reading taken before test (when measurement is made by Pitot Tube). One full traverse shall be made immediately preceding the test and a minimum of three centre point readings shall be taken during the test.			

d) Consistency of test condition

For a valid test, variations in the test condition shall be within the following limits:-

i. Circulating water flow shall not vary by more than 5%.

ii. Heat load shall not vary by more than 5%.

iii. Range shall not vary by more than 5%.

iv. Instantaneous air temperature readings may fluctuate, but variations in the averages during the test period shall not exceed the following.

1. Wet bulb temp - 1^0 C/hr.
2. Dry bulb temp. (if applicable) - 3^0 C/hr.

18.5.5 **Test Instruments, their location and method of measurements**

All instrumentation used for Performance Testing shall conform to Clause 3, page 5 of CTI cod ATC 105/ February 2000.

a) Wet Bulb Temperature.

i. The wet bulb temperature shall be measured with mechanically aspirated instruments, each meeting the following requirements:

ii. The indicator shall be graduated in increments of not more than 0.1oC. The temperature sensitive element shall be accurate to + 0.05oC. The temperature sensitive element shall be shielded from

direct sunlight or from other significant sources of radiant heat. Shielding devices shall be substantially at the dry bulb temperature. The temperature sensitive element shall be covered with a wick that is continuously fed by distilled water.

iii. The temperature of the distilled water used to wet the wick shall be at approximately the wet bulb temp. being measured. This may be obtained in practice by allowing adequate ventilated wick between the water supply and the temperature sensitive element. The wick shall fit snugly over the temperature sensitive element and extend at least two centimetres past the element over the stem. It shall be kept clean while in use.

iv. The air velocity over the temperature sensitive element shall be maintained between 290 and 320 M/minute.

Number of stations and their location.

i. Ambient wet bulb temperature.

ii. The ambient wet bulb temperature shall be determined as the arithmetical average of measurements taken at not less than three locations approximately 1.5 M above basin curb elevation, not less than 15 metres or more than 100 M to windward of the equipment, and equally spread along a line substantially bracketing the flow of air to the Tower.

iii. The minimum number of stations for each air intake side may be determined from the following equation:

$n = 0.517 (A)$

iv. Where n is the minimum no. of stations for each side of air intake and A is the area to be traversed in sq. metre. (The area to be traversed applies to each individual air inlet area on each side of the Cooling Tower, rather than the total area applicable for the Cooling Tower).

v. Each intake should be divided into a number of imaginary rectangles and one wet bulb measurement station shall be located in the mid point of each rectangle.

The average of 3 successive readings taken at 10 second intervals at each station shall be considered for wet bulb temperature at that time at that instrument station. The station averages shall be averaged to obtain the effective wet bulb temperature for that run. Such runs shall be made every 5 minutes during the test period and the arithmetic average of these runs shall be considered the ambient wet bulb temperature and shall be used for the evaluation of results.

b) Dry Bulb Temperature

i. The ambient dry bulb temperature shall be measured with instruments each meeting the following requirements:

- The indicator shall be graduated in increments of not more than 0.1^0 C.
- The temperature sensitive element shall be accurate to +/- 0.05^0 C.

- The temperature sensitive element shall be shielded from direct sunlight or from other significant sources of radiant heat. Shielding devices shall be substantially at the dry bulb temperature.

c) Cold Water Temperature.

i. The indicator of the thermometer used for measurement shall be graduated in increments of not more than 0.1^0 C.

ii. The re cooled water temperature can be measured directly at the point where the circulating water is discharged from the basin, the average cold water temperature being determined by simultaneous recording of test reading where possible across the selected sections.

d) Hot Water Temperature.

i. The indicator of the thermometer used for measurement shall be graduated in increments of not more than 0.1^0 C.

ii. Hot water temperature measurement shall be made in the Tower risers or at the discharge of inlet risers into the flume or distribution system.

e) Circulating Water Flow

i. Wherever adequate upstream and downstream straight lengths are available, suitable pitot probes shall be used for the flow measurement. Pitot probes shall conform either to ASME (19.5) Chapter 4 (latest revision) or ISO 3966-1977. The probes shall be provided with calibration carried out in a laboratory approved by the Owner. Pitot Tube not conforming to the above codes but fabricated by Indian Institute of Technology Mumbai/Delhi/Chennai or Indian Institute of Science, Bangalore with recent calibration certificate could be used after obtaining prior approval of the Owner.

ii. In case adequate upstream and downstream straight lengths are not available, the probe should conform to ISO-3966-1977. In addition to the probe for velocity measurement, a Yaw- probe shall be required as per ISO-7194-1983 for the measurement of swirl angle. Alternatively, special probe developed by IIT/IISc for simultaneous measurement of velocity and swirl angle can be used.

iii. For obtaining swirl free and fully developed flow condition the minimum upstream and downstream straight lengths at the measuring cross section shall be 20 pipe diameters and 5 pipe diameters respectively. To meet the above criteria, it shall be necessary to provide the stubs along with the isolating valves in the underground portion of the circulating water pipe/ducts leading hot water to the Tower. Provision shall be made for traversing two diameters at right angles to each other.

iv. In case it is not possible to comply with the straight length requirement, the stubs shall be located in hot water pipes where maximum straight length is available. The flow shall be asymmetric

and traversing of 3 or 4 diametres shall be necessary depending upon the available straight length and the type of disturbance.

v. For the measurement of differential pressure, inclined manometer with low density liquid shall be used to minimize the reading error. In case special probe developed by IIT/IISc is used, another manometer with low density liquid shall be required for orienting the probe in the flow direction.

f) Wind Velocity

i. Wind Velocity shall be measured by a rotating cup type anemometer.

ii. Measurement shall be made in an open and unobstructed location within 30 M of and to windward of the Tower at a point 1.5 M above the basin curb elevation.

iii. For the measurement of ambient wet bulb temperature, direction of the wind shall be determined by the anemometer, to fix the location of measurement stations.

g) Computation of Water Flow

i. The water flow for each radii traversed shall be determined separately by graphical integration method. The curves shall be plotted between (radius) versus (radius x velocity) on milli metre graph-sheets on large scale (not less than 1:5) to minimize computational error. The water flow is computed from the following equation :

Water flow (M3/sec) = 2 X π X Area under the curve.

ii. The average flow of all radii traversed is the actual flow through the pipe.

iii. The computed area by graphical integration shall be cross checked with calculated area by numerical integration method. The area obtained by the two methods, may differ depending upon the smoothening carried out while drawing the curves.

18.6 CALCULATION OF TOWER PERFORMANCE

18.6.1 Determination of predicted Cold Water temperature

18.6.2 The cold water temperature shall be read from the performance curves for 90%, 100% and 110% of rated flows at test wet bulb temperature, range and relative humidity. The three points thus obtained from performance curves shall be plotted to obtain a cross plot, which is a relation between water flow and cold water temperature.

18.6.3 From the cross plot obtained above, the predicted cold water temperature shall be read at corrected test water flow.

18.7 ACCEPTANCE CRITERIA

If the cold water temperature is less than or equal to predicted cold water temperature as described above, the Tower is deemed to have met the

guarantee. If the predicted cold water temperature is higer than the guaranteed value, the Tower shall be accepted with LD as per stipulations in Volume 1 of the bid up to an increase of 1^0 C from the guaranteed cold water temperature. If the increase in the predicted cold water temperature is more than 1^0 C from the guaranteed cold water temperature, then the Tower is liable for rejection by the Owner.

18.8 **GUARANTEES**

18.8.1 The Bidder shall guarantee that the Cooling Tower constructed shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

18.8.2 The cold water temperature as specified in technical data sheets shall be guaranteed by the Bidder for the design conditions of CW flow, range, ambient WBT specified in technical data sheets submitted by the Bidder.

18.8.3 (Performance testing of Cooling Tower shall be carried out as per ATC-105 at a time when the atmospheric conditions are within the permissible limits of deviation from the design conditions. Correction curves shall be applied for correction of the test results for deviation of test conditions such as flow rate, cooling range and wet bulb temperature and dry bulb temperature/ relative humidity from their respective design). The correction curves shall be furnished by the bidder after award of contract.

18.9 **PERFORMANCE GUARANTEES**

18.9.1 Each equipment shall be guaranteed to meet the performance requirements as specified. If during the performance testing of the tower, the actual cooling water temperature obtained is higher than the guaranteed cooling water temperature (obtained from the performance curve) corresponding to the flow, wet bulb temperature, relative humidity and cooling range prevailing during the test, the contractor shall satisfactorily rectify all defects within scheduled time period.

18.9.2 After the tests conducted at the Manufacturer's works in accordance with this specification, rectification of any defect observed shall be satisfactorily done without charging any extra cost to the Owner.

18.9.3 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within scheduled time period. No extra cost shall be charged to the Owner for such rectification. After rectification, retesting will be done by Bidder without any extra cost to Owner till satisfactory performance is achieved.

18.9.4 The bidder shall guarantee that the cooling tower offered shall meet the ratings and performance requirements stipulated in this specification. The bidder shall also furnish a declaration for certain guaranteed parameters like "Fulfillment of cold water temperature" which shall attract levees of liquidated damages for shortfall in performance. In case the contractor does not fulfill the guaranteed parameters, Owner may undertake to rectify the system/equipment and expenditure incurred along with any other incidentals shall be recovered from the contractor.

DATA SHEET

S. No.	DESCRIPTION		PARAMETER
1.	**General Information**		
1.1.	Type of Cooling Tower	:	Natural Draft, Hyperbolic
1.2.	No. of Cooling Towers Required	:	One (1)
1.3.	Location	:	Outdoor
1.4.	Duty	:	Continuous
2.	**DESIGN PARAMETERS**		
2.1.	Quantity of Water to be cooled	:	By Bidder
2.2.	Duty of each tower	:	To cool plant circulating water and auxiliary Cooling Water
2.3.	Hot water temperature (°C)	:	Bidder to indicate
2.4.	Cold water temperature (°C)	:	33 (guaranteed)
2.5.	Cooling range (°C)	:	Temperature rise across condenser plus 1 deg. C, keeping hot water temperature at outlet of condenser as base.
2.6.	Design ambient wet bulb temp. (°C)	:	28(refer Project Info, Vol II)
2.7.	Approach (°C)	:	5
2.8.	Design Relative Humidity (%)	:	45 %
2.9.	Design Wind Speed	:	As specified in Project information or Civil Specification, whichever is more stringent
2.10.	Quality of makeup water	:	Filtered Water
2.11.	Max. drift losses	:	0.05% (Max.) of rated capacity of Cooling Tower flow
2.12.	Height of basin curb above Terrace level	:	300 mm
	The Cooling Tower shall be designed for continuous operation to meet the parameters mentioned in broad technical parameters in this Section. The hot water distribution system shall be designed to ensure equal distribution of heat load and flow all over the fill area. Wood/timber shall not be used as material of construction in any part of the Cooling Tower.		
3.	**BASIN (to be designed on uncrack basis)**		
3.1.	Type	:	Single
3.2.	Material of construction	:	Refer Chapter 13 Volume VI
3.3.	Effective storage Capacity	:	10 minutes of cooling tower flow at full load operation of the unit (between Min. & Max. water level)

S. No.	DESCRIPTION		PARAMETER
3.4.	Drain box size	:	2000 x 2000 mm for satisfactory cleaning of tower
3.5.	Number of drain boxes	:	Two (2), per tower
3.6.	Cold water discharge channel / pipe	:	Required effective cross-sectional area for 1.0 metres/sec. water velocity
3.7.	Material of construction	:	Refer Chapter 13 Volume VI
3.8.	Stop log gate on cold water channel	:	As required
3.9.	Cleanable screen	:	As required (10mmx10mmx8 SWG) galvanised steel wire mesh in steel channel frame epoxy painted
4.	**MATERIALS OF CONSTRUCTION**		
4.1.	Structure and basin	:	Refer Chapter 13 Volume VI
4.2.	Fill	:	PVC, Poly Propolene UV rays stabilized, with flute not less than 19mm
4.3.	Fill support	:	RCC
4.4.	Drift eliminators	:	PVC, Poly Propolene UV rays stabilised
4.5.	Drift eliminator support from bottom	:	RCC
4.6.	Nozzles (low pressure non clogging)	:	PVC, Poly Propolene UV rays stabilized / Gun metal as per IS 318 Gr VI
4.7.	Distribution pipes	:	PVC (IS 4985 Class 3)/FRP/HDPE (IS 4984 PN6, grade PE 80)/or RCC/ pre-cast open trough
4.8.	Distribution Trough	:	RCC
4.9.	Hot Water Piping	:	IS 3589
4.10.	Hardware	:	Silicone bronze (wet); stainless steel 316 (dry)
5.	**Stop Log gates**		
5.1.	Guides/ Anchors	:	CS IS 2062 Gr B
5.2.	Gate leaf & lifting beam	:	CS IS 2062 Gr B
5.3.	Rubber seals	:	As per Appendix-B of IS: 4622
5.4.	Lifting Beam	:	CS IS 2062 Gr B

CHAPTER – 19

COAL HANDLING PLANT

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COAL HANDLING PLANT

1.0	**Coal Handling System**
1.1	Scope of work
1.1.1	The scope of Coal Handling Plant (CHP package) to be furnished, erected and commissioned under this specification shall be as detailed hereinafter. The contractor shall be fully responsible for system and detailed design, engineering, manufacture, shop fabrication, assembly, testing & inspection at manufacturer's works, packing despatch, transportation, transit insurance, custom clearance etc as applicable, delivery to site, unloading, handling & storage at site, insurance during storage, construction, erection, its supervision, testing ,inspection, commissioning and handing over to Owner and Guarantee testing, including all associated Mechanical, Civil & Structural Steel Works, Architectural Works, Electrical, Control & Instrumentation Works as specified.
1.1.2	The scope of the contractor shall be deemed to include all such items which although not specifically mentioned in the bid documents and /or in contractor's proposal but are needed to make the CHP package complete in all respects for its safe, reliable, efficient and trouble free operation. The general description of the proposed CHP package and the broad scope of work under this specification shall include but not be limited to as elaborated below.
1.1.3	Brief Description of Project An independent Coal Handling Plant consisting of below mentioned equipment are proposed for meeting the coal requirements for DCRTPP 1 x 800 MW ▪ For Coal Unloading: Two (2) nos. of Wagon Tipplers (1W+ 1S) along with other associated equipment/system. ▪ For coal Screening & Crushing: Four(4) grizzly feeders together with four(4) Crusher (Ring granulator) for reducing ROM coal as received to final product size of (-) 20mm ▪ For Coal Storage/Reclaiming Operation: One (1) no. of Bidirectional Stacker cum Reclaimer Machine with reversible yard conveyor together with emergency reclaim hoppers. ▪ Two(2)no of needed Belt conveyor streams in parallel (1W+ 1S) of min 1200 tph rated capacity each together with Auxiliary Equipment / dust control system are proposed to meet the requirement of the plant.
1.1.4	It is not the intent to specify completely herein, all aspects of design and construction of above Coal Handling Plant. However, Coal Handling Plant shall conform in all aspects to high standard of engineering, design and workmanship and be capable of performing satisfactorily during continuous commercial operation in a manner acceptable to M/s HPGCL, who shall interpret the meaning of the specification, drawings and shall have the right to reject or accept any work or material which in their assessment is not conforming to this specification and / or to applicable Indian/ International Standards. Notwithstanding the details furnished in this document, it shall be the responsibility of the Contractor to complete the work in all respects, commission, and complete the final trials & performance tests to the satisfaction of HPGCL/ Consultant.

1.1.5	Before quoting, Bidder shall visit the site and acquaint/ satisfy himself in all respects with site conditions, the terrain, the sub-soil, and other working conditions etc. to be encountered during execution. After acceptance of tender, claim for extra payment on the grounds of any special local working or site conditions, will not be entertained.		
1.1.6	**Miscellaneous Services under Scope of Bidder.**		
i	Detailed Operation & Maintenance Instruction Manual/ Spare part manuals and As Built drawings for of all Conveyors/ Equipment/ associated Systems in soft copy & hard copy (in required number) shall be furnished.		
ii	The bidder shall do the complete O &M of the coal handling plant till handing over of the complete power plant.		
iii	Furnishing of all test certificates, characteristic curves, technical data sheet (as built) etc. as applicable for all equipment and materials supplied by the Contractor.		
iv	Supply of all lubricants, oil, etc. for initial fill, flushing, cleaning, refill and topping up to handing over of CHP.		
v	Bidder shall conform to the requirements of all the relevant Inspection & Test Plan/ QAP etc. as required by M/s HPGCL/ Consultant.		
vi	Where approval by a Regulatory Body/ Statutory Authority is required, it is the Contractor's responsibility to obtain such approval. Any statutory fees in this regard shall be borne by bidder.		
1.1.7	**Major Items of Work Included Under CHP Package:** Coal Handling Plant shall be supplied complete in all respects which shall include but not be limited to providing the following items / items of work and facilities for a complete and satisfactory Coal Handling System.		
1.1.8	**Scope of Work (Mechanical Works)**		
S. No.	**Item Description**	**Qty**	**Remarks**
1.	Wagon Tippler# 3WT-1A / 1B complete with Electronic Integral Weigh Bridge/ mechanical stopper for wagons etc	2	Design & construction of tippler complex including all its equipment/ components/ structures etc shall conform to RDSO: G33 [latest revision].
2.	Side Arm Charger# 3SAC-1A/ 1B [for Inhaul/ placement of Wagons etc]	2	It shall operate in conjunction with Wagon Tippler to achieve required tipping capacity of tippler.
3.	EOT Crane# 3EOT-1A/B	2	For maintenance of equipment/components for Tippler Complex# 3WTC- 1
4.	Apron Feeder (below tippler hopper)#3AF-1A / 1B with Dribble feeder#3 DF-1A/ 1B	2	To transport coal from 3WTH-1A/ 1B to belt conv. # 3BC-1A/ 1B.
5.	Belt Conveyors# 3BC-1A/1B / 2A/2B / 3A/3B / 4A/4B / 5A/5B	22	----

	/ 6A/6B / 7A/ 7B / 8A/8B/ 9A/9B/10A10B/11A/11B		
6.	Belt Conveyors# 3BF-1A/ 1B	2	
7.	Reversible Yard Belt Conveyors# 3RYBC-1A	1	For Bidirectional Stacker cum Reclaimer M/c # 3SR-1A
8.	Tripper belt Conveyor# 3TBC-1A/ 1B/ 2A/ 2B	4	----
9.	Travelling Tripper# 3TRT-1A/ 1B/ 2A/ 2B with two way discharge chute having flap gate	4	----
10.	Belt sealing arrangement# 3BSA-1A/ 1B/2A/2B	4 set	For bunker sealing
11.	Bunker Level Indicator	Lot	Refer Specification of C&I Works
12.	Discharge chute	Lot	As per flow diagram/ system requirement
13.	Floor cleaning chute/tramp iron chute	Lot	As per flow diagram/ system requirement
14.	Flap Gate [FG]	Lot	As per flow diagram
15.	Divertor Gate [DG]	Lot	As per flow diagram
16.	Rod Gate (RG)	Lot	As per flow diagram
17.	Rack & Pinion Gate (RPG)	Lot	As per flow diagram
18.	Vibrating Feeder # 3VF-1A/1B/2A/2B	4	.....
19.	In line Magnetic Separator# 3ILMS-1A/ 1B/ 2A/ 2B/ 3A/ 3B complete with Electric Hoist & Tramp Metal Trolley.	6	One Tramp metal collection trolley shall be provided for each In line Magnetic Separator.
20.	Suspended Electro Magnet# 3SEM-1A / 1B complete with Manual Hoist with Electric Trolley.	2	One Tramp metal collection trolley shall be provided for each suspended electromagnet.
21.	Belt Weigher #BW-1A/1B/2A/2B/2C/2D /2E/2F/3A/3B	10	As per Flow Diagram
22.	Metal Detector #3MD-1A/ 1B/ 2A/ 3A/ 3B	Lot	As per Flow Diagram
23.	Coal scooper #3CS-1A/ 1B/ 2A/3A/ 3B	Lot	To operate in conjunction with metal detector As per Flow Diagram

24.	Vibrating Grizzly Feeder# 3VGF-1A/ 1B/ 2A/ 2B	4	----
25.	Crusher# 3CR-1A/1B/2A/2B with bypass facility	4	Necessary RCC Deck, Vibration Isolation System along with temperature detection system & vibration monitoring system shall be provided for each crusher.
26.	Rail mounted Bidirectional Stacker-cum-Reclaimer Machine# 3SR-1A (Bucket Wheel Type) with on-board Dry Fog Dust Suppression System	1	.....
27.	Sump Pump complete with discharge piping up to drain	Lot	As per flow diagram/ system requirements
28.	Manual Hoist with monorail	Lot	For equipment/ component removal for maintenance purpose.
29.	Electric Hoist with monorail	Lot	For equipment/ component removal for maintenance purpose.
30.	Belt Vulcanizing Machine# 3BVM-1/ 2	2	-----
31.	Tunnel Ventilation System# 3VS	Lot	For underground areas of tippler complex/Junction Towers/conveyor tunnels etc
32.	Dry Type Dust Extraction[DE] System#3DE-1A/1B	2	One independent DE system shall be provided for each stream A & B in Crusher house#3CRH-1 At other transfer point locations Dry Fog Dust Suppression shall be provided.
33.	Insertable type Bin Vent Filters for Coal Bunkers	Lot	Dry type dust extraction system for coal bunkers.
34.	Pre-Spray System# 3PSS-1 for waiting wagons for Wagon Tippler# 3WT-1A/ 1B	Lot	----
35.	Dust Suppression System# DST-1	Lot	Plain water DS system for Track Hopper complex
36.	Plain Water Dust Suppression System# 3PWDS-1 [with its own tank/ piping/ valves/ sprinkler etc.]	Lot	PWDS-1 for Crushed Coal Stockpile# 3CCS-1/ 2
37.	Dry Fog Type Dust Suppression System [DFDSS] for transfer points	Lot	----

38.	High wall mounted split type A.C Unit & Wall mounted Fans.	Lot	Refer Building List
39.	Air Curtain with auto door facility at entrance door of Control room in Bldg# 3ER-1A/ 1B/3 ER-2 and O&M office in Bldg#ER-2	Lot	.....
40.	Unitary Type Pressurized Ventilation System [UPTV]	Lot	To be provided for all MCC Room Areas in all Electrical Buildings
41.	Exhaust Fans	Lot	For battery room/toilets
42.	Elevator# 3EL-1/2[Passenger–cum-goods lift, payload : 2000kg]	2	.....
43.	Bull dozer with one coal blade & one earth blade	4	For use on stockpile# 3CCS-1/ 2 & dosing coal into underground hoppers of RHC-1
44.	Payloader	3	For removal of oversize pieces of shale/sandstone/other extraneous material from bar grid at tippler hopper. These M/c shall also be for housekeeping/coal dosing etc.
45.	Water System (service & potable water)	Lot	----
46.	Insert Plates/ channels/ pipe sleeves/ safety guards etc.	Lot	----
47.	Fixing / foundation / anchor bolts for base plates of all conveyors & other equipments [for steel to steel and for steel to concrete] including other necessary hardware	Lot	----
48.	Commissioning Spares	Lot	----
49.	First Fill of Flushing Oil & Lubricants	Lot	----
50.	Tools & Tackles	Lot	Any special tools & tackles required shall be supplied.
51.	Mandatory Spares	Lot	----
52.	Painting	Lot	----
53.	Erection, Testing & Commissioning including Performance Guarantee Testing.	Lot	----

54.	Any other associated equipment/ items/ item of work required for successful completion, installation, and operation of the CHP package.	Lot	----
55.	In motion Weigh Bridge	2	at entry & exit
56.	Diesel Locomotives	4	For movement of coal railway wagons
57.	Dumpers	2	
58.	Chute Liners	Lot	All chute liners shall be of stainless steel
59.	Stone Picker	Lot	Provision of Stone Pickers at conveyor shall be provided by bidder.

1.1.9	**Scope for Electrical work**	
S. No.	**Item Description**	**Qty.**
1	Motors (HT / LT)	Lot
2	MCC and switchgears	Lot
3	PLC / Central Control Desk / Mimic etc.	Lot
4	Control Panel / LT/ HT Panel / Relay Panel / Local Starter & Control Panel etc. as required	Lot
5	Control & Instrumentation Cables and accessories including fixing laying & termination etc.	Lot
6	Power cables and accessories including fixing, laying and termination, etc.	Lot
7	Accessories required for testing & termination of HT cables	Lot
8	Pull chord Switches / Belt-Sway Switches / Zero- Speed Switches	Lot
9	Bus Duct.	Lot
10	Local Push Button Stations and De-interlock switches.	Lot
11	Heavy Duty Limit Switches / Torque Limit Switches Proximity Limit Switches.	Lot
12	Hooters / plant warning sirens	Lot
13	Lighting including lighting transformer, sub-distribution boards, cables, plug and socket, lighting fixtures, conduits & junction boxes, etc. including emergency lighting in underground conveyor tunnels & buildings. One (1) standby lighting transformer shall be provided.	Lot
14	Earthing & Lightning Protection	Lot
15	Lighting poles & Towers	Lot
16	Control Transformers	Lot

17	Comprehensive Annunciation System	Lot
18	Industrial type single phase and three phase socket outlets in tunnel (both sides) and at Junction Towers / Crusher House.	Lot
19	Three Phase Welding Receptacles	Lot
1.1.10	**Scope for Civil work:** Refer Civil Volume	
1.1.11	**Scope for Structural Steel Works**	
S. No.	**Item Description**	**Qty.**
1	Steel frame construction shed for Wagon Tippler Complex & Reclaim Hopper Complex # 3RHC-1 complete with side cladding of permanently color coated zincalume sheet minimum 0.55mm TCT (total coated thickness), 550 MPa tensile strength IS: 277 & IS: 513 / equivalent approved,	Lot
2	Steel frame construction Junction towers, Sampling Tower & Crusher House Buildings etc with RCC roof and RCC floors complete with side cladding of permanently color coated zincalume sheet minimum 0.55mm TCT (total coated thickness), 550 MPa tensile strength IS: 277 & IS: 513 / equivalent approved, complete with 1000 mm wide stair case with hand railing & toe plate, rain water pipes etc. / FRP panels (translucent sheets) provided (for natural lighting).	Lot
3	Conveyors galleries complete with walkway & hand railing with toe plate and supporting trestles for all conveyors. Roof and side cladding of permanently color coated zincalume sheet minimum 0.55mm TCT (Total coated thickness), 550 MPa tensile strength IS: 277 & IS: 513 / equal approved. FRP panels (Translucent sheets) provided (for natural lighting) on both side of gallery and roof (every sixth panel). Minimum crossover per enclosed drawings shall be provided.	Lot
4	Chequered plate walkways with anti-skidding flats for over ground conveyor galleries complete with hand railing and toe plate etc.	Lot
5	Crossover platforms in conveyor gallery complete with ladder hand railings etc.	Lot
6	Minimum 5mm thk. Seal plate (throughout gallery) for each conveyor.	Lot
7	Doors / Windows for buildings/conveyor galleries	Lot
8	Counter Weight / Take-up Towers steel fabricated structure, miscellaneous steel fabricated ladders, staircase, maintenance platforms, structural supports / base frames for equipments/drives etc, hand railings, gratings, chequered plates, removable chequered plates/ grating/safety hand railing around floor openings, pipe supports etc.	Lot
9	Laying & fixing of Rails including supply complete with fixing accessories for tippler table / Side Arm Charger # 3SAC-1A/1B	Lot
10	Laying & fixing of Rails including supply complete with fixing accessories for Bidirectional Stacker / Reclaimer Machine # 3SR-1A & Travelling Tripper #3TBC-1A / 1B & 3TBC-2A / 2B	Lot

11	Bar grid for Tippler Hopper # 3WTH-1A/1B & Reclaim Hopper # 3RH-1A/1B/2A/2B	Lot
12	Cable trays, cable supports etc.	Lot
13	Monorails / Beams [for Electric Hoists and Manual Hoist] in Junction Towers / Sampling Tower / Crusher House / Pump House etc. & above drive of Tripper Conveyors/ Travelling Trippers/dual drives etc.	Lot
14	Supply / fabrication / erection / painting of all structural steel works / other items for the entire CHP Package.	Lot
15	Any other associated requirements / items for the satisfactory completion and operation of the Coal Handling Plant shall be deemed to be included in the Bidder's scope of work.	Lot

1.2	**System Description for CHP [Refer Flow Diagram / Layout Plan]**
1.2.1	ROM Coal will be brought to Power Plant site using coal rake of Indian Railways.
1.2.2	Wagon Tippler # 3WT-1A / 1B will unload coal from wagons and coal will be delivered on to Conv. # 3BC-1A / 1B by Apron Feeder # 3AF-1A / 1B located below Tippler Hopper # 3WTH-1A / 1B.
1.2.3	Conv. # 3BC-1A / 1B will receive coal either from Wagon Tippler Complex # 3WTC-1 and deliver coal (one to one basis) onto conveyor # 3BC-2A / 2B which in turn will transport coal to Crusher House #3CRH-1.
1.2.4	Though the two (2) way chute with diverter gate, Belt conv. # 3BC-3A / 3B will feed ROM coal into vibrating grizzly feeder # 3VGF-1A / 2A & VGF-1B / 2B. Grizzly feeder will separate out (-) 20mm coal from its feed and deliver oversize coal i.e. (+) 20mm lump size into Crusher # 3CR-1A / 2A & 3CR-1B / 2B for crushing coal down to (-) 20 mm product. Chute liner shall be of stainless steel.
1.2.5	Under size material i.e. (-) 20 mm size coal from grizzly feeder bottom will be fed via chute on to belt feeder # 3BF-1A / 1B. Crushed coal of (-) 20 mm lump size from crusher bottom shall be fed via chute onto belt feeder # 3RBF-1A / 1B which will deliver coal onto Conv. # BC-4A / 4B. Chute liner shall be of stainless steel.
1.2.6	Conveyors # BC-4A / 4B are provided with their head ends located in 3JT-2. Fixed trippers 3FT-1A/1B located in 3JT-2 shall feed crushed coal either to coal stockpiles #CCS-1/2 using Rail mounted Stacker cum Reclaimer Machine#SR-1A or onto Conveyors # 3BC-5A / 5B for onwards transport of crushed coal to Coal Bunkers via connected set of conv # 3BC- 7A/7B/8A/8B/9A/9B & bunker filling tripper conv#3TBC-1A/1B/2A/2B. The crushed coal is fed to stockpiles#3CCS-1/2 using reversible yard belt conv#3RYBC-1A operating in conjunction with Stacker cum Reclaimer Machine#3SR-1A.
1.2.7	When coal rakes do not arrive at tippler complex, crushed coal from stockpile # 3CCS-1 / 2 will be reclaimed by the bucket wheel of Stacker-cum-Reclaimer M/C # 3SR-1A and fed onto respective boom belt / reversible yard belt which in turn will transport & feed crushed coal to Coal Bunkers via connected conveyor system & bunker feeding tripper conveyor # 3TBC-1A / 1B/2A/2B as noted above.
1.2.8	In the vicinity of stockpiles#3CCS-1/2,Reclaim Hopper Complex# 3RHC is provided on top of conveyor tunnel for conv#3RC-1.During extreme emergency

	situation, crushed coal will be dosed from either of the above stockpiles]by dozers into Reclaim Hopper Complex# 3RHC which will feed coal onto conv#3 RC-1 [via vib feeders for onwards transport of crushed coal to Bunkers.
1.2.9	Reclaim Hopper Complex is provided with four (4) underground RCC hoppers, each fitted with one vibrating feeder with feed control gate. Coal dosed from stockpiles into above hoppers will be fed onto conv. # 3RC-1 using vib feeders. Conv. # 3RC-1 will then transport coal to Coal Bunkers via connected conveyor system & bunker feeding tripper conveyor # 3TBC-1A / 1/2A/2B as noted above.
1.2.10	Thus under above CHP coal can be fed to coal bunkers as follows:
A	Directly from tippler complex# 3WTC-1 to coal bunkers via Crusher House # 3CRH-1 / Conv. # 3BC-4A/4B/ 5A/5B/ 6A / 6B / 8A / 8B / 9A / 9B /10A/10B/11A/11B/ bunker filling tripper conv. # TBC-1A/1B/2A/2B.
B	Directly from tippler complex# 3WTC-1 to coal bunkers via Crusher House # 3CRH-1 / reversible yard belt # 3RYBC-1A & connected Conv. # 3BC- 7A/7B /8A/8B/9A/9B/10A/10B/11A/11B /bunker filling tripper conv#3TBC-1A/1B/ 2A/2B. [Note: stockpile by pass facility of M/C#3SR-1A to be used in above route]
C	From crushed coal stockpiles # 3CCS -1 / 2 to Coal Bunkers via Bucket wheel of Stacker-cum-Reclaimer M/C # 3SR-1A/boom belt /Yard Belt # RYBC-1A /Conv#BC-7A/7B and connected set of conveyors including bunker filling tripper conveyors # TBC-1A / 1B/2A/2B.
F	From crushed coal stockpiles # 3CCS -1/2 to Coal Bunkers via dozers/ reclaim hopper complex# 3RHC vib feeders/conv# 3RC-1 and connected set of conveyors including bunker filling tripper conveyors # 3TBC-1A / 1B/2A/2B. Pay loaders can also be deployed to feed coal from stockpiles to reclaim hoppers

1.3	**Performance Guarantee Requirements:** Following rated capacities / ratings etc. shall be guaranteed:-	
1	Belt Conveyors	1200 tph[rated] each (for all conveyors)
2	Reversible Belt Feeder	1200 tph[rated] each
3	Wagon Tippler	Each Tippler shall operate its rated capacity of 25 tips per hour. It shall be capable of safely unloading Twenty five (25) numbers of Wagons per hour on a continuous basis Including hauling, pause, decoupling and weighing time etc in conjunction with side arm charger.
4	Side Arm Charger	It shall be used for pushing/ pulling rake of maximum 60 loaded wagons, each of 140 tonne gross weight. It shall operate in conjunction with Wagon tippler to achieve 25 tips / hour[rated].
5	Vibrating Grizzly Feeder	1200 tph[rated] each at separation size of (-) 20 mm.

6	Vibrating Feeder	300 tph[rated] each of crushed coal (-) 20 mm size coal.
7	Ring Granulator with By-pass facility	1100 tph each[rated] Feed size: Refer relevant cl. 1.5.1/b Product size: (-) 20mm (98 %), Coal
8	Bidirectional Stacker-cum-Reclaimer	a) 1200 tph [rated] (Stacking capacity) b) 1200 tph [rated] (Peak Reclaim capacity) c) 1000 tph (average Reclaim Capacity over 4 hrs. block cutting operation)
9	Travelling Tripper	1200 tph[rated] each
10	In Line Magnetic Separator	It shall pick 20 mm size MS cube, upto 15Kg Brake shoe of Railway Wagon & up to 50 kg rail piece/ MS Round (L/D not exceeding 5) from the specified conveyor at specified operating height.
11	Suspended Electro Magnet	It shall pick 20 mm size MS cube, upto 15Kg Brake shoe of Railway Wagon & up to 50 kg rail piece/ MS Round (L/D not exceeding 5) from the specified conveyor at specified operating height.
12	Metal Detector	It shall detect 30mm dia. aluminum sphere and also MS cube of 20mm from the specified conveyor (at specified operating height).
13	Belt Weigher	Accuracy : ±0.25% (excluding boom belt weigher) Accuracy : ±1% (boom belt weigher)
14	Dry Fog Dust Suppression System	The respirable dust level of 50 microns should be restricted to within 3m radius of application point: (a) 2mg/Nm³ over and above ambient dust level (in closed area) & (b) 5mg/Nm³ over and above ambient dust level (in open area)
15	Dust Extraction System	Dust emission level shall not exceed 50mg / Nm³ or as per stipulations of Pollution Control Board whichever is lower. Bag filter/Bin vent filter efficiency shall be minimum 99.9% down to 5-micron particles.
16	Noise Level	Individually and collectively Noise Level shall not be more than 85 dBA measured at a height of 1.5 m above floor level in elevation and at a distance of 1.00 m horizontally from any equipment in any direction and at any load condition.
17	Vibration Levels	Limits shall be as per VDI2056/BS4675

18	Illumination Levels	Average illumination level shall be achieved during normal operation of the plant with dust-laden atmosphere for one (1) month.
19	Earthing Resistance	Less than one (1) ohm shall be achieved when measured after-isolating CHP earthing system from main grid.
1.4	**Service / Maintenance Facility for CHP Buildings**	
1.4.1	Monorail for Magnetic Separators (ILMS & SEM) shall extend outside the building by minimum 3.0m. Tramp iron chute up to ground level shall be provided at floor on which above magnetic separators are installed. The monorail beam shall extend through suitable opening in the building fitted with an approved steel door (double flap), removable handrails, platform etc to enable removal of equipment to ground level or vice versa.	
1.4.2	Monorail beam with Electric / Manual Hoist shall be provided as specified at all locations where equipment likes conveyor drives, pumps or other heavy equipment are located. The monorail shall be extended to outside the buildings by minimum 3m. The monorail beam shall extend through suitable opening in the building fitted with an approved steel door (double flap), removable handrails, platforms etc to enable removal of equipment to ground level or vice-versa. Suitable machine-hatch, removable steel gratings / covers / hand-railing etc. shall be provided in Wagon Tippler Complex / all Junction Towers / Crusher Houses / other CHP Buildings etc as found necessary during detailed engineering.	
1.4.3	Approach with a platform to each Electric Hoist shall be provided on one side for maintenance purpose.	
1.4.4	Monorail beam with hook & manual hoist shall be provided above Cwt. Of HGTU.	
1.4.5	Mono rail beam with hook and Manual Hoist shall be fixed between the bend pulleys of all vertical gravity take-up arrangements for belt conveyors so as to lift the take-up pulley / counterweight at the time of belt joining to get the required loop.	
1.4.6	All safety guards wherever needed shall be provided for safety of operators. All pulley guards shall have adequate opening so that pulley bearings can be lubricated without removing the entire guard. The safety guard for the Take-up Carriage / Cwt. Box of the Gravity Take-up unit shall be provided with a removable panel for entry of operating personnel for greasing / maintenance of pulleys etc.	
1.4.7	Each Floor cleaning chute (for all Junction Towers / Crusher House) shall terminate at about 1.5 m above ground level. Floor cleaning chute shall be connected to tramp metal chute wherever feasible.	
1.4.8	For all Belt Conveyors / Feeders, steel fabricated stools shall be provided for fixing base plate of short post / Head, Tail, Bend Pulleys etc. in areas where RCC floor is provided.	
1.4.9	Adequate maintenance space (minimum 1200mm clear) around equipment and the drives, suitable operating & maintenance platforms as necessary with access for equipment, gates, pumps & other equipment etc. shall be provided.	

1.4.10	Monorails, inserts, handrails of 32 NB (M) pipe with toe guards, stairs/ ladders (as applicable) and angle protection for cut-outs in RCC floors shall be provided wherever required.	
1.5	**Design Criteria & General Requirement for CHP**	
1.5.1	Physical Characteristic of Coal/ Other Technical Parameters	
a.	Material handled	Imported/ Indian Coal.
b.	Max. lump size of coal received at Power Plant	a) 250 mm & below Indian ROM Coal with 400 mm lumps up to 20 to 30% or b) 100 mm Imported Coal or c) 20 mm Washed Coal. Note: ROM coal may contain shale and sandstone upto 20%. Also occasionally metal pieces like broken shovel/teeth/brake shoe/wire etc may also come along with ROM coal.
c.	Hard Grove Index (HGI)	44 – 65
d.	Bulk Density of Coal for equipment sizing	800 kg/m^3 (for volumetric calculation) & 1200 kg/m^3 [for load/stress on structure]
e.	Moisture Content	12 to 15% normally. However for design purpose moisture content of 20% shall be considered.
f.	Angle of surcharge	20 degree
g.	Max. Height of stockpile by Stacker Reclaimer (for crushed coal storage)	12 m (from Ground level)
h.	Size of Crushed Coal	(-) 20 mm
i.	Angle of repose of crushed coal	37 degree
j.	Bulk Density of crushed & compacted coal (in stockpile)	1200 kg/m^3 (for design of Bucket Wheel Reclaimer)
1.5.2	No. of stream provided	Two (2)
1.5.3	Stream Operation	(i)Entire Electrical/Mechanical System/Civil &Structural Design etc of the CHP shall be designed for simultaneous operations of both streams operating at 1200tph each including associated systems such as DE & DS systems etc. (ii) Complete Coal Handling Plant shall be designed to operate 24 hour per day round the clock.

1.5.4	Maximum Inclination of Belt	Up to 14 degree.
1.5.5	Wagon Tippler Complex# WTC-1	
a.	No. of Tippler provided	Two(2)
b.	Payload per wagon	60 tonne[av]
c.	Discharge equipment below tippler hopper	Apron feeder with dribble conveyor
1.5.6	**Stockpile Details**	
a.	No. of Stockpiles provided for crushed coal storage	Two (2)
b.	Type of cross section of stockpile	Trapezoidal
c.	Length of each stockpile	As per Plot Plan
d.	Width of stockpile at base	As per Plot Plan
1.5.8	The coal as received shall contain varying percentage of fines. Coal with such fines may tend to form adhesive lumps particularly during monsoon when the surface moisture is at its maximum value. The system shall be designed to minimize choking.	
1.5.9	The drive equipment including motor for equipment viz Gates/ Vibrating Feeders/ Grizzly Feeders/ Crushers/ Stacker cum Reclaimer etc shall be sized for minimum 110% of requirement of driven equipment at its design capacity.	
1.5.10	For the purpose of volumetric computation the bulk density of Coal shall be taken as 800 kg/m^3. Therefore for calculation of Belt Conveyors/feeders capacity for their drive & drive motor kw requirement & sizing of chute / hopper etc. above bulk density shall be considered. For all other purposes namely for stresses / load on structures, loading on apron feeder, loading on vibrating feeder/vibrating grizzly feeder, sizing of actuators for divertor gates, flap gates & rack & pinion gates, calculations of plugged chutes / hopper loads etc. bulk density of coal shall be taken as 1200kg/m^3.	
1.5.11	Each equipment & conveyor drive except Crusher shall be capable to start under fully loaded condition.	
1.5.12	Temperature & vibration monitoring equipment of reputed & proven make only shall be provided for Crusher House.	
1.5.13	Junction Towers/ Crusher Houses/ Sampling Tower shall be designed for:	
a)	• In steel frame construction (above ground portion) providing sufficient space to accommodate the entire equipment like head end, drive unit and tail end of various conveyors, transfer chutes, supports for conveyor bridges, tensioning arrangements etc. and other equipment. Floors/ roof of all Junction Towers/ Crusher House/ Sampling Tower building shall be in RCC. Floor to mount gate [viz flap/ diverter gate] shall be in steel construction with cheq. Plate floor. Steel doors and windows fitted with glazed glass, access doors, platforms, equipment hatch, monorails, hoists etc as necessary shall be provided. • Underground portion of above buildings and its all floors/ access stairs shall be RCC.	

	• One (1) external Independent steel staircase up to roof level [minimum1000 mm (clear) width] shall be provided for above buildings except crusher houses/ sampling tower with landing facility at all floors. • Two (2) external Independent steel staircase up to roof level [minimum 1200 mm (clear) width] shall be provided for Crusher house building with landing facility at all floors. • One (1) external Independent steel staircase up to roof level [minimum1000 mm (clear) width] shall be provided for Sampling Tower Building# ST-1 with landing facility at all floors. On the other side of gallery, One (1) partial internal staircase commencing from floor level below conveyor floor level to reach other side of gallery/samplers etc shall be provided. • For underground / semi ground Junction Towers minimum 1200mm wide RCC stair shall be provided.
b)	Edges of floor openings shall be protected by embedding ISA 65 x 65 x 6 around its periphery. Safety handrails shall be provided around the openings.
c)	Working floors and equipment floors shall be enclosed with suitable precolour coated metal claddings to ensure full protection from rain and strong wind. Also claddings shall be designed to provide sufficient day lighting and ventilation
d)	Necessary rain water down comer minimum two (2) no per building/ tower & minimum four (4) no for crusher house & electrical rooms shall be provided.
e)	All Pent House shall be In RCC construction with brick wall cladding for above ground portion with necessary opening for doors etc.
f)	RCC staircase[1200mm wide] shall be provided for approach to Tail/ portion of Conveyor/ other equipment etc which are located in pit/ underground portion of Wagon tippler Complex/ Junction Towers with landings facility on all floors.
g)	The contractor shall ensure/ make water proofing arrangement to provide for 100% leak-proof construction of buildings, structures, underground RCC work etc.
h)	While designing Wagon Tippler Complex/ Junction Towers/ Crusher House/ Sampling Tower the Contractor shall ensure that chute openings in floors are located correctly so as to ensure adequate size of opening without sacrificing the chute inclination or cross-sectional area of the chute.
i)	For maintenance purpose of equipment/ drive etc ample space shall be provided around each equipment. Minimum 1200mm clearance around drive unit/ equipment etc shall be available for maintenance purpose.
j)	In all conveyor tunnels, suitable insert plates at about 1.5m spacing shall be embedded in both sides of tunnel and underside of tunnel roof for fixing supports/ brackets etc for mounting the cable trays, lighting fixtures, fire fighting headers, handrails, ventilation ducts, control panels etc. Steps shall be provided in conveyor tunnels if tunnel slope is equal to 10 degrees or more.
k)	Each sump pit shall be provided with two (2) sump pumps,1W+1S
1.5.14	The clearance between underside of Monorail and top of drive pulley at discharge end shall be minimum 3.5 m (clear) or more, if required. For mounting ILMS/ SEM the clearance shall be minimum 6.5 m between top of pulley & bottom of monorail. Machinery hatch and monorail arrangement etc as per HPGCL

	Engineer/ Consultant's approval shall be provided so as to ensure trouble free handling of equipment/ material for maintenance purposes.
1.5.15	Minimum number of Cross-over (as shown in tender drawings) shall be provided. Trestle spacing shown is indicative only and is subject to change during detailed engineering & to suit site conditions.
1.5.16	The wagon tippler pit shall be provided with adequate head room and space, monorails, hoist, stairways, equipment hatch etc. for ease of operation and maintenance of feeder, gates & conveyors etc as per Engineer's approval.
1.5.17	Hydraulic piping, if required, (for wagon tippler) shall not be laid on ground or floor. If necessary, the piping shall be kept minimum six (6) inches above floor/ ground level. For hydraulic piping besides WT hopper, 20g, GI covers shall be provided over hydraulic piping to prevent accumulation of coal dust and consequent corrosion of pipe due to moisture, coal dust etc.
1.5.18	The Contractor shall ensure that there is no fouling of piping for Dust Suppression and other lines in the monorail areas so as to ensure safe handling of equipment or its heavy parts for maintenance purposes without damaging the piping structures.
1.5.19	Deck plate at loading point only shall be provided for boom belt of Stacker Reclaimer M/C & Reclaimer M/C.
1.5.20	Suitable soiling with mortar covering shall be provided between the rails of the Stacker-Reclaimer.
1.5.21	Suitable cable trays about 6" to 8" above ground floor/ level shall be provided for Rail Mounted M/C# SR-1A trailing cables and tripper trailing cable to prevent damage to the cables. In Crusher House, Junction Towers, tunnels/ galleries etc. power and control cables shall run in separate vertically supported cable trays provided with minimum 20 (g) GI covers which shall be easily removable.
1.5.22	Coal Yard Drainage System: Drainage canal around stockpiles to be constructed ultimately leading to a sump to take all the effluent water from coal stock yard (sprinkling water, rain water). Sump pumps shall be provided to pump the water from sump pit to the guard pond.
1.5.24	For Stacker-Reclaimer, Wagon Tippler & Coal sampling System, PLC based control system shall be provided.
1.5.25	Except for Stacker-Reclaimer, Wagon Tippler the complete Coal Handling Plant shall be operated from stand-alone DDCMIS based control system with the provision of local control panels. DDCMIS shall be located in Central Control Room at 1st floor of Bldg # ER-2. Necessary operator work station (OWS)/ engineer work station (EWS) shall be provided suitably. In Building# ER-2, the MCC shall be arranged on the ground floor with suitable partitions etc. O&M office Room together with Central Control Room shall be located at 1st floor of Bldg # ER-2. Central Control Room & O&M Office shall be designed to house min. fifteen (15) persons in each area. Both shall be provided with AC system (Split Type) including wall mounted fans for O&M staff/ other personnel seating areas. Necessary false ceiling shall be provided for Air Conditioned areas.

1.6	**Standards, Codes and Regulations** All construction, installation, workmanship, design & equipment shall conform to acts, rules & regulations of the jurisdiction within which the project is located, and to the current edition of the following or equivalent standards or codes, in so far as they apply: American Iron and Steel Institute (AISI) American Society of Mechanical Engineers (ASME) American Society for Testing and Materials (ASTM) American Wire Gauge (AWG) Institute of Electrical and Electronics Engineers (IEEE) Instrument Society of America (ISA) National Electrical Code (NEC) National Electrical Manufacturers Association (NEMA) United States of America Standards (USAS) Bureau of Indian Standards (BIS) CEMA^{5th} - Conveyor Equipment Manufacturers Association
1.6.1	Contractor shall indicate the particulars of standard / code that have been followed against each work. The contractor shall be in a position to produce details of particular standard / code, if asked to do so by HPGCL / Consultant
1.6.2	Coal Handling System included under this specification shall comply with all currently applicable statues, regulation and safety codes related to design, construction and operation of Bulk Material Handling Facility (for coal) in the locality where the system will be installed. Nothing in this specification shall be construed as to relieve the contractor of the statutory responsibility.
1.7	**Painting & Surface Treatment** (For all Technological Structure / Equipment / Conveyor posts support, Misc Structure such as T.U Tower / O&M platform for maintenance & ladder etc) Refer Volume II

1.8 **List of Building required for CHP[other than Junction Towers/ crusher house/ sampling tower]**

SW: service water facility, PW: potable water facility, OWS / EWS: Operator/Engineer Work Station

S. No.	Building	PW	SW	Toilets / Urinal Facility	A.C unit {split type}	Exhaust Fan	Unitary Type Pressure Ventilation System	Remarks
1	Bldg # 3ER-1A / 3ER-1B [MCC room cum control cabin for WT-1A/1B]	Yes	Yes	.....	AC unit to be provided in Control cabin area at 1st floor along with wall mounted fan for OWS/EWS area Ample glassed area for Control Room to have all around view of Tippler Complex On Ground Floor MCC, other electrical items etc. shall be located.	.....	To be provided for MCC/other electrical items area located at ground floor of this building.	RCC Framed building [two storey] False ceiling for AC area/ vitrified ceramic tiles (mirror polished, 800x800x10thk) flooring at first floor / aluminium doors& windows with glazed glass etc shall be provided. Stair case upto roof level shall be provided, I.P.S (cement concrete flooring) with metallic hardener at gr floor
2	Bldg # 3WBCR-1A/1B [Weigh Bridge Control Room Bldg]	Yes	.....	.....	AC unit to be provided along with wall mounted fan to be provided for OWS / EWS area. Ample glassed area shall be provided to have all around view of Rake movement.	.....	.....	RCC Framed building [single storey] False ceiling for AC area/ vitrified ceramic tiles (mirror polished, 800x800x10thk) flooring aluminium doors& windows with glazed glass etc shall be provided. Stair case upto roof level shall be provided.
3	Electrical Bldg # 3ER-3/4 [MCC Room]	Ye s	Yes	Yes one (1) Toilet shall be provided in the building	.....	To be provided for Toilets	To be provided for MCC/other electrical items area	RCC Framed building [single storey] Aluminium doors& windows with glazed glass etc shall be provided. Stair case upto roof level shall be provided, I.P.S (cement concrete

S. No.	Building	PW	SW	Toilets / Urinal Facility	A.C unit {split type}	Exhaust Fan	Unitary Type Pressure Ventilation System	Remarks
				having heavy duty ceramic tile with matt finish			located at ground floor of this building.	flooring) with metallic hardenerat gr floor
4	Pump house building # 3PMH-1A/1B/ 2/3A/3B/4 & compressor house #3ACH-1	Yes	Yes	Yes one (1) Toilet shall be provided[for each 20lumi] having heavy duty ceramic tile with matt finish	.....	To be provided for Toilet & also at equipment area	.....	RCC Framed building [single storey] I.P.S (cement concrete flooring) with metallic hardenerat gr floor Stair case upto roof level shall be provided Ample area shall be available around each equipment Monorail with hoist (as specified) shall be provided to suit.
5	One operator's cabin in a) Crusher House b) On Tripper Floor in Bunker Row #1 c) On Tripper Floor in	yes	yes	Yes	A.C. Unit along with Wall mounted fans shall be provided.	.....	.....	Sufficient glassed area shall be provided. Noise Level shall be within permissible limit.

S. No.	Building	PW	SW	Toilets / Urinal Facility	A.C unit {split type}	Exhaust Fan	Unitary Type Pressure Ventilation System	Remarks
	Bunker Row #2							
6	Loco Shed	Yes	Yes	Yes				Refer Volume VI for further details
7	Dozer Shed	Yes	Yes	Yes		Yes		Refer Volume VI for further details

1.9	**Drawings / Documents**
	Broad list of drawings/documents (soft & hard copies) to be furnished during design & engineering stage are given below
1.9.1	GA / Layout / schematic drawings / design calculations / technical data / other relevant documents to be submitted for Approval
a.	Flow Diagram of CHP, Layout Plan of CHP showing the coordinates / location of Wagon Tippler Complex / location of Reclaim Hopper Complex / location of Crusher House / location of Junction Towers / Stockpile Area / Pump House / Electrical Buildings / other CHP buildings etc.
b.	GA drawings of Wagon Tippler Complex / Reclaim Hopper Complex / Junction Towers / Crusher House / Pent House / other CHP buildings etc complete with load data / sectional view / typical details of equipment fixing arrangement & showing monorails/ staircases / handrails / hatch / machinery well / rain water down comer etc.
c.	GA drawing of all conveyors / feeders / other equipments of CHP.
d.	GA drawing of Wagon Tippler / Side Arm Charger / Apron Feeder /Crusher / Vibrating Feeder / Vibrating Grizzly Feeder / Gates / Belt Weigher / Inline Magnetic Separator / Suspended Electromagnet / Metal Detector / Coal Scooper / Travelling Tripper / Fixed Tripper / Sump Pumps / Elevator / Belt Vulcanizing Machine / Belt Sealing Arrangement / Hoists / Bunker Level Indicator / A.C. Unit /Exhaust fans etc along with load data / technical particulars / technical data sheet etc.
e.	GA / Plan / cross sectional drawing crushed coal stockpile area / stacker-cum-reclaimer machine
f.	Design Basis Report / Flow & P&I Diagram / GA / Layout Drawing For Equipments & Subsystems etc involved with Dust Suppression Systems / Dust Extraction System / Ventilation Systems / Unitary Type Pressurized Ventilation & Water System / Coal Sampling System / Compressed Air System / other system etc.
g.	Civil / structural design calculations along with relevant GA / other applicable drawings
h.	Single line diagram / PLC / operation & control philosophy / other relevant calculations / documents / drawings etc. for electrical equipment / components / items including those for instrumentation work etc.
i.	Technical data/particulars of all equipments / conveyors etc.
j.	Design Calculation / technical documents
	i. Conveyor calculation for motor kw rating / Drive Components & Belting Selection/ Pulley dia & its rim thk, Shaft Diameter / radius of curvature / coasting down time / Load data Calculation etc.
	ii. Design calculation / Load data for conveyor gallery, tunnel, trestle, wagon tippler hopper, reclaim hopper complex, crusher houses, other building / Structures etc.
	iii. QAP for all manufactured and sub contracted items.
	iv. Procedure for conducting Performance guarantee test along with the Performa.
	v. Manufacturer's standard test list along with test certificate etc.
k.	Any other drawing / document which may be called for by HPGCL / Consultant.

1.9.2	Drawings / documents/schedules to be submitted for Information Category / Record / Reference. Each of above items shall be comprehensive in nature indicating qty/technical particulars/ratings/locations etc. on "As Built Basis".
a.	Electric load list / Hoist Schedule (manual & electric)
b.	Idler / Pulley / belting / drive components schedule & other applicable schedule for conveyors
c.	Conveyor safety switch schedule
d.	Motor data sheet including Characteristic curves / Coupling / Gearbox / other items & components for all equipment & systems.
e.	Calculations for Hydraulic power pack, number of buckets, bucket sizing, reclaim capacity for Stacker-cum-Reclaimer Machine
f.	Operation &Control Philosophy for Side Arm Charger / Wagon Tippler / Stacker-cum-Reclaimer M/C,Coal Sampling system
g.	Calculation for power pack of Wagon tippler / Side arm Charger & Tractive effort calculation for side arm charger.
h.	Calculation for rotary discharge machine.
i.	Calculation in support of strength of magnet of ILMS / SEM.
j.	Specification / Catalogues of all standard bought-out-items / components etc.
k.	Conveyor component drawings, such as idlers, pulleys, skirt boards, safety switches etc.
l.	As built drawings for equipments / system / building / structures etc for the coal handling plant.
m.	Operation / Maintenance / Spare Parts Manuals.
n.	Vendor / Supplier's drawings for all electrical / electro-mechanical / Instrumentation items etc
o.	Any other drawing / document required by HPGCL / Consultant.
1.9.3	Information / Guarantee data to be furnished along with the Bid.
a.	Guaranteed capacity for Belt conveyors / reversible conveyors / wagon tippler / side arm charger / apron feeder / crushers / vibrating feeder / vibrating grizzly feeder / stacker-cum-reclaimer machine / tripper conveyor / gates etc
b.	Average reclaiming capacities over four (4) hours block cutting operation of Stacker-cum-Reclaimer M/C and also its peak capacity.
c.	Capacity of stockpiles for crushed coal storage
d.	Guaranteed power consumption in different paths (KW)
e.	Water Consumption for potable and non-potable water.
f.	Motor list for all Equipment.
g.	Conveyor profile drawing / flow diagram / other drawings etc

1.10	**Technical Specification**
M-1	**Belt Conveyors**
1.0	Each Belt Conveyor shall be complete with all types of idler sets with mounting brackets, all types of pulley assemblies with Plummer blocks supported on ruggedly designed steel frames, complete drive unit with base frame, belting, take-up device, deck plate, skirt board, primary/secondary belt scrapers, v-plow cleaners, discharge chute, stringer frames, short supports with base plate, seal plate, safety switches and all the necessary fixing bolts including anchor bolts etc.
2.0	**Applicable Standards & Codes**
	Belt Conveyors with their components and accessories shall be designed and manufactured in accordance with the latest revision of the Indian Standards listed below. Wherever IS are not available, British Standards, American Standards, DIN, ISO or other reputed standards shall be followed. i) IS: 4776 (Part-I) : Specification for troughed belt conveyor for surface installations. ii) IS: 4776 (Part-II) : Specification for troughed belt conveyors for underground installation iii) IS: 8598 : Specification for Idler sets for belt conveyors. iv) IS: 8531 : Specification for pulleys for belt conveyors. v) IS: 1891(Part-I) : Specification for rubber conveyor and elevator belting. vi) IS: 7155 : Code of Recommended Practice for conveyor safety vii) IS: 11592 : Code of Practice for selection and design of Belt Conveyors. viii) CAN/ CASA-M422M87: Canadian Standard Association. ix) IS4009 (Part-III) : Conical Head grease nipples. x) IS226 : Structural steel (Standard Quality) xi) IS 4682 : Codes and Practices for lining of Vessels & equipment for chemical processes.
3.0	**Design basis:**
3.1	Belt sag on the carrying side shall not exceed 2% of idler spacing. Maximum operating tension in the belt shall not exceed eighty (80) percent of maximum allowable working tension of the belt at the specified load (for Nylon/Nylon belt).
3.2	Maximum inclination of the belt shall not exceed 14degree.
3.3	Wrap angle shall be generally 200°/400° for single snub drive pulley / dual drive pulley. All drive pulleys shall be lagged. However, wrap angle shall be such so as to ensure proper mounting arrangement of the external belt scrapers assembly.
3.4	Under all operating conditions including running, starting, fully or partially loaded or empty belt, the belt shall not lift off the idlers. The radius of curvature shall be adequate so that there is no lift off of the belt in case of Concave curve and no overstress at edges of belt or lack of tension at belt centre in case of Convex curve. An extra allowance of minimum 10% shall be kept on the calculated radius of curvature. Further suitable holding down pulley shall be provided at concave curve of all conveyors.
3.5	All Conveyors shall be capable of starting fully loaded. All inclined Conveyors shall be provided with holdback device. As an additional safety, each inclined Conveyor

	shall also be provided with brake. Brake shall also be provided on conveyor where coasting time is to be adjusted.
3.6	Design capacity of each conveyor shall be as per data sheet. Design capacity shall be considered for the selection of belting, idlers, pulleys and drive etc. The drive motor of each belt conveyor shall be rated for minimum 110% of actual requirement of driven equipment at motor output shaft at the specified design tph of conveyor. CEMA (5^{th} Edition) shall be used for KW rating calculation / selection of drive motor, belting etc. Minimum value of K_y to be considered shall not be less than 0.025 in the above calculations.
3.7	Clearance between top of rail track / road and bottom of conveyor gallery shall be kept at least (6) meter for conveyor gallery crossing over rail track/road.
3.8	Structural steel, covered conveyor galleries with steel trestles as required shall be provided for all above ground conveyors. 600mm wide Crossovers shall be provided as shown on tender drawings enclosed.
3.9	Components of belt conveyors shall be standardized to the extent possible viz. belting, pulleys, bearings, gearboxes and coupling to facilitate Interchangeability as well as inventory control.
4.0	**CONVEYOR COMPONENTS**
[A]	**Belting:**
i)	Belting shall be Nylon-Nylon/ Steel Cord type with FR grade cover [as per conveyor data sheet] suitable for heavy duty application with adequate flexibility to give troughing angle of 35 degree. The Belting shall be of cut edge construction. Belting shall conform to IS: 1891 (Part-I). Electronic Rip detection system shall be provided for steel cord belting. Steel cord belt shall be provided with "Rip Protection" as follows: Bidder shall provide proven experience of Rip protection Belt. Rip protection shall be of Nylon fabric breaker (of weft strength minimum 150kN/m) or steel cord breaker for top & bottom cover. Combination of steel cord for top & Nylon fabric breaker for bottom is also acceptable
ii)	F.R. properties of cover shall conform to CAN/CSA-M422-M87 TYPE –C for Drum friction and Electrical surface resistance test and ISO 340 for flame tests
iii)	Belt joint shall be properly vulcanized and finished. Belt shall have hot vulcanized joints after erection. Vulcanizing shall be done on single setting. Vulcanizing chemicals, splicing tools and equipment shall be supplied as per scope of work. A length allowance for field joints and also for test samples shall be added to all belt lengths.
[B]	**Idler Units**
i)	All idlers shall be made out of ERW tube and shall conform to IS: 8598. Mechanical properties of ERW tube shall be equal to or better than Yst 210 grade [IS: 9295]. Friction factor of idler shall not be more than 0.017 while testing at works. For standardization of idlers, all rollers shall be identical and interchangeable type for the same category. Idlers shall be easily removable type. Idler shaft shall be of bright bar (UTS 45 kgf/mm^2,IS:9550)
ii)	Idler bearings shall be `sealed and lubricated for life' provided with double labyrinth seal and rain cap to prevent entry of dust & moisture. Deep grooved ball bearing with C-3 clearance of SKF/FAG make only shall be used.

iii)	Normal Spacing of idler shall be 1.2m for carrying side and 3m on return side However at convex curve; spacing shall not exceed 50% of the above idler spacing.
iv)	All carrying idlers shall be 3-Equal roll fixed type x 35^0 Troughing suitable for 1400 mm belt width. All carrying idlers shall have interchangeable rolls.
v)	Impact type idlers shall be provided with number of tough rubber discs with minimum shore hardness of 65 ± 5 deg on shore 'A' scale. Impact idler frame shall be inverted channel. Rubber ring thickness shall be minimum: OD ERW tube + 50mm. Minimum of six (6) set of impact idlers shall be provided at each loading point of the conveyor with maximum spacing of 400 mm. Material used shall be of resilient type. For Conv. # RBF-1A/1B continuous skirt board along with impact idler @ 400mm spacing shall be provided for entire length.
vi)	Sufficient number of adjustable type transition idlers with 10-degree steps, shall be provided adjacent to terminal pulleys. Minimum three trough (transition) idlers shall be used at the head end of each conveyor. Transition length shall be provided as recommended by the belt manufacturer.
vii)	Return idlers shall be 2- Equal roll V-type x 10^0 Troughing.
viii)	The self-aligning carrying/return idlers shall be provided one each within approximately 5m / 10 m (respectively) distance from Conveyor ends and the spacing of intermediate self-aligning carrying/return idlers shall not exceed 10 times the normal idler spacing of carrying/ return side.
ix)	Suitable deflector roller of at least 219.1 mm OD x 10mm thk shell on 70mm dia. [min.] shaft at hub mounted on Plummer block and lagged with 6mm thk neoprene rubber lagging shall be provided for each conveyor at each end.
x)	Non-magnetic idlers made of 26luminium tube lagged with 5mm neoprene rubber lagging shall be provided in conveyor portion over which magnetic separator (Suspended Electromagnet) is mounted.
xi)	All roller brackets shall be fabricated from steel plate sections of adequate thickness & strength and with stiffeners. Brackets shall be mounted on inverted steel angle or channel frame. Adequate arrangement for proper alignment of the brackets over supporting steel frame shall be provided. Fixing arrangement of roller with brackets shall be drop in slot type. Direction of belt travel shall be clearly marked on the brackets of carrying idlers by embossing / punching.
xii)	Each conveyor shall be provided with one (1) no self cleaning type rubber disc return idler located near head end.
xii)	Following idler test shall be carried out at works. a. Idler friction factor test b. Dust and Water proof test. c. Diametric run-out check d. Bearing Noise Check e. Any other tests as per relevant codes & standards.
[C]	**Pulleys**

i)	All pulleys shall conform to the requirement of IS: 1891/ IS: 8531. Pulleys shall be of welded steel construction (MS: IS: 2062) having continuous rim and two end discs fitted with hubs and the required internal stiffeners. However finished shell thickness shall not be less than 14 mm for any drive pulley and not less than 12mm for any non-drive pulley.
ii)	Pulleys shall be duly stress relieved before machining. Hubs shall be of forged steel. Hubs and end discs shall be accurately machined for concentricity. All pulley shafts shall be EN-8 or equivalent. Shafting shall be fitted by using ring feeder / taper lock assembly only, of reputed & proven make.
iii)	All pulley shafts shall be designed in accordance with CEMA (5^{th} Edition) considering minimum service factor of 1.5 for bending and 1.0 for torsion. Shaft deflection shall not exceed six (6) minutes for any pulley. Shaft diameter shall be calculated based on rubber lagging only. i.e. T_1 / T_2 etc. shall be based on rubber lagging only.
iv)	All pulleys shall be straight faced having face width equal to Belt width plus 200mm and lagged as stated below:
a)	All drive pulley shall have minimum 12 mm (4mm ceramic + 8mm rubber) thick Ceramic rubber lagging [Al_2O_3 (92%) ceramic tiles embedded into the natural rubber by vulcanizing process, Hardness=9 on Mohr's scale]. Coefficient of friction shall not be less than 0.7(Dry Conditions)/0.5(Wet condition) for the above lagging.
b)	All other pulleys shall have minimum 12 mm thick (plain) natural rubber lagging having 55 to 65 degree hardness on shore "A" scale.
v)	Pulley assemblies shall be statically balanced and run concentric when mounted on shaft. Balancing weight shall not exceed 0.5 percent of pulley weight. Out of roundness of any pulley shall be within ± 0.5% of diameter without lagging.
vi)	Pulley shafting shall be supported by heavy duty antifriction – double row self aligning spherical roller bearings (SKF / FAG make only) with double labyrinth with synthetic seals and grease nipples. Bearings shall be housed in horizontally split type Plummer block equipped with four fixing bolts and complete with side covers. Plummer blocks shall be of cast iron construction. Adjustable screw and lock nut shall be provided on one side of Plummer block for alignment purpose. Vendor shall ascertain pulley diameter, shell thickness and shaft diameter and suitable calculations shall be submitted for approval during detailed engineering. Pulleys shall be standardized to the extent possible and the relevant details furnished. L10 Life of bearing shall be 60000 hrs minimum.
vii)	The shell of drive/head pulleys having overhead inline magnetic separator [if provided] shall be made out of non-magnetic material that is Stainless Steel SS-304 of 16 mm thk (min).
viii)	Bend / Tail / T.U pulley shall be kept identical in all respects including bearing centres for a given conveyor.
ix)	Necessary safety guard of expanded metal shall be provided for the pulleys. Pulley guard shall have adequate opening to allow greasing of pulley bearings.
x)	**<u>Conveyor Technological Structure</u>**: Stringer size: ISMC-150 (Minimum); Short support: ISA 65x65x6 (Minimum);

	Short support spacing: 3m (Maximum) Non loading area and 2.4m (Maximum) in impact loading zone.
[D]	**Skirt Board**
i)	Skirt board of 16 mm thk SAILHARD/equal shall be provided at each loading point. Minimum skirt board shall be as shown on drawings. Minimum height of skirt plate shall be 900 mm. Inside Clear width between skirt boards shall be 2/3rd of belt width. Skirt-boards shall terminate above an idler preferably.
ii)	Skirt board shall be covered from top and provided with necessary flanges for connecting to feed chute. 5mm thk. MS cover plate along with 3mm thk neoprene rubber gasket, bolted to skirt flanges shall be provided for dust tightness. Rubber curtain shall be fixed at skirt board end for reducing dust nuisance. Back plate of skirt board shall be kept about 200mm away from the feed Chute edge.
iii)	The gap between the skirt and the belt shall be closed or controlled by exterior rubber strips of 50-55 degree durometer hardness on shore 'A' scale. Rubber strip shall be minimum 200 mm deep x 20 mm thk. The rubber strips shall be held in position by steel clamps spaced at maximum spacing of 400mm. The rubber strips shall be adjustable for minimum height of 100 mm.
[E]	**Deck Plate**
	Continuous deck plate self cleaning inverted V- deck type made out of 3.15 mm thick MS sheet for full length of all conveyors shall be provided. Suitable ribs for adequate stiffness of deck plate shall be provided.
[F]	**Belt Take-ups**
i)	Each belt conveyor shall be provided with take-up device as per Data Sheet. For horizontal gravity T.U., necessary sheaves shall be provided to reduce the movement of counter weight box. Counter weights shall be made out of cast iron with standardized denominations. In all cases space shall be provided for an addition of 25% of the counter weight. Provision shall be made for dismantling the counter weight or relieving the tension in the belt. Height of the take-up guide steel sections frame shall be sufficient to allow the take-up main pulley at the time of belt jointing to get the required loop.
ii)	For Take-up travel length shall be equal to minimum: 2.5 % (of C/C Pulley) + 600mm for all Nylon/Nylon Belts & 0.5 % (of C/C Pulley), mm for Steel Chord Belts. Screw Take-up (if applicable)shall be hydraulic operated type.
iii)	Suitable expanded metal guards and access platform & stair (800mm wide) with handrails shall be provided for maintenance for VGTU. In case of horizontal gravity take-up (HGTU), necessary pulley carriages, sheaves, rope of adequate strength, take-up tower, counter weight, access ladder, handrail etc. shall be provided. To measure counter wt. travel suitable scale shall be provided in addition to limit switches for T.U travel. Rope shall be of reputed and proven make conforming to IS: 2266, [Grade: 1770] flexible 6 x 19 (minimum) construction with fibre core.
iv)	Each gravity take-up unit shall have a 0.6 m deep sand pit provided under the counter weight. The area below the counter weight shall be guarded to a height of 1.8 m above any access level. Where it is not feasible to provide sand pit suitable Impact beam / Sand bags shall be provided below the counter wt. box in addition to safety guard.

v)	The design of the counter weight assembly shall have a self-cleaning top. For HGTU – twin sheave/loop arrangement shall be provided to reduce Counter wt travel to about 50%.
vi)	A lifting beam with Manual Hoist of minimum capacity 150% the total weight of counter wt unit shall be provided, located on the centre line of the take-up unit and above the Take-up Pulley in case of VGTU and above the Cwt. Box in case of HGTU.
vii)	The pulley slide frame shall be self-cleaning type. The pulley slide carriage shall be equipped with V – type wheels [attached to shaft] running on guide rails. End Travel limit switch shall be provided at both ends of take-up travel. In case of HGTU, suitable buffers at both ends of Travel of Pulley carriage shall be provided.
[G]	**Seal Plate**
i)	5mm thk. MS (IS:2062) seal plate shall be provided throughout conveyor gallery for all conveyor which are installed in overhead conveyor gallery
[H]	**Drive Unit:**
i)	The drive shall be complete with motor, gear reducer, L.S & H.S. coupling with guards, hold back device, brake etc mounted on steel fabricated base frame. All components of drive unit shall be designed based on 50°C (maximum) ambient temperature and continuous duty of 24hrs operation per day. Water cooled Gear Box or Coupling will not be accepted.
ii)	Drive unit shall have common base frame of welded steel construction, designed with sufficient depth and stiffness to ensure rigidity of drive assembly. Base frame shall be fabricated to achieve accurate alignment of the various components of drive unit. All machinery mounting surfaces shall be machined. Base plates shall be suitable for erection on both concrete and structural steel base. Base plates shall be provided with lockable adjustment screws to facilitate alignment of heavy gear reducers and motors in the horizontal plane. All equipment shall be totally enclosed and completely sealed against dust & moisture. Necessary hoist with monorails for lifting of drive unit components/drive pulley shall be provided. Drive unit with its base frame shall be mounted on heavy concrete block. Only high tensile bolts shall be used for fixing drive component to base frame and base frame to the concrete block or steel surface.
iii)	**Gear Box:**
a)	Only bevel-helical gearbox, natural/fan cooled and of reputed & approved make shall be provided for conveyor drive. Water –cooled gearbox will not be accepted. Gear box shall be adequately sealed.
b)	Gearbox mechanical power rating shall not be less than 1.80 times of the belt kw. Thermal rating shall be adequate and if required only fan cooling shall be provided. This is subject to purchaser's approval. Input kw rating/Thermal rating/Reduction ratio/selection calculation's etc for gearboxes shall be submitted for approval by Engineer/Consultant. Splash type lubrication shall be provided for gear box.
c)	Gear Box Casing shall be of closed grained cast iron of grade FG-260 of IS-210 or equivalent and stress relieved. Casing area shall be sufficient to ensure effective cooling. Suitable ribs shall be placed under the bearing seats for strength to withstand the most severe stress encountered during operation. Gear box shall have oil filling cap, adequate air breathing arrangement, visible oil indicator & oil drain plug, inspection openings, lifting lugs. All bearings shall be splash lubricated

	and gear box casing shall have adequate oil reservoir. The base of the housings shall be machined and shall be suitable for bolting to base plate.		
d)	Gear & pinions shall be manufactured out of high tensile carbon/alloy steel, duly hardened and ground to withstand operating conditions. Forged / Alloy Steel shafting to suit shall be provided. Shaft ends shall be properly sealed for protection from any ingress of dust. Antifriction ball/roller bearing of ample size shall be incorporated.		
e)	Integral Hold back device built in with gear box shall be provided for all inclined conveyors.		
f)	Following Tests shall be performed:- 1. Noise Level 2. Guaranteed Efficiency 3. Guaranteed Reduction Ratio 4. Max. Temperature Rise. 5. Bearing Performance. 6. All test as per relevant codes and standard 7. All test as per manufacturer's standard.		
iv)	**Coupling**		
a) b)	All couplings shall provide for lateral, angular and longitudinal misalignment of shafts. Type of couplings to be used shall be as given below		
S. No.	**Motor kw rating**	**Type of LS coupling**	**Type of H.S. Coupling**
1.	Less than 30 kw	Geared type	Resilient type flexible coupling
2.	30 kw & above but less than 160 kw	Geared type	Delay Filled Chamber (DFC) type fluid coupling
3.	160 kw & above as well as dual drive and H T Motor	Geared type	Actuator operated Scoop type fluid coupling (air cooled design)
4	If kw rating of motor >30kw and drive unit provided at each end of conveyor.	Geared type	Actuator operated Scoop type fluid coupling (air cooled design)
b)	**Gear Coupling:**		
	Coupling shall be able to absorb parallel and angular misalignment. Coupling shall have crowned external teeth, which engage, with the straight internal teeth of the sleeve. The pressure angle, the amount of crowning & backlash value shall be selected to achieve the best results in load carrying capacity. Lubrication arrangement shall be adequate to ensure silent operation and minimum wear of gear teeth. Coupling shall be dust proof and suitable sealing device shall be provided. Permissible parallel & angular misalignment shall be within 3-5mm & (±) 1.5 degree respectively. Service factor shall not be less than 1.5 (to be used on belt kw) for coupling selection.		
c)	**Fluid Coupling:**		

i)	Fluid couplings shall be suitable for providing controlled starting for conveyor driven by direct online squirrel cage induction motor. Starting torque applied to conveyor shall at no time exceed 140% of the torque corresponding to the full load belt kW. Actuator operated scoop type fluid coupling, shall be equipped with adjustable controlled torque transmission device. It shall be possible to de-clutch the driven machine keeping the motor running. Particular attention shall be given in selection of casing material of Fluid coupling in view of chemical properties of material to be handled by the conveyor.
ii)	The fluid coupling shall have resilient mounting arrangement to take care of misalignment between the motor and reducer input shaft. The fluid coupling shall be designed for ease of maintenance so that it can be taken out without shifting the motor or gearbox.
iii)	Fluid coupling rating shall be selected with minimum service factor of one (1) on kw rating of motor.
iv)	Running slip vs torque characteristic curve of fluid coupling shall be such that slip across the coupling is not more than 3%. Rating (KW) of fluid coupling shall not be less than the connected motor kw rating.
v)	Impeller of the coupling shall have member with radial vanes extending to the Periphery. Runner shall be similar proportioned bowl and shall be set facing the impeller keeping adequate clearance yet providing acceptable efficiency. Housing of coupling shall be of robust design.
vi)	Housing shall be so designed that effective cooling can be ensured. Provision shall be kept so that oil quantity inside housing can be adjusted at site. Water-cooling is not acceptable. Suitable fusible plug shall be provided for fluid coupling in order to protect against thermal over load and allow oil to be disposed such that hydraulic connection between impeller and runner ceases.
vii)	The equipment shall be suitable for full load, part load and no-load starting of the drive equipment without hampering safety of the motor and rate of acceleration.
viii)	Technical Particular: (i) Housing material : Aluminum Alloy Steel (ii) Type of Cooling : Air-cooled (iii) Semi-flexible coupling : Yes, at output side with brake drum, if applicable (iv) Maximum starting Torque : Adjustable in the range of 120% to 275% (v) Direction of rotation : Should be capable of rotating in both directions (vi) Balancing : Dynamically Balanced (vii) Tests:- 1) Test to establish torque-speed and slip characteristic. 2) Pressure tightness and leak-proof test. 3) Temperature rise test 4) Over speed (125%) withstand tests.
v)	**Brakes**
a)	Hydraulically operated Thrustor brake only [mounted on brake drum coupling] shall be provided.

b)	Brakes shall generally be mounted outside either on motor shaft or on high speed shaft of reducer.
c)	Rating of brakes for conveyor drives shall be adequate to stop a fully loaded conveyor belt before the successive conveyor stops. While computing conveyor coasting time least practicable resistance shall be considered.
d)	Hydraulic Thrustor operated brakes shall be spring set double shoe floating type. Barring any specific requirements all brakes shall be thrustor type.
e)	The thermal capacity shall be adequate to limit the contact surface temperature within the permissible limit recommended by brake liner manufacturer for similar application.
f)	Suitable devices/limit switches shall be incorporated to ensure that motor does not start before the brake is released.
[I]	**Belt Cleaner/ Scrapers**
a)	To ensure proper cleaning of belt, belt cleaners shall be provided as stated below. Each belt cleaner shall be of tested and proven design suitable for belt conveyors handling uncrushed / crushed coal.
b)	**Multi bladed Type [Secondary Belt Cleaner]**: A multi bladed (full belt width is made up of small individual cleaners), having tungsten carbide blades mounted on a carrier assembly of steel tube shall be provided. The steel tube shall be supported on both sides with elastomount or equivalent arrangement having tensioning arrangement such that blade adjustment towards wear is automatic. The cleaner shall be located in such a way that effective cleaning of belt is ensured and all scrapped material is lead into the main chute. Discharge Chute shall enclose the snub pulley so that there is no accumulation of scrapped material on floor. Qty: one (1) per Discharge pulley (located between discharge and snub pulley).
c)	**Primary Belt Cleaner:** Construction of this type of cleaner shall be similar to **Multi-bladed Type** cleaner but the blade-shall be made out of polyurethane material for such application. Qty: a) One (1) per discharge pulley. b) For Travelling / Fixed Tripper: One(1) no. at tripper head pulley
d)	**V plow type cleaner:** This cleaner shall be made out of MS flats and polyurethane strips 20mm thk (minimum) mounted suitably with the conveyor frame. a) Qty: 1 no. on return side near tail pulley + 1 no. on first bend pulley of GTU. b) For Fixed Tripper: One (1) no. at lower return side bend pulley.
[J]	**Safety and Control Devices**
	In the design and construction of the equipment all normal safety provisions shall be observed. It shall be the responsibility of the Contractor to ensure that the equipment satisfies in every respect the statutory requirements.
[K]	**Belt Protection Switches**
a)	<u>Pull Cord Switches (in pair): Addressable type with built-on terminal box</u> Manual reset type x 10 Amp rating, pull cord type emergency stop switches (in pairs) shall be provided at 20 m intervals for all Conveyors longer than 20m. Minimum one pair of switch shall be provided for conveyor length of 20m or shorter than 20m length. Each switch shall have Cast aluminium field mounting enclosure epoxy painted, Flame Proof (as per NEC class2, Division I Area), 2NO

	+2NC, with LED indicating lamp. PC wire shall be 6mm O.D x PVC coated GI wire conforming to the relevant Indian Standards. One pair of above switch shall be provided within 15m interval of both conveyor ends. For detailed specification, refer C&I (Vol. V),Part-B, chapter 2.
b)	Belt Sway Switches (in pair): Addressable type with built-on terminal box Mechanical lever operated, auto reset type, 10A, die cast aluminium, field mounting enclosure epoxy painted, Flame Proof (as per NEC class2, Division I Area), 2NO +2NC, Belt sway switches (in pairs) shall be provided at 30 meters intervals for all conveyors having length greater than 30m. Minimum One (1) pair of belt sway switches shall be provided for conveyor of 30m or shorter than 30m length. Ball bearing shall be provided for roller & cam shaft. For detailed specification, refer C&I (Vol. V),Part-B, chapter 2.
c)	Zero Speed (Electronic, Non-Contact Type) One Zero speed switches with cast Aluminium housing of 5 A electrical rating shall be provided to permit monitoring of correct mechanical operation of conveyor belt. This switch shall be provided at tail pulley of all conveyors. The unit shall be field mounting model, Flame Proof (as per NEC class2, Division I Area), electronic speed monitor having output contact two (2) change over contact , complete with initial bypass time delay. For detailed specification, refer C&I (Vol. V),Part-B, chapter 2.

Data Sheet: Belt Conveyors																
S. No	**Conv. No.**	**3BC-1A/1B**	**3BC-2A/2B**	**3BC-3A/3B**	**3BC-4A/4B**	**3BC-5A/5B**	**3BC-6A/6B**	**3BC-7A/7B**	**3BC-8A/8B**	**3BC-9A/9B**	**3BC-10A/10B**	**3BC-11A/11B**	**3BC-12A/12B**	**3RYBC-1A/1B (reversible)**	**3TBC-1A/1B/2A/2B**	**3BF-1A/1B)**
1.0	Qty, no.	2	2	2	2	2	2	2	2	2	2	2		2	4	2
2.0	Material Handled	◄----------Uncrushed Coal----------►				◄----------..----------Crushed Coal----------►										
3.0	Max. Lump size, mm (Nominal)	◄----------Refer cl. No. 1.5.1----------►			(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20	(-) 20
4.0	Bulk Density, t/cum	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
5.0	Rated capacity, tph	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
6.0	Design Capacity, tph	1320	1320	1320	1320	1320	1320	1320	1320	1320	1320	1320	1320	1320	1320	1320
7.0	Belt Width, mm	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
8.0	Troughing angle, degree	◄----------3-equal roll x 35° tr.----------►														
9.0	Troughing angle, return side	◄----------2-equal roll x 10° tr.----------►														
10.0	Belt Speed (min),m/s	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
11.0	Length / Lift, m	◄---------- As per Layout----------►														
12.0	Type of Take-up.	VGTU	HGTU	VGTU	VGTU	HGTU	VGTU	VGTU	VGTU	VGTU	VGTU	VGTU	VGTU	HGTU	VGTU	VGTU
13.0	T.U.travel, m (Minimum)	For Gravity Take-up:- 2.5 % of C/C Pulley (mm)+ 600mm for Nylon / Nylon Belts & 0.5 % of pulley CRS, mm for Steel Chord Belts														
14.0	Type of Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive	Single Snub Drive (Reversible Type)	Single Snub Drive	Single Snub Drive
14.1	Location of Drive	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	Head cum Discharge end	At one of the two Discharge ends
14.2	Motor speed, RPM (Syn.)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
15.0	**Belting**															
15.1	Type	Steel cord	Steel cord	Steel cord	Nylon	Nylon	Nylon	Nylon	Steel cord	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon
15.2	Minimum rating	ST-800	ST-800	ST-1000	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4	NN-1000/4

Data Sheet: Belt Conveyors																
S. No	**Conv. No.**	**3BC-1A/1B**	**3BC-2A/2B**	**3BC-3A/3B**	**3BC-4A/4B**	**3BC-5A/5B**	**3BC-6A/6B**	**3BC-7A/7B**	**3BC-8A/8B**	**3BC-9A/9B**	**3BC-10A/10B**	**3BC-11A/11B**	**3BC-12A/12B**	**3RYBC-1A/1B (reversible)**	**3TBC-1A/1B/2A/2B**	**3BF-1A/1B)**
15.3	Operating Tension, kN/m (T_1) / FOS				T_1 Not to exceed 80% of Recommended Max Belt working tension for N/N Belt & Factor of safety (FOS) shall be minimum six(6) for steel cord belt for belt selection											
15.4	Top Cover thk, mm (Mini.)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	8
15.5	Bottom Cover thk, mm (Min.)	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3
15.6	Minimum Radius of Curvature				Concave Curve:- 250 m & Convex Curve:- 50 m											
16.0	**Pulleys**															
16.1	Type of construction				◄----------Welded steel construction (MS, IS:2062) ----------►											
16.2	Drive pulley drum dia. , mm (min.)	630	630	800	630	630	630	630	630	630	630	630	630	630	630	630
16.3	Non drive pulleys drum dia., mm (min.).Bend/Tail/ Take-up excluding tripper pulley	500	500	630	500	500	500	500	500	500	500	500	500	500	500	500
16.4	Tripper Head & Bend(carrying side)drum dia. ,Minimum,mm	N/A	N/A	N/A	630	N/A	N/A	N/A	N/A	630	630	630	630	630	630	N/A
16.5	Tripper Bend (return side), Min.	N/A	N/A	N/A	500	N/A	N/A	N/A	N/A	500	500	500	500	N/A	N/A	N/A
16.6	Snub pulley drum	400	400	500	400	400	400	400	400	400	400	400	400	400	400	400
16.7	Bearing centres, mm (min.)	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100	2100
16.8	MOC of shell / end discs				Plate ST-42 carbon steel, IS:2062 for all pulleys & except Non magnetic pulleys (SS-304 of minimum 16mm thk.) where magnetic separator shall be provided											
16.9	MOC of hub				Forged steel											
16.10	Shaft Diameter				As per design requirements											
17.0	**Troughing & Self aligning troughing idler**															
17.1	No. of Rolls				◄----------3-equal roll x 35° tr.----------►											
17.2	Roll dia[OD],mm	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4	152.4
17.3	Shell thk, mm [nominal]	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85
17.4	Type & size of bearings				30Φ Deep Grooved Ball Bearing with C-3 Clearance lubricated for life											
17.4	Self Aligning Tr. Idler				Necessary Self Aligning arrangement Swiveling type shall be provided											
18.0	**Return Idlers & Self Aligning return Idler**															
18.1	No. of Rolls				◄----------2-equal roll x 10° tr.----------►											

Data Sheet: Belt Conveyors																
S. No	**Conv. No.**	**3BC-1A/1B**	**3BC-2A/2B**	**3BC-3A/3B**	**3BC-4A/4B**	**3BC-5A/5B**	**3BC-6A/6B**	**3BC-7A/7B**	**3BC-8A/8B**	**3BC-9A/9B**	**3BC-10A/10B**	**3BC-11A/11B**	**3BC-12A/12B**	**3RYBC-1A/1B (reversible)**	**3TBC-1A/1B/2A/2B**	**3BF-1A/1B)**
18.2	Roll dia[OD],mm	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7
18.3	Shell thk, mm [nominal]	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85	4.85
18.4	Type & size of bearings				30Φ Deep Grooved Ball Bearing with C-3 Clearance lubricated for life											
18.5	Self Aligning return Idler				Necessary Self Aligning arrangement Swiveling type shall be provided											
19.0	Transition Idler				These shall be identical in construction to Troughing Idler except for troughing angle, Tr. Angle range : 10-35 Deg. Qty to suit design.											
20.0	**Rubber Disc Type Impact Idlers**															
20.1	Roll Dia. With Rubber Discs on, mm	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190
20.2	Shell Outer Dia. , mm[OD steel]	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7	139.7
20.3	Shell thk, mm [nominal]	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
20.4	Type & size of bearings				30Φ Deep Grooved Ball Bearing with C-3 Clearance lubricated for life											
20.5	MOC rubber				Resilient Rubber ring											
21.0	**Gearbox**															
21.1	Type of Lubrication				Splash Type Lubrication											
21.2	Type				Natural / Fan cooled, Bevel Helical											
21.3	Holdback Device				Holdback device built in with gear box shall be provided for all inclined conveyors											
22.0	**High Speed Coupling**															
22.1	Location / Type				Between Gear Box & Motor / Fluid Type											
22.2	Type of Coupling				Fluid Coupling											
23.0	**Low Speed Coupling**															
23.1	Location / Type				Between Gear Box & Drive Pulley Shaft / Flexible Type											
23.2	Type of Flexible Coupling				Geared											
24.0	**Brakes**															
24.1	Type				Thruster operated Electro – hydraulic brake											
24.2	Rating				As per Design requirement											
24.3	Thrustor Protection				Class-B Insulation, IP-55											
			Co-ordinates of all Buildings / Towers length and lift of conveyors/feeders are indicative only and during detailed engineering it may vary. No price variation whatsoever on this account shall be given to the Bidder.													

M-2	**CHUTES**	
1.1	The material of construction shall be as per Data Sheet. Inspection Doors : Hinged & leak proof construction (min. size 350 x 450mm) <u>Chute Construction</u> a) Corners : One face of removable bolted flange connection b) Joint Bolted : Flange joints of dust tight construction c) Bolt size : Min. M-12 d) Bolts spacing : Not more than 125mm c/c e) Fixing Arrangement : Bolts with plain spring washers	
1.2	Each chute shall have adequate cross sectional area with minimum sloping angle of 60 degrees or more [to horizontal] to ensure smooth flow of material. Belt loading chute shall be designed so as to ensure centralized loading of material on the receiving belt to prevent off centre loading/ excessive swaying of belt. The material shall be fed in the direction of motion of the belt to the extent possible.	
1.3	Each chute shall be made in a suitable number of units complete with matching flanges. These units shall be suitably bolt jointed. Each unit shall be easily replaceable as a whole. Each joint shall be made dust leak proof by providing neoprene rubber gaskets minimum 3mm thk. Dust tight hinged inspection doors/ bolted removable covers/ manhole covers at strategic locations shall be provided to facilitate inspection and to clear jammed coal in the chute.	
1.4	Chute brackets shall be welded to the main plate and suitably anchored to the Floors/ Platforms.	
1.5	All welded and bolted joints shall be dust tight so that dust laden air is not emitted during material flow.	
2.0	**Data Sheet: Chutes**	
2.1	Location/qty	Lot/ As per flow diagram and scope of work
2.2	Material of Hood above C.L Drive/ head pulley	5 mm thk MS plate (IS: 2062),Necessary neoprene rubber curtain[minimum 10thk] shall be provided to minimise dust nuisance.
2.3	Material of Parent Plate	20 mm thk. SAILHARD/equal
3.0	Tramp iron / Floor Cleaning Chutes	
3.1	Location	For complete coal handling plant in all transfer towers/crusher houses etc
3.2	Number of chutes	Lot
3.3	Material of chute (Tramp Iron)	Min. 400mm Dia. X 5 mm thk MS plate
3.4	Material of chute (Floor Cleaning)	Min 400mm Dia. X 5 mm thk MS plate
3.5	Type of construction	• Floor cleaning chute shall be provided at all floors, which shall be suitably connected to a main down-coming chute. Suitable grating as

		necessary shall be provided at the chute opening in the floor for safety. Chute shall terminate outside the building about 1.5m above ground level. • One (1) no. mobile trolley shall be provided for collection of tramp metal for each Magnetic Separator (ILMS & SEM) to dispose of tramp metal into tramp metal chute.
3.6	3mm thk. Neoprene Rubber Gasket between matching flanges.	To be provided for all types of chutes.
Note # 1: In chute layout – inspection door, poking holes etc. shall be provided suitably and the discharge chute shall enclose the snub pulley.		
Note # 2: Where inline magnetic separator is provided, chute made out of non magnetic material (parent plate) of minimum 10mm thk SS-304 steel for a distance of 1.5m [minimum] from magnet face shall be provided.		
Note # 3 : All Chute liner shall be of stainless steel.		
M-3	**GATES**	
A.0	**Flap Gate (FG)**	
1.0.	Flap gate used in bifurcated chute (i.e. 2-way chute) shall be linear actuator operated. Linear actuator used shall be completely dust tight and its rating shall account for the gate operation considering worst loading out of moving weight of coal and/ or vertical coal column in chute.	
1.1.	The gate leaf shall be fabricated out of abrasion resistant plate. Gate shaft shall be suitable to withstand high torque and it shall be mounted over antifriction ball or roller bearing enclosed in dust tight housing complete with lubrication arrangement.	
1.2.	The drive equipment of gate shall be capable of being operated for at least fifteen (15) switching/ hr and with ten (10) consecutive starts [minimum] at rated load.	
1.3.	**Data Sheet: Flap Gate**	
a)	Type	Motor operated linear Actuator with Flap Plate
b)	Make	As per approved vendor list
c)	Equipment Designation/ Location & qty	FG/ As per flow Diagram
d)	Locking position	Two (2) extremes
e)	Provision for alternative manual operation	To be provided. Convenient for single operator by declutch able hand wheel of minimum diameter 500mm. Manual effort shall not exceed 25kgf
f)	Provision for non reversal of gate during operation	To be provided
g)	Provision for lubrication	To be provided

h)	Type of limit switches	Heavy Duty type, Overload protection switch and travel adjustment switch shall be provided.
i)	Built in thrust limit switch	To be provided
j)	Travel range	60 to 70 degree (with limit switches on both sides)
k)	Flap	2Nos. of 12 mm thick plate of SAILHARD/ TISCRAL welded together to form the desired shape.
l)	Type of bearing	Dust tight, antifriction, ball or roller bearings
m)	Gate shaft	EN-8/ Equal and minimum diameter 150mm
n)	Bearing life (minimum)	50,000 hr (L-10)
o)	Flap gate position indication on control/ mimic panel	Two (2) position
p)	Drive	Dust tight motor driven with suitable linkages
B.0	**Divertor Gate (DG)**	
1.0	Divertor Gate shall be operated through rack and pinion arrangement.	
1.1	The gate shall move inside a totally enclosed steel framework mounted below & connected to the discharge chute of the feeding conveyor. Positive to and fro motion for the two positions shall be imparted to the gate-supporting frame through rack and pinion arrangement driven by bevel geared drive. Chain drive will not be accepted.	
1.2	Limit switches for positioning and position indication shall be provided.	
1.3	Provision for manual operation of the gate shall also be provided at the extended motor shaft. Manual force required shall not exceed 25 kg.	
1.4	Rubber buffers on the gate shall be provided at both ends inside the casing.	
1.6	Two (2) numbers inspection windows (hinged type and dust tight) shall be provided suitably for the casing.	
1.7	The drive equipment of gate shall be capable of being operated for at least fifteen (15) switching/ hr and minimum ten (10) consecutive starts (minimum) at rated load.	
2.0	**Data Sheet: Divertor Gate**	
2.1	Type	Travelling type through rack & pinion arrangement
2.2	Equipment Designation / Location & Qty.	DG/ As per flow Diagram
2.3	Speed of the gate (approx)	30mm / sec
2.4	Gate casing	10mm thk M.S plate with liners

2.5	Conical portion of the diverter gate	20 mm thick plate of SAILHARD/ TISCRAL
2.6	Material of construction Rack.	EN-8/equal
2.7	Material of construction of the Pinion.	EN-9/equal
2.8	Gate shaft	EN-8/ Equal
2.9	Travel range	To suit.
2.10	Motor	To conform to enclosed specification for motors.
2.11	Type of bearing	Dust tight, antifriction, ball or roller bearings
2.12	Bearing life (minimum)	50,000 hr (L-10)
2.13	Provision of non reversal of gate during operation	To be provided
2.14	Divertor gate position indication on control/ mimic panel	Two (2) position
2.15	Limit switches	Heavy Duty type, Overload protection and travel limit switches shall be provided.
2.16	Provision for lubrication	To be provided
C.0	**Rack & Pinion Gate (RPG)**	
1.0	The R&P gate's outgoing chute shall be so designed that the gate rollers are completely guarded. The gate rollers shall not be damaged due to material flow.	
1.1	The gate body shall be of MS plate with reinforcing ribs etc. the gate assembly shall have adequately sized flanged ends on either side to match companion flanges of minimum 12mm thk. MS material. The gate plate is operated by double rack and pinion.	
1.2	The drive equipment of gate shall be capable of being operated for at least fifteen (15) switching/ hr and minimum ten (10) consecutive starts (minimum) at rated load.	
1.3	The gate shall also be provided with CI hand wheel and chain assembly so that it can be operated from the nearest floor during emergency. The manual effort to operate gate shall not exceed 25kgf.	
1.4	Suitable Mechanical locking arrangement shall be provided for the gate.	
1.5	CI rollers with life lubricated design shall be provided.	
1.6	Pressure lubricated, dust tight, anti friction bearing shall be provided for shaft and rollers.	
1.7	The gates shall be provided with lapped or equivalent sealing on all four (4) sided and shall close/open through standing coal column.	
1.8	The limit switches shall be of dust proof type of approved make and gate opening and closing positions indication shall be provided on control/ mimic. panel	

2.0	**Data Sheet: Rack & Pinion Gate**	
2.1	Type	Motor operated
2.2	Equipment Designation/ Location & Qty.	RPG/ As per flow Diagram
2.3	Type of Bearing	Dust tight, anti friction bearings
2.4	Bearing life (minimum)	50,000 hr (L-10)
2.5	Method of lubrication	Single shot, pressure Lubrication.
2.6	Limit switches	Heavy Duty type, Overload protection and travel limit switches shall be provided.
2.7	**Material of construction**	
i	Body	12 mm thk. M.S (IS: 2062)
ii	Slide gate	20 mm thk. SAILHARD / Equal
iii	Rack	EN-8/equal
iv	Pinion	EN-9/equal
v	Shaft	EN-8/equal
2.8	Locking positions	Two extreme position
D.0	**Rod Gate (RG)**	
1.1	Rod gate shall be manually operated. The gate body shall be of heavy structural sections (MS, IS:2062). The gate assembly shall have adequately sized flanged ends on either side to match companion flanges. Minimum 3mm thk. neoprene gasket to be provided to fit with matching flange of gate with the flange of the equipment installed below rod gate for dust tightness.	
1.2	The sliding rods shall be supported by pipe sleeve with stiffeners at body for guiding sliding rods. The rods shall be staggered so as to minimize coal leakage from the gate. The sliding rods shall have stopper arrangement at one end.	
1.3	**Technical Data:**	
a)	Type	Manually Operated. Minimum two rows of rod to be provided.
b)	Equipment Designation / Location / Qty.	As per flow Diagram
c)	Material of Rod	MS, Rods (IS: 2062), 38mm Φ
d)	Distances between two adjacent rods.	40 mm (approx.)
M-4	**MONORAIL & HOISTS**	
1.0	Each Hoist shall be sturdy, compact unit complete with all the needed accessories and shall conform to duty Class-II as per relevant Indian Standards Specifications and shall operate on I-section beam.	

1.1	All components of electric hoist of identical capacity & duty shall be interchangeable.
1.2	All components of manual hoist of identical capacity & duty shall be interchangeable.
1.3	Monorail girder of adequate strength and length shall be provided for each hoist at various locations in the transfer towers/ other CHP buildings. Monorail profile & Qty. shall be strictly subject to Engineer/ consultant approval in order to fulfil maintenance needs. Minimum 3 meter length of Cantilever from edge of building to lower equipment to ground level clearing the building sidewalls/ cladding and any other facilities beneath the floor upto ground level. Contractor shall take clear note of the fact that the number and monorail hoisting systems shall also be decided considering the movement of equipment being lifted over/ by the side of other equipments without removing the later. The necessary level of floors in various buildings shall be decided considering the above requirement. Monorails shall be extended outside the building to handle the equipment to ground level. For Monorail/hoist routed inside the buildings, suitable machinery well and removable handrailing and grating shall be provided on various floors of buildings, as necessary, to handle the equipment.
1.4	Centre line of Monorail shall not deviate by more than 500mm from the centre of gravity of any equipment that is to be lifted.
1.5	The opening provided at various floor of building for equipment /its component removal shall be covered with easily removable grating with safety handrail etc. to suit the requirements. Floor opening shall be protected by edge protection angle.
1.6	Ropes, pulleys, hoist blocks and other accessories shall have liberal factor of safety. All steel wire ropes shall be flexible 6 x 37 constructions with UTS of 160 to180 kgf/ mm^2. Safety factor of minimum six (6) or as specified in IS shall be used to select the rope.
1.7	The trolley frame shall be of rolled steel with extended side plates to provide bumper protection for the wheels.
1.8	All axles and shafts shall be of carbon steel and accurately machined and properly supported in antifriction bearings.
1.9	All the wheels shall have perfect bearing at the flange and in no case the trolley shall fall out of the hoist girder. All needed safety devices, end stops, guards etc., proper lubrication arrangement, anti-friction ball/ roller or bush bearings with dust tight enclosures shall be provided.
1.10	Hook shall be of swivelling type made of solid, forged, heat treated alloy or carbon steel. It shall be provided with a safety latch/locking arrangement to suit the requirement.
1.11	All hoists shall be tested for minimum 125 percent of the rated load.
1.12	Type/ Location/ Capacity/ Lift: Refer Schedule of hoist.
1.13	Make of Hoist: As per "Approved Vendor List".
2.0	**Electric Hoists:**

2.1	Type	Electrically operated Hoist & Trolley with Pendant switch, Control panel wall mounted. Pendant control station suspended from hoist.
2.2	Drive Motors	SQIM, Separate for travel & lift
2.3	No. of starts for drive motor	150 starts per hr at 40%CDF
2.4	Pendant	It shall be provided with fluorescent" Up/ Down/ Forward/ Reverse" travel push button & indicating lamp.
2.5	Class/ Duty/ Indian Standard	Class II, Indoor, IS: 3938
2.6	Hoist Speed	6 m/min (max.)
2.7	Carriage travel speed	5 m/min (max.)
2.8	One(1) Inspection cum maintenance platform	To be provided complete with access ladder.
2.9	**Material of Construction**	
a)	Drum & Sheave	M.S./ Cast steel as per IS: 3938
b)	Load Hook	Swivelling type forged circular shank section as per IS: 3815
c)	Wire rope	Construction 6x37 as per IS: 3938 with hemp core regular lay with min. strength of 160-180 kgf/ sq.mm. Safety factor of minimum Six (6) or as specified in IS shall be used to select the rope.
d)	Gear	Forged/ Cast steel
2.10	Brake type	Electro Mechanical type to suit duty and of adequate rating to be provided
2.11	Brake for Hoist & Trolley	Electromechanical type
2.12	Bearing	Antifriction type Ball/ Roller bearing with minimum 20 year life as per IS: 3938. Bearing of reputed make: SKF/ FAG/equal approved
2.13	Lubrication	Oil/ Grease
2.14	Motor	Suitable for hoist duty, 415V+/- 10%, 50Hz+/- 5%, 3 phase AC supply,
2.15	Type of power feeding arrangement	Festoon cabling.
2.16	Type of limit switch	Over lowering and over hoisting and for Over travel at end position
2.17	Control Station:	Weather and dust proof with specified degree of protection in electrical specification
2.18	Electrical Protective devices provided	Yes, to be provided

2.19	Monorail location / layout	
a)	Cross section	I-Bean
b)	Distance b/w Centre line of Monorail & centre of gravity of equipment to be lifted.	Maximum 500mm
c)	Power Cables support	Festoon type arrangement
2.20	**Tests:** All tests as per relevant codes and standard, manufacturer's standard shall be conducted. Over load test as per IS: 3832 shall be conducted**.**	
3.0	**Chain Operated Hoist (Manual Hoist)**	
3.1	Maximum manual effort for operation of hoist shall not exceed 30kgf	
3.2	Steel frame made out of steel plates to support all gears and ensuring alignment shall be provided. Rigid pressed steel covers for inspection and gear lubrication shall be provided. Graded cast iron trolley wheels having inbuilt gear teeth and alloy steel pinion with Hob cut teeth shall be provided.	
3.3	Alloy steel load chain conforming to IS: 6216 Grade T(8), hooks made out of forged steel having high ductility and toughness as per IS: 8610 Grade M & P shall be provided. Hook shall rotate through 360 deg. and shall be mounted through ball bearing to enable rotation of hooks at full load without twisting the load chain.	
3.4	The automatic brake for the lifting gear shall always be in action. It shall be either of screw and friction disc type, self-actuating load pressure brake or of any other standard design. The brake shall offer no resistance during hoisting.	
3.5	Load wheel, main arm holding upper hook and bottom hook holding block shall be of steel casting. Hand chain shall be made out of standard quality steel and shall be provided with suitable guarding to prevent fouling of chain.	
3.6	All the gearing shall be generally enclosed type. Gears shall be cut from solid cast or forged steel blanks. Pinions shall be of forged carbon or heat-treated alloy steel. Proper lubrication arrangement shall be provided for bearings and pinions.	

Schedule of Hoists

Sr. No.	Location	Min. Capacity Tonne	Lift (Approx.)m	QTY. (No.)	Type	Building
1	Above Drive unit of Apron Feeder# 3AF-1A/1B	5	To suit	2	EH	3WTC-1
2	Above length of Apron Feeder# 3AF-1A/1B	2	To suit	2	CPB	3WTC-1
3	Above tail sprocket of Apron Feeder# 3AF-1A/1B	2	To suit	1	CPB	3WTC-1
4	Above Tail Pulley of Conv. # 3BC-1A/1B	2	To suit	1	CPB	3WTC-1
5	Divertor Gate	1	To suit	2	CPB	3WTC-1

Schedule of Hoists						
Sr. No.	**Location**	**Min. Capacity Tonne**	**Lift (Approx.)m**	**QTY. (No.)**	**Type**	**Building**
6	Equipment Hatch for3 WT-1	5	To suit	2	EH	3WTC-1
7	Drive Pulley / Drive Unit of Conv. # 3BC-1A/1B	5	To suit	1	EH	3JT-1
8	Tail Pulley of Conv. # 3BC-2A/2B	2	To suit	1	CPB	3JT-1
9	Divertor gate	1	To suit	1	CPB	3JT-1
10	Suspended Electromagnet # SEM-1A/1B (on BC-2A/2B)	15	To suit	2	MHE	3PH-1
11	ILMS-1A/1B above Head End of Conv. # 3BC-2A/2B	15	To suit	2	EH	3CRH-1
12	Drive Pulley / Drive Unit of Conv. # 3BC-2A/2B	5	To suit	2	EH	3CRH-1
13	Divertor Gate	1	To suit	2	CPB	3CRH-1
14	Vibrating Grizzly Feeder#3 VGF-1A/ 2A	10	To suit	1	EH	3CRH-1
15	Vibrating Grizzly Feeder# 3VGF-1B/ 2B	10	To suit	1	EH	3CRH-1
16	Crusher# 3CR - 1A/2A	15	To suit	1	EH	3CRH-1
17	Crusher# 3CR - 1B/2B	15	To suit	1	EH	3CRH-1
18	Tail Pulley of Belt Feeder # 3BF-1A/1B	2	To suit	1	CPB	3CRH-1
19	Drive Pulley / Drive Unit of Reversible Belt Feeder # 3RBF-1A/1B	3	To suit	1	EH	3CRH-1
20	Tail Pulley of Conv. # 3BC-6A/6B	2	To suit	1	CPB	3CRH-1
21	Divertor Gate	1	To suit	1	CPB	3CRH-1
22	Tail Pulley of Conv. # 3BC-4A/4B	2	To suit	1	CPB	CRH-1
23	Drive Pulley/ Drive Unit of Conv.# BC-4A/4B	5	To suit	1	EH	3JT-3
24	Tail Pulley of Conv. # YBC-1B	2	To suit	1	CPB	3JT-3
25	Equipment Hatch at Reclaim Hopper Complex #3 RHC	3	To suit	1	EH	3RHC
26	Vibrating Feeder # 3VB-1A/1B	3	To suit	2	EH	3RHC
27	Tail Pulley of Conv. # 3BC-5A/5B	2	To suit	2	CPB	3RHC
28	Drive Pulley/ Drive Unit of Conv.# 3RYBC-1A	5	To suit	1	EH	3JT-3
29	Suspended Electromagnet # SEM-2B on Conv. # 3RYBC-1A	15	To suit	1	MHE	3JT-3
30	Divertor Gate	1	To suit	1	CPB	JT-3
31	ILMS-2A/2B above Head End of Conv. #3BC-5A/5B	15	To suit	2	EH	3JT-4

Schedule of Hoists						
Sr. No.	**Location**	**Min. Capacity Tonne**	**Lift (Approx.)m**	**QTY. (No.)**	**Type**	**Building**
32	Drive Pulley/ Drive Unit of Conv.# 3BC-5A/5B	5	To suit	2	EH	3JT-4
33	Divertor Gate	1	To suit	1	CPB	3JT-4
34	Tail Pulley of Conv. # 3BC-6A/6B	2	To suit	1	CPB	3JT-4
35	Drive Pulley/ Drive Unit of Conv.# 3BC-6A/6B	5	To suit	2	EH	3JT-5
36	Divertor Gate	1	To suit	1	CPB	3JT-5
37	Tail Pulley of Conv. # 3BC-7A/7B	2	To suit	1	CPB	3JT-5
38	Drive Pulley/ Drive Unit of Conv.# 3BC-7A/7B	5	To suit	2	EH	3JT-5
39	Divertor Gate	1	To suit	1	CPB	3JT-5
40	Tail Pulley of Conv. # 3BC-8B/8B	2	To suit	1	CPB	3JT-6
41	Drive Pulley/ Drive Unit of Conv.# 3BC-8A/8B	5	To suit	2	EH	3JT-6
42	Divertor Gate	1	To suit	1	CPB	3JT-6
43	Tail Pulley of Conv. # 3BC-9B/9B	2	To suit	1	CPB	3JT-6
44	Drive Pulley/ Drive Unit of Conv.# 3BC-9A/9B	5	To suit	2	EH	3JT-7
45	ILMS-2A/2B above Head End of Conv. #3BC-9A/9B	15	To suit	2	EH	3JT-7
46	Divertor Gate	1	To suit	1	CPB	3JT-7
47	Tail Pulley of Conv.# 3BC-10A/10B	2	To suit	2	CPB	3JT-8
48	Drive Pulley/ Drive Unit of Conv.# 3BC-10A/10B	5	To suit	2	EH	3JT-8
49	ILMS-3A/3B above Head End of Conv. #3BC-10A/10B	15	To suit	2	EH	3JT-8
50	Divertor Gate	1	To suit	1	CPB	3JT-8
51	Tail Pulley of Conv. # 3BC-11A/11B	2	To suit	1	EH	3JT-9
52	Drive Pullet of Conv. # 3BC-11A/11B	3	To suit	2	EH	3JT-9
53	Fixed Tripper (Discharge Pulley) of Conv. # 3BC-9A/9B	3	To suit	2	EH	3JT-9
54	Divertor Gate	1	To suit	1	CPB	3JT9
55	Fixed Tripper Bend Pulleys of Conv. # 3BC-11A/11B	2	To suit	1	CPB	3JT-9
56	Tail Pulley of Conv. # 3TBC-1A/1B	3	To suit	1	EH	3JT-9
57	Drive Pulley/ Drive Unit of Conv.# 3BC-12A/12B	5	To suit	2	EH	3JT-10
58	Divertor Gate	1	To suit	1	CPB	3JT-10
59	Tail Pulley of Conv. # 3TBC-2A/2B	3	To suit	1	EH	3JT-10

Schedule of Hoists						
Sr. No.	**Location**	**Min. Capacity Tonne**	**Lift (Approx.)m**	**QTY. (No.)**	**Type**	**Building**
60	Drive Pulley/ Drive Unit of Conv.# 3TBC-1A/1B	5	To suit	2	EH	Coal Bunker Row #1
61	Travelling Tripper of conv. #3TBC-1A/1B	2	To suit	2	CPB	Coal Bunker Row #1
62	Drive Pulley/ Drive Unit of Conv.# 3TBC-2A/2B	5	To suit	2	EH	Coal Bunker Row #2
63	For Travelling Tripper of conv. #3TBC-2A/2B	2	To suit	2	CPB	Coal Bunker Row #2
64	C'WT of Conv. # 3BC-1A/1B	To suit	To suit	2	EH	VGTU
65	C'WT of Conv. # 3BC-2A/2B	To suit	To suit	2	EH	HGTU
66	C'WT of Conv. # 3BC-3A/3B	To suit	To suit	2	EH	VGTU
67	C'WT of Conv. # 3BC-4A/4B	To suit	To suit	2	EH	VGTU
68	C'WT of Conv. # 3BC-6A/6B	To suit	To suit	2	EH	VGTU
69	C'WT of Conv. # 3BC-7A/7B	To suit	To suit	2	EH	VGTU
70	C'WT of Conv. # 3BC-8A/8B	To suit	To suit	2	EH	VGTU
71	C'WT of Conv. # 3BC-9A/9B	To suit	To suit	2	EH	VGTU
72	C'WT of Conv. # 3BC-10A/10B	To suit	To suit	2	EH	VGTU
73	C'WT of Conv. # 3BC-11A/11B	To suit	To suit	2	EH	VGTU
74	C'WT of Conv. # 3BC-12A/12B	To suit	To suit	2	EH	VGTU
75	C'WT of Conv. # 3RBF-1A/1B	To suit	To suit	2	EH	VGTU
76	C'WT of Conv. # 3TBC-1A/1B	To suit	To suit	2	EH	VGTU
77	C'WT of Conv. # 3TBC-2A/2B	To suit	To suit	2	EH	VGTU
78	C'WT of Conv. # 3BC-5A/5B	To suit	To suit	2	EH	HGTU
79	C'WT of Conv. # RYBC-1A	To suit	To suit	1	EH	HGTU
EH: Electric Hoist with Monorail						
CPB: Chain Pulley Block with Manually operated Geared Trolley (Manual Hoist) with Monorail						
MHE: Manual Hoist with Electric Trolley						
Note# 1: In addition to above Two (2) no. Manual Hoist x 6t Capacity each x 10m lift portable type each shall be supplied complete in all respects.						

Schedule of Hoists						
Sr. No.	**Location**	**Min. Capacity Tonne**	**Lift (Approx.)m**	**QTY. (No.)**	**Type**	**Building**
Note# 2: Above lifting capacity is minimum specified. In case during Detailed Engg., if higher capacity is required than the same shall be provided by Vendor without any extra cost implications.						
Note# 3: Above each bend one beam piece with hook, 3t capacity shall be provided.						
Note# 4 : above list is only indicative and additional hoists as required during detailed engineering shall be provided by the bidder without and cost implication..						

M-5	Belt Vulcanizing Machine		
1.1	The equipment furnished shall be suitable for vulcanizing Steel Cord type belt/ N/N Belt as specified for Belt Conveyor/ Conveyor Data.		
1.2	Each Machine shall preferably be capable of making vulcanized joints for 1400mm wide steel cord belt as well as N/N Belt.		
1.3	The heating element shall have adequate rating complete with temperature controller for efficient utilization. Size of platen shall be adequate for vulcanizing the belt width given in Technical Data below.		
1.4	The equipment shall be light in construction so that it can be transported easily to the desired location.		
1.5	One (1) no set of complete repair kit shall be furnished along with each equipment.		
1.6	The equipment shall be of reputed, proven & approved make.		
2.0	**Data sheet: Belt Vulcanizing Machine**		
2.1	**Designation no.**	**3BVM-1 (Steel Cord Belt)**	**3BVM-2 (N/N Belt)**
2.2	Type of belting to be vulcanized	1400mm wide steel cord belting	1400mm wide Nylon-Nylon belting
2.3	Type	Hydro-mechanical type, pressure generated by Hydraulic pump	Hydro-mechanical type, pressure generated by Hydraulic pump
2.4	Quantity	One(1) no	One(1) no
2.5	Type temperature controller	Thermostat	Thermostat
2.6	Operating pressure	8kgf/sq.cm./ to suit	8kgf/sq.cm./ to suit
2.7	Operating temperature(approx range)	145-155°C	145-155°C
2.8	Method of heating	Electrically heated	Electrically heated
2.9	Connected load	30 KW (Approx.)	30 KW (Approx.)
2.10	Power receiving plug, switch & cable	To be provided	To be provided
2.11	Cable length (Approx.)	Minimum 30m length between socket & temp. Control box & Minimum 6m between control box & platen	Minimum 30m length between socket & temp. Control box & Minimum 6m between control box & platen
2.12	Operating voltage	415V x 3-Ph. x 50 Hz. A-C. Supply	415V x 3-Ph. x 50 Hz. A-C. Supply
2.13	Minimum Vulcanization accessories to be supplied.		

2.14	Tool kit	One (1) set	One (1) set
2.15	Measuring tool	One (1) set	One (1) set
2.16	Belt Clamping device	Two (2) pair	Two (2) pair
2.17	Roughing Machine	One(1) set	One(1) set
2.18	Edge Bars	Two(2) pair	Two(2) pair
2.19	Portable motorized Winch 5 tonne capacity complete with accessories	One(1) no. to be furnished	One(1) no. to be furnished
M-6	**MAGNETIC SEPARATOR [ILMS]**		
1.0	**Constructional Features**		
1.1	Magnetic Separator (Inline Magnetic Separator) shall be of electromagnetic type, with oil-cooled design. All equipment shall be totally enclosed. Magnet circuit comprising of insulated Aluminum adequately impregnated with epoxy resin making it impervious to moisture shall be provided. One Electric Hoist with monorail beam shall be provided suitable for handling/ removal of magnetic separator for maintenance (as per Schedule of Hoist).		
1.2	Each Magnetic Separator shall provide for continuous and automatic extraction and discharge of tramp metal (magnetic pieces) from coal mass on the given belt conveyor (refer Data Sheet below).		
1.3	The Magnetic Separator unit shall be mounted from structural member from the top. The required turnbuckle arrangement to facilitate the necessary adjustments during operation shall be provided. The unit shall be complete in all respects including all electrical ancillaries, viz. Local Control Panel, ON/ OFF control push buttons and indicating lamps etc.		
1.4	Magnet Core material shall be of pure annealed iron or equivalent having high magnetic permeability. The coil shall be of aluminium wire with class 'H' insulation.		
1.5	Dimensions and shape of the core and side poles shall be optimized to obtain wider, deeper field ensuring large force index to effect higher lifting capacity over wide area.		
1.6	Magnetic pieces picked up by Magnetic Separator shall be discharged into tramp metal chute located suitably.		
1.7	Suitable arrangement shall be provided in the magnet for keeping the coil of Magnet dry from atmospheric condition when Magnetic Separator is not in use.		
1.8	The other Mechanical Components of the Magnetic Separator like pulleys, bearing blocks, drive, belt etc. shall be liberally designed to ensure trouble free operation. The motor and gear reduction unit for driving the belt shall be adequately sized.		
1.9	The separator belt shall be designed to withstand high temperature at the bottom of the magnet and also to withstand impact of the sharp edges of the tramp iron pieces. The belt shall be provided with suitably spaced built in ribs.		
1.10	All the equipment and accessories shall be proven design and manufactured to the best engineering practice.		
1.11	Each Magnetic Separator shall be suitable to lift the following tramp iron piece from the given belt:-		

	a) MS cube of 20mm size. b) 250mm x 250mm size, 50kg[max] MS plate. c) MS round bar of 50 kg with L/D ratio not exceeding 5 d) MS bolt of M12, minimum length equal to 5 times the size. e) Brake shoe of Railway Wagon (Cast Iron 15 Kg) f) Shovel teeth & spikes.	
1.12	Make: As per "Approved Vendor List"	
1.13	One (1) Tramp Metal Trolley shall be provided for each Magnetic Separator	
2.0	**Data Sheet: Magnetic Separator (ILMS)**	
2.1	Type	Magnetic Separator, Oil cooled type electromagnet with self-cleaning arrangement complete with Local Panel. Tramp Metal collecting chute to be provided for each Magnetic Separator.
2.2	Orientation/Equipment Designation/location/qty	As per Flow Diagram
2.3	Non magnetic head pulley at location of ILMSN	Non Magnetic head pulley [as per Belt Conveyor specification] shall be provided.
2.3	Belt width/ Tr. angle	1400mm x 35°x 3-Equal Roll
2.4	For other details of belt conveyor	Ref. Belt Conveyor Specification / Datasheet
2.5	Operating height[Minimum]	400mm (for crushed coal) & 450mm (for uncrushed coal)
2.6	Flux density[Minimum]	1000 Gauss at operating height specified above.
2.7	Force Index[Minimum]	100000 Gauss at operating height specified above
2.8	Degree of Protection	IP-65
2.9	Magnet Core Material	Pure annealed iron/ eq. having high magnetic permeability, IS-4491
2.10	Coils	Aluminium wounded coils with class "H" insulation
2.11	Rectifier	3ph, full wave bridge using Silicon diodes forming rectifier set
2.12	Wear plate	Wear plate of Stainless steel SS-304 shall be provided at electromagnet surface
2.13	Separator Belt	EP Type of F.R-Grade complete with built- in ribs and zero speed switch. Geared motor drive shall be provided
2.14	Control	Local and remote
2.15	Electric Supply 415V, 3 phase, 50Hz input	Silicon Rectifier units
2.16	Handling Arrangement for inline Magnetic separator suspended magnet a) Height adjustment:- With turn buckle arrangement b) Cross travel: - Electric Hoist operated cross travel facility.	

M-7	**SUSPENDED ELECTROMAGNET (SEM)**	
1.0	**Constructional Features**	
1.1	Magnetic Separator shall be Suspended Electromagnet with oil-cooled design mounted near head end of the belt conveyor. All equipment shall be totally enclosed. Magnet circuit comprising of insulated Aluminum adequately impregnated with epoxy resin making it impervious to moisture shall be provided.	
1.2	The Magnetic Separator unit shall be mounted from structural member from the top. The required turnbuckle arrangement to facilitate the necessary adjustments during operation shall be provided. The unit shall be complete in all respects including all electrical ancillaries, viz. Local Control Panel, ON/ OFF control push buttons and indicating lamps etc.	
1.3	Monorail with manual Hoist & Electric trolley shall be provided for Suspended Electro Magnet (SEM) for disposal of tramp metal pieces into floor cleaning tramp metal chute.	
1.4	Each magnetic Separator (SEM) shall be suitable to lift the following tramp iron piece from the given belt:- g) MS cube of 20mm size. h) 250mm x 250mm size, 50kg [max] MS plate. i) MS round bar of 50 kg with L/D ratio not exceeding 5 j) MS bolt of M12, minimum length equal to 5 times the size. k) Brake shoe of Railway Wagon (Cast Iron 15 Kg) l) Shovel teeth & spikes.	
1.5	Make: As per "Approved Vendor List"	
1.6	One (1) no Tramp Metal Trolley shall be provided for each Suspended Electro magnet (SEM)	
2.0	**Data Sheet: Suspended Electromagnet**	
2.1	Type of Magnetic Separator	Oil cooled type Electromagnet Suspended above & near discharge end of conveyor.
2.2	Equipment Designation/location/qty	As per Flow Diagram
2.3	Belt width /Tr. angle	1400mm x 35°x 3-Equal Roll
2.4	For other details of belt conveyor	Ref. Belt Conveyor Specification / Datasheet
2.5	Operating height (Minimum)	450mm for uncrushed coal/ 400mm for crushed coal
2.6	Flux density (Minimum)	1000 Gauss at operating height specified above.
2.7	Force Index (Minimum)	100000 Gauss at above operating height
2.8	Degree of Protection	IP-65
2.9	Control	Local and remote
2.10	Electric Supply 415V, 3 phase, 50Hz input	Silicon Rectifier units
2.11	Handling Arrangement for Suspended Electromagnet a) Height adjustment:- With turn buckle arrangement	

	b) Cross travel: - Manual hoist with Electric operated cross travel facility.	
2.12	Magnet Core Material	Pure annealed iron/eq. having high magnetic permeability, IS-4491
2.13	Coils	Aluminium wounded coils with class "H" insulation
2.14	Rectifier	3ph, full wave bridge using Silicon diodes forming rectifier set
2.15	Non-Magnetic Idlers	Non-Magnetic Idlers of 6 mm thk. (min) Aluminum & lagged with 5mm thk. neoprene rubber shall be provided suitably on conveyor in the magnetic zone
2.16	Wear plate of Stainless steel SS-304 shall be provided at electromagnet surface.	
M-8	**METAL DETECTOR**	
1.0	**Constructional Features**	
1.1	Each metal Detector would comprise of :- a) 1 No. Search Coil, b) 1 No. Electronic Cabinet, c) 1 No. Signal Horn, d) 1 No. Signal lamp.	
1.2	Search Coil Unit houses an oscillator coil and a receiver coil, Oscillator coil sets up electromagnetic field which is concentrated in aperture of the search coil. In normal condition when there is no tramp metal the receiver coil is so arranged that the output from it is extremely small. When a tramp iron piece is passing through the coil, it disturbs the flux distribution and this induces a voltage in the receiver coil. This voltage is then processed in the electronic unit and a DC voltage proportional to the size and type of metal is obtained. This voltage is compared with a threshold setting voltage which is used to set sensitivity of detection. When a metal of required size passes through the coil a switching signal is available at the output of the above comparator, which drives a monostable circuit. This monostable circuit actuates the relay for a fixed time and returns back after that time. Thus a momentary change over contact is available for this relay. The contacts of this relay are rated 5-A/220-V-AC. Suitable spark suppression is also incorporated.	
1.3	The metal detector shall operate on a principle that tramp metal causes a reaction in the sensing device of the detector unit, in case, tramp metal passes through without being lifted, the metal detector on sensing the tramp metal will activate the signal light and operate the sand marker device to indicate location of metal piece and will also signal & actuate Coal Scooper. The hook of the sand bag marker is lowered by means of a relay contact. The sand bag is dropped on or near the approx. location of the metal piece.	
1.4	Metal Detector shall operate in conjunction with coal scooper so that metal contaminated coal is scooped out by hammer device of coal scooper without stoppage of belt.	
1.5	Metal Detector shall be designed to operate in conjunction with coal scooper.	
1.6	To maintain the safe height of material burden on belt at detector location, MS angle/channel fabricated Protection device shall be fixed prior to each metal	

	detector so that oversize material resting on top of burden/excessive burden height is controlled to avoid damage to underside of metal detector.	
2.0	**Data Sheet: Metal Detector**	
2.1.	Equipment Designation/ location / qty	As per Flow Diagram
2.2.	For other details of Belt Conv.	Ref. Belt Conveyor Specification/ Datasheet
2.3.	Detector Type.	Electronic solid-state type, Each unit shall be complete with search coil, electronic cabinet, signal lamp, signal horn, sand bag marker and provision for testing the unit.
2.4.	Capacity	Single channel suitable to detect a) 25 mm dia. aluminium sphere below coal for synthetic belting b) 35 mm dia. aluminium sphere below coal for stee cord belting c) MS nut of size M-20.
2.5.	Annunciation/ Hooter provided	Yes
2.6.	Audible range of Hooter	300m
2.7.	Indication Type	Audio and Visual
2.8.	Power Supply	230V±15%, 50 Hz±2%, single phase, AC supply
2.9.	Enclosure	Fibre Glass
2.10.	Control	Through local control panel
2.11.	Calibration	Provision for automatic static calibration with adjustable sensitivity
M-9	**Coal Scooper**	
1.0	Coal Scooper shall operate in conjunction with metal detector & shall be installed downstream of metal detector. Coal scooper actuation will be based on its distance from Metal Detector & conv. belt Speed.	
1.1	In its normal park position over a moving conveyor belt, the counter-weighted stainless steel (SS-304) cutter rests at the top of its backswing. When activated, the electromechanical drive rotates the cutter through its swing in a perfect arc, extracting a cross-sectional sample cut (i.e. coal containing metal piece) on the moving belt. An adjustable wiper blade assembly mounted on the rear of the cutter and minimum two (2) adjustable 5-Roll idlers for adapting to the given belt to the cutter's radius help ensure that material is deposited into the M.S. Container via discharge chute of scooper. The cutter follows through and is stopped by the brake motor in its original parked position.	
1.2	Metal Detector senses presence of tramp metal in the coal mass on belt (being examined by metal detector) will transmit signal to coal scooper so as to actuate its hammer type cutter. Cutter will scoop out mass of coal contaminated with the metal pieces/ tramp metal without stopping the belt.	

	Contaminated coal will be collected into a M.S. fabricated container via discharge chute of scooper.	
2.0	**Data Sheet: Coal Scooper**	
2.1	Type	Automatic/ Semiautomatic
2.2	Qty. / Location	As per flow diagram
2.3	Construction	Steel fabricated, Necessary 5-Roll idler at scooper location shall be provided.
2.4	Conveyor Data :	
i.	Belt Width / Capacity / Speed	Refer Flow Diagram & Conveyor Data sheet
ii.	Material to be handled	Crushed Coal / ROM Coal
iii.	Lump Size	(-) 20mm / ref.cl. 1.5.1/b
iv.	Cutter opening	300mm (minimum)
v.	Scooper Discharge Chute	Welded Steel construction made out of 5mm thk. M.S. plate (IS:2062)
vi.	Contaminated coal receiving container	Welded Steel construction made out of 5mm thk. M.S plate. (IS:2062)
M-10	**BELT WEIGHER**	
1.0	The belt weigher shall consist of the carriage/ weighbridge assembly, belt speed sensor and the electronic cabinet (Totaliser or Integrator Unit). The weighbridge shall be of multi idler system. Frictionless pivots trunnion type suitably sealed/ flexure plates shall be provided which shall be impervious to vibration, moisture and material deposits. The weighbridge shall be of rigid frame type having no moving parts and it shall maintain alignment permanently. It shall be of modular type for quick and easy installation in the field.	
1.1	The speed sensor mechanically connected to tail pulley/ deflector roller/ speed sensor arm between the belts shall provide pulses, proportional to belt speed. The Totaliser Package (Integrator Unit) shall provide the necessary intelligence to the system. The integrator receives the output signal from the weighbridge & the speed sensor and adds them to the total on the Master Counter. Flow rate is displayed by computation against a time base. The Integrator shall have feature such as automatic span and zero calibration and self-diagnostics facility.	
1.2	The digital speed sensor shall be packaged in rugged cast aluminum/ S.S housing suitable for outdoor installation. The speed-sensing element shall employ a brushless pulse generator producing pulses, proportional to true belt speed. The pulse output is fed to the Integrator Unit.	
1.3	The Electronic Cabinet shall comprise of the Totaliser, Rate Indicator etc. having microprocessor based integrator. Total material weight, the material flow rate etc. shall be displayed on eight (8) digits LED. It shall have facility such as Run/ Set up/ Lamp test/ Auto zero/ Auto Span/ Enter etc. The Electronic Unit shall have facility of digital processing, totalization of data etc., and shall have bright easy to read digital display of flow rate of material and total tonnage passed etc. Electronic cabinet shall be rugged design with IP-55 degree of protection. Belt weigher system and main control room PLC communication interface to be	

	provided. Minimum three signals (Flow rate, Pulse Totalizer & Reset) from Control room are required.	
1.4	High precision load cell of strain gauge type/ transducer fully temperature compensated shall be provided.	
1.5	The accuracy shall be guaranteed for a minimum of (±) 0.25 % for all belt weighers except for Stacker Reclaimer M/c where accuracy level shall be guaranteed for a minimum of (±) 1 %. All electronic equipment used shall be suitable for service in dust-laden atmosphere and shall be actually tested, checked as per applicable standards to ensure continued reliability.	
2.0	**Data Sheet: Belt Weigher**	
2.1.	Type of Belt Weigher	Electronic Load Cell Type, Microprocessor based
2.2.	Equipment Designation / location / qty	As per Flow Diagram
2.3.	Capacity of conveyor (tph)	Ref. Conv. Spec. / Data Sheet
2.4.	Belt width	1400mm wide x 3-Equal Roll x 35° Tr.
2.5.	Belt Speed, m/s (approx.)	Ref. Conv. Spec. / Data Sheet
2.6.	Weighing range	20% to 120%
2.7.	Accuracy over full weighing Range	For S/R belt scale: Minimum ± 1% For others : Minimum ± 0.25%
2.8.	Totalizing Unit	Eight digits, digital Totalizer to be Provided
2.9.	Type	Strain gauge type hermetically sealed.
2.10.	Location of Electronic Cabinet	Central Control Room at building# ER-2
2.11.	Flow Rate indicator	Electronic Digital Display Minimum 4 digits both Local as well as remote to be provided
2.12.	Type	Digital type
2.13.	Location of display	Control Room/ Local
2.14.	Calibrating instruments as required	To be Provided
2.15.	Ambient Temperature	50^0C
2.16.	Structural Capacity	250% of rated belt scale capacity
2.17.	Calibration Automatic Manual a) Test load chain length b) Chain reel equipment	 Zero & span calibration With test load chain Two idler spaces more than weighing lengths Complete with weight adding facility.
M-11	**FIXED TRIPPER**	
1.0	The fixed belt tripper shall be provided on Conveyor# 3BC- 4A/4B	

1.1	Tripper head (discharge) pulley shall be identical to conveyor drive pulley for pulley dia., bearing size. Similarly, bend pulley of fixed tripper shall also be identical to bend pulley of conveyor.	
1.2	3.15mm thk MS Deck Plate continuous shall be provided. Suitable tripper slope together with adequate radius of curvature (if required) shall be provided to avoid any lifting of carrying side belt.	
1.3	The tripper chute shall be provided with two - way chute having divertor gate. Access platform complete with hand railing & access ladder etc shall be provided for operation of divertor gate.	
1.4	Necessary belt guide rollers for belt shall be provided near to the discharge pulley for carrying side belt.	
1.5	Belt cleaners, chutes, skirt board, divertor gate, pulleys, rollers, and idlers shall comply with the requirements stated elsewhere in this specification. The tripper shall have provision for dropping coal to one side of conveyor and also onto conveyor itself.	
2.0	**Data Sheet: Fixed Tripper**	
2.1	Type of Tripper	Fixed Type
2.2	Designation no/ Location/ Qty	3FT-1A/1B As per flow diagram/ Two (2) no.
2.3	Type of belt cleaner required	Primary cleaner at discharge pulley and V-plow cleaner at lower return side bend pulley.
2.4	Belt width	1400 mm x 35° Tr. X 3-Eq.Roll
2.5	Hinged inspection door on the chute	Provided
2.6	Skirt board	Refer spec. for conveyors
2.7	Type of operation	Local operation. However, necessary indication on central control panel of divertor gate position shall be provided.
M-12	**Travelling Tripper** **Design Requirement** The Travelling tripper on bunker conveyors shall be motor driven type. It shall consist of structures, supports, walkways, rails, belt scraper, rubber lagged head & bend pulleys complete with shaft bearings, chutes, stops, limit switches, brakes etc. The tripper shall have provision for dropping coal from conveyor onto side of tripper to the bunker or back to the conveyor for the purpose of skipping intermediate bunkers. The rating of tripper travel motor shall be adequate to move the tripper smoothly either in same or opposite direction to belt direction under fully loaded conditions. Adhesive weight requirement and tractive effort calculations shall be subject to the approval of HPGCL / DESEIN. Co-efficient of adhesion shall be considered as maximum 0.15. Minimum two (2) drive axles shall be provided for tripper travel. Arrangement shall be provided at the starting point of the tripper to avoid folding of belt. In case of tripper running at a speed more than its rated speed due to chute jamming or other reason, conveyor shall trip and annunciation shall appear. Supply of adequate length of rails to cover the runway length for the motor driven tripper shall be included. The supporting structures for the rails with	

	necessary end stops shall also be supplied under this specification. Suitable belt hold down guide pulley shall be provided over the concave curve of belt over tripper. The Contractor shall include in his proposal necessary electricals for travelling trippers. Adequate length of trailing cables (power & control) with festoon arrangement shall be supplied for each of the travelling tipper. Alternatively, drag chain arrangement may be provided for trailing cables (power & control) for each travelling tipper. Three (3) pairs of control cables shall be provided the control trailing cable each machine for connecting operator's telephone & PA equipment to be provided on each machine. Isolating switch to isolate the power supply to the machines shall be provided in each power JBs to be located GT the centre of travel length. The travelling trippers shall be provided with fail safe AC Thrustor operated brake of totally enclosed type which shall engage as soon as tripper travel motor stops. A.C Thrustor operated rail clamps along with manual Rail clamps on both side of the tripper shall also be provided. The specifications of brakes and clamps are as discussed elsewhere. For selection & specification of drive motor, gearboxes, pulleys, belt cleaners and all other equipment associated with tripper & Bunker sealing arrangement relevant sections of this specification shall be referred to. Independent motorized linear actuator shall be provided to operate each flap gate of the tripper chute. Monorail & electric hoist shall be provided for lifting conveyor drum to bunker floors. Monorail all along the tripper travel length to facilitate maintenance of tripper shall be provided.
1.0	**Constructional Features**
1.1	The travelling belt tripper shall be suitable for installation on bunker feeding tripper conveyor.
1.2	The tripper shall have a sturdy, welded, structural steel frame and supports for mounting all the machinery. A service platform shall be provided on one side. Tripper shall be equipped with welded steel cross over platform with handrail and access ladder at each end of the platform. The tripper shall be mounted on two (2) sets of flanged cast steel wheels and axles of medium carbon steel. Antifriction bearings with suitable dust seals and easily accessible pressure gun lubrication fittings shall be provided. Necessary guide rollers with bearings etc. shall be mounted on the tripper.
1.3	The C.G of tripper shall be kept low so as to avoid "RUN-AWAY" condition of the tripper and to ensure good stability for smooth operation of the tripper on full load.
1.4	Each tripper shall be provided with two (2) way discharge chute.
1.5	One primary belt cleaner at tripper head pulley, flap gate (for tripper chute), pulleys, rollers, and idlers shall comply with the requirements stated elsewhere in this specification. Tripper head pulleys shall be identical with drive pulley of tripper conveyor for its drum dia & shaft dia.
1.6	Tripper shall be suitable to operate at any desired position within the range of travel with positive arrangement to ensure stoppage of travel. One (1) linear actuator operated flap gates shall be provided to direct the material flow through the tripper's two (2) way discharge chute to deliver coal either into Coal Bunkers opening or the tripper conveyor itself.

1.7	All grease fittings shall be accessible from the outside of the tripper, from the service platform.	
1.8	Limit switches provided at the ends to limit the travel of tripper, shall be of heavy-duty type and interlocked with drive of the tripper.	
1.9	The rating of tripper travel motor shall be adequate to move the tripper smoothly either in same or reverse direction to belt direction under fully loaded conditions.	
1.10	Motorized cable reeling drum and adequate length of trailing cables (power & control cable), push buttons shall be supplied for each travelling tripper. Suitable cable tray, minimum 250mm above floor level, shall be provided along the travel of the tripper for supporting and guiding the trailing cables.	
1.11	Fail-safe AC Thrustor operated hydraulic brake of totally enclosed type shall be provided, which shall engage as soon as tripper travel motor stops. In addition to brake, tripper shall be provided with hand operated rail clamps to hold it in any desired position.	
1.12	Suitable rail cleaners shall be provided on leading and trailing edge of tripper for each rail track.	
1.13	3.15 mm thk M.S. deck plate continuous for full length of tripper shall be provided below carrying idlers.	
1.14	All drive equipment shall be selected based on 125% of actual power required at specified guaranteed capacity. Further complete drive equipment shall be suitable for minimum fifteen (15) starts/hr and minimum 10 consecutive starts.	
1.15	The axle should be directly coupled to drive unit through coupling/ hollow shaft gearbox. No chain / sprocket arrangement shall be used for tripper travel drive unit.	
1.16	Protection in the cable reeling mechanism shall be provided to avoid over tensioning & damage to trailing cables.	
1.17	Over travel protection switches shall be provided on both ends.	
1.18	Mechanical stoppers with buffers shall be provided on rails to prevent over travel of tripper.	
2.0	**Data Sheet: Travelling Tripper**	
2.1.	Type	Motor operated travelling tripper
2.2.	Quantity/ Location	Lot/ As per flow diagram.
2.3.	Type of drive unit for tripper Travel.	Motor (reversible) coupled to gearbox & gear box coupled to drive axle complete with flexible couplings or with shaft mounted gear box. No chain drive
2.4.	Rail size	52 kg/m (Minimum)
2.5.	Rail Gauge	To suit requirement
2.6.	Tripper capacity	To suit conveyor # 3TBC-1A/1B & 2A/2B
2.7.	Travel speed of Tripper (approx.)	12 m/min.
2.8.	Type of discharge chute	Two-way with flap gate having Linear actuator

2.9.	**Travel Wheels**	
i.	Type & material of wheel	Flanged, Cast Steel, quenched and tempered wheels
ii.	Type & life of Bearings	Spherical roller bearing having 60000 hr. (L-10) life. Method of lubrication through grease nipple
iii.	Axle material	C-45 / EN-8. One axle assembly (1 pair of wheels) driven by drive unit.
2.10.	Rail clamps	Manually operated rail clamps, two (2) set per Tripper
2.11.	Head, Bend & Hold Down Pulley of Tripper	
i.	Type	M.S. welded construction (IS:2062)
ii.	Material & Thickness of lagging for (Tripper head & bend pulley).	12 thk, plain natural rubber lagging
iii.	Hold down pulley	Shall be provided to suit layout.
iv.	**Limit Switches**	To be provided as required.
2.12.	Mechanical End Stopper/ Buffer Post provided	Yes
2.13.	Type of operation	Only Local operation to be provided
M-13	**Wagon Tippler & Accessories**	
1.0	Wagon tippler shall be a simple and compact machine with low drive power. It unloads one wagon at a time by inverting the loaded wagon over a ground hopper and discharges material into the ground hopper located beneath the Tippler.	
2.0	Wagon Tippler shall be complete with: - Tippler Table with rails, end frame with necessary rack segments, clamp girder, side beam etc. - Wagon Tippler with electromechanical drive -- All foundation bolts. - Control Cabin where from the Wagon Tippler and Side Arm Charger can be operated jointly or independently. - Any other item / accessory / fixtures to complete supply of the equipment.	
3.0	Wagon Tippler shall be provided complete with all structural members, tippler platform, tipping mechanism, tippler drive, brakes, coupling, shafting and all automatic controls for positioning, tipping, discharging the contents of entire wagon into the Wagon Tippler hopper. The tippler is a positive GEAR DRIVEN machine of proven design and suitable for continuous duty operation of 24 hours per day.	
4.0	The design, manufacture, inspection and testing of Wagon Tippler shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the Wagon Tipper is to be installed. The Wagon Tippler shall be	

	built in accordance with the latest requirements of RDSO Technical Pamphlet G-33.
5.0	**Wagon Unloading System**
5.1	The rake comprising of 60 no of wagons shall be pushed into the reach of in-haul equipment by a locomotive. Further placing of wagons over tippler platform and carrying away the empty wagons shall be accomplished with the help of a side arm charger.
5.2	The Wagon Tippler shall be used for unloading of ROM coal/washed coal/imported coal from wagons into the RCC hoppers. It shall also perform function of weighing the gross & tare weight of wagons by incorporating an integral weighbridge. Wagon Tippler shall be of sturdy and robust construction. Tippler is provided with the safety features such as ultimate shunt limit, over travel limit switches etc., so as to operate the tippler safely without damaging the railway wagons, integral weighbridge etc.
5.3	Maximum moving dimensions of locomotive & wagons as per Indian Railway norms shall be adopted for providing clearances with respect to structures, equipment and tippler arrangement.
6.0	**Design Parameters**
6.1	The design and construction of components of tippler and auxiliary handling equipment coming into contact with any part of wagon shall be such that no damage whatsoever is caused to the wagon equipment or its paint.
6.2	The side supports for tippler shall meet the following requirements
a)	The side support shall consist of a longitudinal beam, which shall be as long as the longest wagon to be tippled. This beam shall be continuous.
b)	The side support shall be articulated so that it can take the tapered as well as parallel stanchions on the body of the wagons. Alternatively, the cradle shall be articulated on trunnion to achieve this. There shall be metal to metal contact between the side support beam & the side stanchions of the wagon i.e. no rubber pad or any other alternative, shall be provided on the contact face of the side support beam.
c)	The side support beam shall be movable type, the movement being done by electromechanical arrangement. (No external or moveable counter weights should be used with the side support beam)
6.3	The top clamping arrangement shall conform to the following requirements.
a)	The top clamping pressure shall be such as will hold the wagons firmly in position on rails and keep the running gear from getting dislodged without causing any deformation to the wagon structure.
b)	Top clamp locks should include a wagon bogie spring relief mechanism for permitting release of forces generated by the re-exertion of bogies springs during unloading of wagon.
c)	Top clamping arrangement shall be of longitudinal / transverse type and provided with self aligning feature.
d)	Minimum 50mm thick rubber lining on top clamp pads shall be provided. The shore hardness of the rubber pads shall be at least 70A.

e)	Forces exerted by top clamps of the tippler on wagons copings shall be within permissible limits /as per RDSO.
7.0	**CONSTRUCTIONAL FEATURES**
7.1	Wagon Tippler shall be built in accordance with latest standards and the recognized safety rules.
7.2	Operator is positioned behind the Wagon Tippler control Desk inside the operator's cabin to monitor the unloading process and shall intervene whenever necessary.
7.3	The following are the main components of Wagon Tippler: a) Tippler drive unit b) Entry & Exit End frame with open segmental gear rack c) Tippler platform d) Clamp girder e) Side Beam f) Operator Cabin g) Moving Side Support Beam h) Brakes i) Tip Side and off Side Clamp gears j) Support Rollers k) Photocells and limit switches l) Main Hydraulic Cylinders m) Main Bearing and Main Shaft n) Wagon Holding Paw Cylinders o) Cantilever arms p) Centering Device. q) Wheel Grippers r) Retractable wheel chocks. Tippler consists of end frame and a corresponding supporting structure. The supporting structure of the Tippler is designed as a Tippler Platform placed on a concrete civil foundation through a centering device. The Platform supports the Wagons, which rotates along with End frame. The Wagon is held in position during rotation by means of Top Clamping Beam, (which is hydraulically operated) and side support beam. The hydraulic power unit is housed in a shed near Wagon Tippler. Metered quantity of the material (which is dumped into the hopper) is discharged on to the conveyor system through Apron Feeder located below the hopper.
7.4	**Tippler Drive Unit:** Low speed electromechanical motor drive shall be provided. The drive unit consists of the following components; i) Frame for mounting of motors. ii) Power pack. iii) Drive pinions for rotating End Frame. iv) Wagon Tippler shall be driven by 3 nos, motors.
7.5	**End Frame:** End frame are in a sector form and is fabricated out of plate works. This is roughly of semicircular shape and rotates on main pedestal bearings

	supported on the R.C.C. pedestals. A cantilever arm is fixed at the bottom of each of the sectors through this cantilever the end frame are connected to the main table via Bearing Eye. End frame is having toothed rim on its periphery and these teeth are driven through a pinion mounted on the line shaft. When end frame gets its motion through pinion it moves the table and the wagon placed on it along with it.
7.6	**Rail Platform:** The Rail Platform is a heavy steel fabricated box section, which carries a section of standard steel rail track (60kg/m) through the structure, and is of sufficient length to accommodate the two longest wagons to be handled. The Platform acts as a bridge between the End Frames and is designed to support the heaviest wagons on a cyclic basis during unloading and the passage of locomotives on an infrequent basis as required. In conjunction with the Side Beam and Clamp Girder, the Rail Platform acts to transmit vertical and torsional loads throughout the Cage Structure and ensures the Cage acts as a homogeneous structure during rotation. Rail Platform to End Frame connections are carefully designed to avoid high stress concentrations and minimise fatigue effects that are inherent in Wagon Tipplers. Walk and access ways are mounted on both sides of the Rail Platform to facilitate foot traffic and maintenance activities. Bearing eye, centering device and rollers shall be provided to suit. The platform rests on civil foundation via a cup and cone type-centering device.
7.7	**Top Clamping Beam:** This is a structural work made out of plate work, and connected at the ends with Side Arms, which are supported on the main bearings.
7.8	**Side Beam** The Side Beam is a long heavy steel fabricated box section, which connects the End Frames at the mid-vertical point. The Side Beam accommodates the mounting of an integral moveable Side support beam and is designed as the ultimate support for the heaviest wagons on a cyclic basis during the unloading operation.
7.9	**Operator's Cabin:** The operator's cabin shall be equipped with: - The necessary control units and instruments, - A floor to accommodate the electric cables, - Air conditioners etc.
7.10	**Spill Plate:** The Spill Plate acts as a chute when the tippler discharges the contents from the wagon. The spill plate rotates along with the rotation of the chock beam.
7.11	**Brake:** Automatic, electro-hydraulic thrustor operated brake is provided to hold the tippler platform. The brake shall be suitable for operation & shall hold the tippler platform with wagon in case of power failure.
7.12	**In Motion Weigh Bridge –** Refer Clause M-39 in this chapter
8.0	**Marking:** All tipplers shall be marked permanently and legibly at a clearly visible place with the name of the manufacturer, serial number, year of manufacturer, type and capacity of tippler and RDSO allotted Serial No.
9.0	**Train & Wagon Holding Devices**

	Wheel grippers shall be designed so that balanced pressure is applied on both sides of the wheel rim. It shall have a floating arrangement so as to ensure that force on each gripper is same and shall have some lateral float so that it can take a new position in case of variation in wheel gauge. Wheel grippers shall be free horn serrations or any such provision on its holding face wheel grippers shall be made of soft material. **Retractable wheel chocks** shall be designed so that flange of the wheel is not contacted while blocking tread of the wheel. Shape or the choke shall take into account the wheel incline, so that a line contact is made with the wheel. Clicking stops: These are not acceptable	
10.0	**The design of the top clamping arrangement shall fulfil the following requirements**	
10.1	The top clamping of the wagon shall be done through hydraulically locked top clamps. No external or moveable counter weights shall be used with the hydraulic clamps.	
10.2	Top clamps should engage when the wagon tilts by more than 15 degree. Top clamp locks shall include a wagon bogies spring relief mechanism for permitting release of bogie springs.	
10.3	Top clamps should exert the bare minimum pressure on the top coping of the wagon, so as to just keep it in position. The pressure exerted by the top clamps at the tilt angle of 160 degrees shall be just enough to bear the weight of the empty wagon. Wagon bogie springs shall be fully relieved in the position, through the bogie spring relief mechanism.	
10.4	The design of Top Clamping arrangement shall be of longitudinal / transverse type and provided with self aligning feature whereby the load is borne on the top at each of the wagons. The longitudinal / transverse type clamping shall have six transverse top clamping beams i.e. the bearing face of the beam shall contact the top of the wagon at 12 locations six on each side). Each bearing face shall contact the top of the wagon over a width of not less than 250 mm and shall provided with rubber pads or suitable alternative not less than 50 mm thick.	
10.5	The side supports for tipplers shall meet the following requirements. Full face contact between the side support beam and the side stanchions shall be ensured. The side supports shall extend tom a height of 1000 mm upto 2950 mm from rail level, i.e. contact the side of the wagon over a width of not less than 1950 mm, and shall be provided with rubber pads or suitable alternative not less than 50 mm thk. Pressure gauges should be mounted at easily accessible location for reading the hydraulic pressure of the side support hydraulic arrangement.	
11.0	**Data Sheet: Wagon Tippler & Accessories**	
1	Type	Electromechanicaly operated only, Rotaside, Side Discharge Type to suit tipping capacity of Tippler
2	Equipment Designation / Location /	3WT-1A/3WT-1B,in Wagon Tippler Complex # 3WTC-1
3	Qty, no	Two(2)

4	Material of Construction of Main Parts / Units	IS : 2062
5	Type of Wagons that can be Handled at a time	BOX, BOXN, BOXNHA, BOXNLW, BOXNHL, BOXN25,DFC & other type of open wagons for coal as per RDSO standard and design used by Indian Railways to move coal.
6	Mode of Placement of Wagons	By Side Arm Charger
7	Gross Weight of Wagon that can be handled at a time	140 t
8	Rail Gauge	1676 mm
9	No. of Tips per Hr (Guaranteed)	25 tips/hr.[tippler shall be designed as per RDSO]
10	Type of clamping	Electromechanical
11	Mmotor for tippler drive	Low speed high torque type
12	Average Cycle Time	To Suit.
13	Angle of Rotation	160[minimum] Degree.
14	Type of clamping	Electromechanical clamping arrangement, articulated
15	Type of motor, brake etc	Electrical motor
16	Diesel loco passage	Yes, allowed
17	Clearance profile	As per RDSO G-33
18	Mode of Control	Semi automatic/manual, PLC control for remote operation & control shall be provided.
19	Safety Features	All the necessary safety features shall be provided for each machine
20	Lubrication Arrangement.	Motorized group Lubrication system of proven design shall be provided.
21	Special Feature,	Heavy Duty Tippler as per Proven Design, suitable for Round the Clock Duty.
22	EOT crane for tippler maintenance	Required
23	G.A drawing of W.T Complex	Bidder to furnish along with offer.
M-14	**Side Arm Charger [SAC]**	
1.0	**Application:** The side arm charger shall be used for wagon positioning at the wagon tippler for unloading of coal. It shall be used for pushing/ pulling rake of maximum 60 loaded wagons of 140 tonne gross weight each and locating wagon one by one on tippler table.	
1.1	**Operation:** The rake shall be brought in by locomotive either heading or pushing and placed on the pre-tippling line such that the leading wagon will be within range of the Side Arm Charger. The charger shall be driven to the leading wagon, its arm shall be lowered and it shall be coupled to the first wagon of the rake.	

	The rake shall be hauled forward by the charger near the tippler. The charger shall stop and the first pair of wagon shall be uncoupled from the rake. The charger shall then propel the leading wagon on to the tippler, automatically uncouple and shall run clear of the tippler. Its arm shall be raised and it shall travel back to the rake and the tippler shall rotate. On reaching near the standing rake, the charger arm shall be lowered and shall be coupled to the rake ready for repeating the cycle. In next cycle the rake shall be drawn up by about two (2) wagon length and the previously tippled wagons shall be ejected simultaneously. After tippling of the last wagon, the charger shall be used under manual control to eject the last wagon from the tippler, if the next wagon is not already in position.
1.2	**Constructional Features**
1.2.1	Equipment supply includes Side Arm Charger with power pack, electric supply system, supports, rack and pinion, electrics, buffer stop etc.
1.2.2	SAC travel carriage with push arm shall be propelled to & fro, parallel to rake track through motor driving through gear box & EHT brake.
1.2.3	The Side Arm changer shall be mounted alongside the main rail track and shall run on its rail track parallel to the main track. The SAC track rails have a rack/spine bar drive assembly mounted between the rails.
1.2.4	It shall be fitted with an arm pivoted at right angles to the track capable of being raised and lowered and carrying at its outer end an automatic coupler to couple the rake.
1.2.5	The Charger frame shall consist of a single fabrication from rolled steel sections and plate on which every other item shall be directly mounted to form a robust and compact unit. Frame shall also include lifting lugs and these will be sized to allow lifting of the assembled SAC within workshop and during site installation.
1.2.6	The Charger shall run on four (4) Cast/ forged Steel wheels mounted on anti-frictional bearings.
1.2.7	To resist the moment reaction of the pushing force, two pair of steel side guide rollers shall be fitted. They shall be fitted on antifriction bearings and shall have a simple lockable adjustment for true running. The side guide rollers shall run on the head of Charger running track. One of the four guide roller units incorporates a spring assembly which ensures that all four wheels make contact with the running rails.
1.2.8	The side arm shall be of welded construction. Raising and lowering of the arm shall be by means of a cylinder driven through power pack mounted on the Charger frame. A standard coupler enables automatic coupling of the arm to the wagon coupler and an actuator release mechanism with a cylinder is provided for decoupling.
1.2.9	Coupler proximity switches are also attached to the coupler end of the arm. These detect that the SAC couplers are engaged and locked.
1.2.10	The Charger shall have adequate power for hauling a rake load of 60 fully loaded wagons on the rail track, it shall be electromechanically driven by means of a pinion and land mounted rack.
1.2.11	A shock absorbing mechanism is mounted within the arm head to reduce the shock loading effects experienced in handling the rake of full wagons in to the plant and also pushing the empty wagons from the tippler complex.

1.2.12	Cushioned emergency bumpers shall be provided at the forward and return end of carriage travel run for protection.	
2.0	**Data Sheet: Side Arm Charger**	
2.1	Type	Rail Mounted, Rack & Pinion Type
2.2	Qty. & Equipment Designation No.	Two (2); 3SAC-1A/ 1B
2.3	Type of wagon to be Hauled	All types as per RDSO Standard.
2.4	Hauling Capacity	60 Nos. wagon, each having gross wt. of 140 t
2.5	Duty	Continuous; 24 hr/day
2.6	Operating Speed (Forward & Reverse)	Forward: ~ 0.6 m/s (To Suit) ; Reverse: ~1.2 m/s (To Suit) However travelling Speed of SAC shall be to suit tippler design capacity of 25tip/hr
2.7	Maximum Pull of Inhaul	To Suit 60 Nos. Loaded Wagon
2.8	Mode of Control	Semi Automatic from Remote Control & Local
2.9	Mode of Power Supply	Festooning Cable Arrangement
2.10	Drive Arrangement	Motors (operated by Power Pack) driving a set of pinions onto ground drive rack.
2.11	Safety Features	Over Travel Protection / other safety features as necessary shall be provided for safe operation
2.12	Arm Raise / Lower Arrgt.	Operated by Power Pack
2.13	Type of Lubrication Arrangement	Manual centralized.
2.14	No. of Carriage Wheels	4Nos.
2.15	Track Gauge (approx.)	1500mm to 1800 mm
2.16	Length of Track (approx.)	62 m
2.17	Location of Control Desk	Duly covered control desk provided on Side Arm Charger
2.18	Detail of Color Signal lights provided for Loco Operator's guidance	Red & Green Light
M-15	**EOT CRANE**	
1.0	One (1) no Pendant Controlled, Double Girder EOT Crane to suit tippler & associated equipment [in Wagon Tippler complex] with suitable span & lift and with adequate runway length for W.T Complex shall be provided. Crane shall be provided with main and auxiliary hoist.	
1.2	The crane shall be complete with all accessories including following:	

1.2.1.	One (1) set of lattice truss complete with rails, end stops, walkway platforms, handrails, access ladders, curved rail bent wheel stoppers for crab, buffers, maintenance cabin, DSL guards , jack pads etc.	
1.2.2.	End carriages complete with minimum four (4) wheels for each end carriage and access ladders from gantry platforms and spring buffers etc.	
1.2.3.	One (1) – Crab [trolley] with wheels and drive equipment for the Crane and trolley drives complete with motors, reduction gear boxes, brakes, coupling, shaft bearings, limit switches etc.	
1.2.4.	One (1) set of crane longitudinal drive equipment complete with motor, reduction gear boxes, brakes, coupling, shaft bearings, gear pinions, limit switches etc.	
1.2.5.	One (1) – Lot, crane runway rails complete with fixtures comprising of fixing clamps [machined to suit rail flange contour], bolts, nuts etc for effective crane longitudinal runway length.	
1.2.6.	Set of electrical conductors through festooned flexible trailing cables with track and trolley complete with fixtures arranged along bridge for power supply to crab.	
1.2.7.	Set of limit switches, electrical protective gear and various others needed electrical/ control accessories.	
1.2.8.	One [1] set of down shop leads complete with current collectors/ insulators and fixtures, hardware etc for the crane runway length.	
1.2.9.	End stops & curved rail bends for crane longitudinal travel.	
1.2.10.	Recommended spare parts for satisfactory operation of crane for 2000 hrs of operation	
1.2.11.	Requisite sets of erection, operation and maintenance instruction manuals and drawings as per distribution schedule.	
1.3	**Duty and Capacity of EOT Crane:** The EOT crane shall be used for maintenance of wagon tippler and associated equipment of the Wagon Tippler Complex.	
1.4	Structural Steel shed above tippler shall be of adequate width and length so that no rain water falls into the equipment hatch during rainy season. Bidder shall ensure the above during preparation of GA drawing.	
2.0	**Data Sheet: EOT Crane**	
2.1.	Number of crane required/designation no	One (1) no./ EOT-1
2.2.	Location	Structural Steel Shed Above WT Hopper/ Tippler etc. of wagon tippler complex.
2.3.	Type of Crane required	Double girder EOT Crane
2.4.	Duty	Class :M5,Indoor [IS 3177 / IS:807]
2.5.	Mode of operation	Pendant Station [consists of push buttons housed in dust proof housing and suspended from hoist, movable on independent monorail]. To prevent pull on pendant, cable steel wire rope provided.
2.6.	Crane span/ Crane runway length /lift, m	To Suit. Bidder to furnish

2.7.	Capacity of Main Hoist (SWL)/ Aux. Hoist (SWL)	20tonne/ 6.3tonne
2.8.	Rated Speed [For any load from zero to SWL]	Main hoist - 3m/min Aux. hoist - 6m/min Trolley travel - 10m/min Bridge travel - 15m/min
2.9.	Design Temperature for Motors	50 degree C
2.10.	No. of Starts Per Hour	150
2.11.	Type of Main Hook	C-shank Type swiveling hook with locking device, Trapezoidal section
2.12.	Type of Auxiliary hook	Standard single swiveling type with locking device
2.13.	Wire rope/ Drum	IS:2266,6x36,steel core/ seamless pipe drum ASTM A106
2.14.	Crane Structure	Bridge Girders of box steel type steel fabricated construction. Full-length access platforms shall be provided on both sides of crane with walkways [IS:807/IS:3177/ IS:800]
2.15.	End carriage	Fabricated from rolled sections/plate box
2.16.	LT wheels	EN-8/EN-9 forged steel, double flanged
2.17.	LT wheel bearings	Heavy duty sealed ball bearings
2.18.	Pinion/axles	En-9/16MnCr5, heat treated carbon alloy steel.
2.19.	Crane runway rails	Minimum CR-60
2.20.	Hoists	Generally conforming to IS:3938
2.21.	Brakes	Hoist motion: Electro hydraulic thrustor operated Cab travel : DC disc type Bridge travel :DC disc type
2.22.	Control panel	Sheet metal clad in totally enclosed construction,IP-55 protection
2.23.	Runway conductors (DSL)	MS angle ISA – 75x75x6 section
2.24.	Control supply	240 V, single phase 50 HZ AC supply (necessary step - down transformer for control/ lighting/ space heater power supply required for crane shall be provided by contractor)
2.25.	Safety	Electrical interlocking is provided to avoid accidental simultaneous motions of crane due to activation of multiple push buttons at the same time.

2.26.	Limit switches	Limit switches shall be provided against over hoisting/over lowering/over travel in cross and longitudinal direction.		
2.27.	Detailed Technical Particulars & GA drawing	To be furnished by Vendor.		
M-16	**Wagon Tippler Hopper / Emergency Reclaim Hopper / Bar Grid**			
1.0	Each hopper shall be in RCC Construction with minimum sloping angle of 60°			
1.1	**Wagon Tippler Complex # 3WTC-1**			
a)	Individual RCC hopper shall be provided for each tippler. Necessary ramp/access shall be provided so that Payloader/Hydra/dozer can access hopper top for removal of oversize lumps of shale, sandstone which come along with ROM coal.			
b)	It shall be provided covered with structural steel shed with precolor side cladding and with EOT crane as specified. Also access shaft / equipment hatch with necessary monorails with hoist to bring out underground equipment/ components (for maintenance purposes) up to ground level & vice versa shall be provided. RCC stairs for access to all underground floors shall be provided.			
c)	Tippler complex layout shall ensure satisfactory crane operation in conjunction with various hoists provided for the Tippler Complex. Tippler complex shall be designed taking due care for vent duct layout / sump pump piping / underground monorails & hoist etc.			
d)	The steel grating/ bar Grid above tippler hopper shall allow passage as well as be able to withstand the load due to passage of bulldozer/payloader, weighing up to 36t. Also bar grid shall be designed so that manual breaking of oversize coal can be carried out suitably and safely above the grid.			
e)	Suitable shear beams shall be provided in tippler hopper to reduce coal column load on apron feeder. Beam surface which comes in contact with material shall be lined with min.16mm thk SAILHARD/ TISCRAL liner or equal liner material.			
1.2	**Reclaim Hopper Complex # 3RHC**			
a)	Suitable slope shall be incorporated in the access ramp to each reclaim hopper & M.S. angle shall be embedded at edges of ramp for edge protection. Structural steel shed above Hopper Complex # RHC-1/2/3/4 shall be provided suitably as protection against rain.			
b)	M.S fabricated mouth pieces of suitable size shall be provided at the discharge openings of different hoppers to suit the feeder mounted below each RCC hopper outlet.			
c)	Emergency Reclaim Hopper Complex shall have access shaft with monorail and hoist to bring out equipment up to ground level & vice versa.			
d)	The steel grating / bar Grid above reclaim hoppers shall be able to withstand the load due to passage of bulldozer, weighing up to 36t or 4 m heap of coal over grid whichever is worst.			
2.0	**Data Sheet: WT Hopper / Reclaim Hopper**			
2.1	**Hopper Description**	**WT hopper**		**Reclaim Hopper**
2.2	Designation no.	3WTH-1A/1B		3RH-1A/1B/2A/2B
2.3	Qty, no.	Two (2)		Four (4)

2.4	Hopper Capacity	Minimum 290 cum each (Water filled volume)		50 cum each (Minimum)
2.5	Material handled	ROM Coal/(-) 400mm		Crushed Coal/(-) 20mm
2.6	Type of Construction	Underground RCC Construction complete with steel fabricated bar grid at top and covered with structural steel shed.		
2.7	Hopper Liner	Minimum 50 thk Guniting		
2.8	Type of Feeder below Hopper	Floor Mounted Apron Feeder		Floor Mounted Vibrating feeder, variable capacity
2.9	Bar grid at hopper top	Provided		
2.10	Type & Construction of bar grid	Welded Steel Construction made out of M.S. plate/ flat (IS: 2062)		
2.11	Bar Grid/ Grating Material	Made out of 200 mm x Minimum 20 mm thk MS flat		
2.12	Approx. Clear opening size of grid [it is strictly subject to approval by UPRVNL]	300mm x 300mm		150mm x 150mm
M-17	**APRON FEEDER**			
1.0	**General:** Apron Feeder shall be engineered for heavy-duty operations. Apron Feeder shall be located below the RCC hopper of wagon tippler. In KW calculation shear force due to material column [in W.T. hopper] above feeder shall be considered. Shear beam in tippler hopper (RCC) shall be provided.			
1.1	**Constructional Features:**			
1.2	**Pan:** Pan shall be suitably designed to withstand the impact load of ROM coal lumps having lump size of up to (-) 400mm. High strength pans to resist abrasion and to withstand heavy impact loads shall be provided. Pans shall be bolted to forged link chains supported on heavy-duty life lubricated rollers. Short pitch and precision-machined chain shall be provided to ensure noise-free discharge of material. Chain & Roller flanges shall maintain rigid alignment of pans in relation to skirt. The feeder shall be designed to minimize maintenance			
1.3	**Chain link:** Chain link shall be forged steel. Pins and rollers shall be hardened steel. The chain shall be provided in two rows.			
1.4	**Frame:** Feeder frame shall be manufactured out of rolled steel section (IS: 2062) and bolted together to form a rigid structure. The main two longitudinal members support the carrying rollers.			

1.5	**Bottom Rollers:** To relieve radial load on the head and tail shaft bearings and also to provide support to the return side of the moving apron, return rollers-heavy-duty life lubricated rollers- shall be provided	
1.6	**Head End:** The head end will be of sturdy steel construction suitably stiffened and fitted with spherical roller bearing & 4 bolts, cast steel Plummer Blocks. The sprocket will be made of Cast alloy steel with case hardened teeth.	
1.7	**Tail End:** The tail end will be of sturdy steel construction suitably stiffened and fitted with traction wheels complete with traction wheel assembly bought from the chain supplier as per his standards. The traction wheel will be made of cast steel with hardened surface.	
1.8	**Tensioning:** Screw take up tensioning arrangement with Hydraulic jack for sufficient travel shall be provided for the tensioning of the chain.	
1.9	**Drive Unit:** AC Motor with Variable speed type complete with VFD shall be provided.	
1.10	**Lubrication:** Manual Centralized lubrication system shall be provided with grease pump fitted close to the machine for lubricating Plummer Blocks.	
1.11	**Dribble Conveyer:** The feeder shall be provided with an integral matching belt conveyor with built-in drive to handle spillage.	
2.0	**Data Sheet: Apron Feeder**	
2.1.	Equipment Designation No	Apron Feeder# 3AF- 1A/1B
2.2.	Quantity	Two (2) no.
2.3.	Make	As per approved vendor list
2.4.	Location	Below Wagon Tippler Hopper
2.5.	Material handled	Coal [refer design criteria for physical characteristics of coal]
2.6.	Capacity	1200 tph[rated]/ 1320 tph[design]
2.7.	Pan Width (Minimum)	2000 mm
2.8.	Pan Speed,	0 to 0.2 m/ sec
2.9.	Pan Type	Over lapping
2.10.	Sprocket CRS	Bidder to indicate
2.11.	Vertical rise, m	Nil
2.12.	**Material of Construction**	
a)	Chain Link	Forged alloy steel
b)	Apron pan	Fabricated from 12thk SAILMA HI + 10thk MS IS:2062
c)	Head sprocket	As per standards of crawler chain manufacturer
d)	Traction wheel	As per standards of crawler chain manufacturer

e)	Return Rollers	IS: 2707 – Gr-1 flame hardened
f)	Carrying Rollers	Forged Alloy Steel
g)	Head and Jack shafts	CK-45/equal
h)	Skirt board	20mm thk SAILHARD or superior wear resistant plate
i)	Hood above head sprocket Assembly	6mm thk. M.S[IS:2062]
2.13.	**Drive Unit**	
a)	Motor	AC Motor with VFD control device for speed variation
b)	Reducer	Bevel Helical
c)	Couplings	Provided to suit drive complete with guard
d)	Variable speed	Shall be provided
2.14.	Dribble Conveyor	Integral matching Dribble belt conveyor with built-in drive to handle spillage shall be provided.
M-18	**Crusher [Ring granulator type]**	
1.0	**Design Requirement** The Crusher shall be of ring granulator type and shall be designed based on following clauses and the data sheet enclosed. The crusher designed such that the crushing action is accompanied by the minimum of attrition. Uniform crushing impact shall be assured. Maximum crushing efficiency shall be obtained i.e thermodynamically the ratio of surface energy produced to the kinetic energy expended shall be maximum. Accordingly, the number of central discs along the rotor shaft shall be maximum with minimum spacing in between. The crusher shall be capable of delivering the normal rated output even when handling damp sticky coal having maximum moisture content. No clogging or building up of material on the crushing element shall develop. Temperature sensing devices shall be installed on both bearings of each of the crusher to trip the crusher incase temperature goes beyond limit.	
1.1	Each ring granulator shall be capable of crushing coal from feed size to final product size as given in the Data sheet and shall be complete with adequately sized motor and Scoop type fluid coupling. Each crusher with its drive shall be mounted on its own RCC deck with vibration isolation system.	
1.2	Rear portion of granulator shall be hinged to provide maximum access for routine maintenance and its rings shall be easily renewable type. Door operation shall be hydraulic & necessary power pack shall be provided.	
1.3	The rotor speed shall be in the range of 600-750 rpm	
1.4	For Physical Characteristics of coal refer Design Criteria	

<table>
<tr><td>2.0</td><td colspan="2">Constructional Features</td></tr>
<tr><td>2.1</td><td colspan="2">Rotor: - Rotor assembly shall be completely balanced statically and dynamically to minimize vibrations and noise.
Rotor locking arrangement device shall be provided to facilitate ring hammer changing.</td></tr>
<tr><td>2.2</td><td colspan="2">Cage: - The cage frame shall be fabricated of rugged steel plates and supported from a heavy shaft at the top with adjusting mechanism at the bottom.
Cage assembly can be moved quickly by ratchet wrench and worm gear and linkage either towards or away from the path of crushing. The positive adjustment can be made while the crusher is running. The adjustability provides control over product size within the allowance of the openings in the screen plates and crusher rings by maintaining same clearance and thereby making best utilization of screen plates and hammer rings.</td></tr>
<tr><td>2.3</td><td colspan="2">Removal of Tramp Metal/ Debris: - Tramp iron and other un crushable debris shall be swept across the screens into a tramp pocket automatically. Heavy deflector plate above the trap shall prevent tramp iron from continuing around and back into the crushing cycle. An access door in the housing of crusher shall be provided to permit periodic removal of accumulated debris.</td></tr>
<tr><td>2.4</td><td colspan="2">Drive Unit: - Scoop type fluid coupling with H.T. motor will drive crusher.</td></tr>
<tr><td>2.5</td><td colspan="2">Vibration Monitoring System for Coal Crusher</td></tr>
<tr><td>2.5.1</td><td colspan="2">Vibration monitoring system should be offered for crushers as indicative below:
<table>
<tr><th>Equipment</th><th>Type</th><th>Qty.</th><th>No. of location per equipment</th><th>Equipment bearing type</th></tr>
<tr><td>Crusher</td><td>Ring Granulator</td><td>4</td><td>2 (one at DE & one at NDE)</td><td>As per manufacturer design</td></tr>
</table></td></tr>
<tr><td>2.5.2</td><td colspan="2">Vibration shall be measured at each location in Horizontal as well as vertical direction</td></tr>
<tr><td>2.5.3</td><td colspan="2">Specification for the Vibration Monitoring System</td></tr>
<tr><td>a)</td><td>Number & Type of Vibration</td><td>One (1) Microprocessor based monitoring system able to distinguish between high frequency vibration caused by bearing trouble and low frequency vibration caused by imbalance</td></tr>
<tr><td>b)</td><td>Number of channels</td><td>16 (Rack mounted in cabinet)</td></tr>
<tr><td>c)</td><td>Transducer</td><td>a) Velocity pick-up or a peizo-electric accelerometer. Type shall be decided during detail engfineering based on the details of equipment to be monitored.
b) Light weight stud mounting.
c) Frequency response 1Hz-10kHz</td></tr>
<tr><td>d)</td><td>Connecting cables</td><td>Low noise fir proof coaxial cable to be laid in flexible conduit</td></tr>
<tr><td>e)</td><td>Monitors (to be located in CHP control room)</td><td>Dual channel monitor for each location alongwith
a) Buffered signal output & software for vibration analysis through CHP control desk HMI
b) Recorder signal output</td></tr>
<tr><td>f)</td><td>Alarm</td><td>0-100% full scale adjustable</td></tr>
<tr><td>g)</td><td>Trip</td><td>0-100% full scale adjustable</td></tr>
</table>

h)	Test	Functional checking from inhibiting alarm & trip
3.0.	**Data Sheet: Crusher (Ring Granulator)**	
3.1.	Type of Crusher	Ring Granulator Type Crusher with bypass facility at feed end.
3.2.	Duty	24 hr/day, Continuous.
3.3.	Material to be crushed	Imported/ Indigenous Coal
3.4.	Equipment Designation No.	3CR-1A/ 1B/ 2A/ 2B
3.5.	Qty.	Four (4) no[2W+2S]
3.6.	Material to be crushed	ROM Coal
3.7.	Crushing Capacity for each crusher	1100tph[rated]/1210tph[design]
3.8.	Max. Lump Size of feed (Input to Crusher)	Refer clause no.1.5, Design Criteria
3.9.	Crushed Coal Size (Crusher Output) required	(-) 20 mm Not Less than 98%
3.10.	Output fines (-) 1mm size	Crusher shall be designed considering worst conditions
3.11.	Method of feeding Crusher	Coal feed is pre-screened before entry into crusher. Pre-screening done by Vibrating Grizzly Feeder to remove (-) 20 mm coal fraction from feed to crusher (i.e. Ring Granulator).However, the crusher shall be designed/ sized considering zero passage of coal through screen
3.12.	Anti Vibration GERB mounting arrangement	To be provided for each crusher
3.13.	Vibration Monitoring System	To be Provided one system per Crusher as detailed in the specifications above.
3.14.	Temperature Monitoring System	To be Provided one system per Crusher.
3.15.	Zero speed switch	To be Provided for each Crusher.
3.16.	Type of crusher cleaning	Water jet type
3.17.	Number of rows of hammers	4 rows placed at 90 deg
3.18.	Hammer profile	Toothed and plain alternately or only toothed
3.19.	Weight of each hammer	Not to exceed 40 Kg
3.20.	No. of suspension bars passing through each ring hammers	Max. of Two (2) number
3.21.	No. of holes in each segment of central and end discs for suspension bars (each row of hammers)	Max. Three (3) number

3.22.	Type of Plummer block	Split Type
3.23.	Type of bearing	Spherical Bearing
3.24.	Type of sealing	Labyrinth, dust tight arrangement
3.25.	Top covers of crushers	Hydraulically operated
3.26.	**Material Of Construction**	
[A]	**Rotor Assembly.**	
i)	Crusher Rings	MN Steel, (IS: 276), Gr-III or made of low alloy (silico manganese) steel in forged condition as per ASTM-A 322 grade 9260
ii)	Spacer Rings	45C8, IS: 1570 / Equal
iii)	Rotor Disc	45C8, IS: 1570 / Equal
iv)	End Discs	45C8, IS: 1570 / Equal
v)	Rotor shaft	Forged & heat treated alloy steel, ASTM-668, Class E, EN-19/C-45 (IS 2004)/ E8D, BS 970/ 1955.
vi)	Suspension bars	ASTM-A322, Grade AISI 4140/EN24, Bright bar
vii)	Rotor Balancing	
a)	Type of balancing reqd.	Both static and Dynamic
b)	Grade of balancing	Q-16 as per VDI-2060 1966 (However, for purpose of calculating the unbalanced force for the design of machine supporting structure, balance grade as given in the relevant section for foundation design shall be followed).
[B]	**Housing/ Cage Frame.**	
a)	Housing/ Frame	Heavy MS fabricated steel plates[IS: 2062 – Gr. B]
b)	Frame liners	Material composition shall be as that of breaker plate below, minimum 20 mm thick
c)	Breaker Plate	Heavy cast Mn -Cast steel (IS:276,Gr-III),minimum 40 mm thick
d)	Cage bars/ cage screens and side screen plates	Heavy Mn Cast steel (IS:270,Gr-III)
e)	Guaranteed life Crushing Rings	Bidder to indicate
f)	Tramp Iron door	IS: 2062,Gr.B.
3.27. **w**	Bearing	Heavy duty anti friction bearing
3.28.	Lubrication arrangement	Manual through grease gun or with recommended grade of oil in which case the plummer block shall be designed with oil filling, oil draining and visual oil.

3.29.	Product size adjustment	Manually operated worm screw jack for gap adjustment between cage & rotor.
3.30.	Power transmitting device from motor to crusher	Scoop Type Fluid Coupling electrically actuated. Coupling shall be fan cooled type only i.e. no water to be used for cooling.
3.31.	Crusher cage	Adjustable type to vary output size shall be provided.
3.32.	Maintenance door	Top to be opened / closed with hydraulic cylinders and Power Pack. Inspection cover shall be hinged type.
3.33.	Testing at Works	No load running test to be conducted.
M-19	**Vibrating Grizzly Feeder[**Vibrating Screening Feeder]	
1.0	**Design Requirement** The vibrating screening feeder shall be of mechanical type. The screening feeder shall be capable to segregate the (-) 20 mm size of coal along with coal dust, any muck & muddy coal (which is likely to be encountered during rainy season) etc. The segregated material shall be directly fed onto the corresponding belt conveyors / feeders through separate hoppers / chutes provided under each screening feeder. The width of vibrating screening feeder shall match to feed the material uniformly over the entire length of crusher rotor without any deflectors in the feeding chute. The screening area excluding solid deck area shall be minimum 0.75 m^2 per 100tonnes/hr of incoming feed. Inclination of the screening pan shall be so selected so as to ensuing proper flow ability of Coal on the deck without any hindrance. The equipment shall be designed in such a manner that choking does not occur during operation, particularly during rainy season when the coal gets sticky.	
1.1	**Construction Requirement** The deck of vibrating screening feeder shall have continuous solid deck section in the impact zone under direct coal fall and remaining deck shall be fitted with perforated deck assembly. The solid deck section shall be provided with replaceable TISCRAL or eqvt. Liner plate of adequate thickness. The perforated deck shall be wear resistant and shall be rigidly fixed with main frame along the length of grizzly deck. The vibrating screening feeders shall be mounted on the floor with the help of helical springs made of alloy steel. No rubber/synthetic material for the support shall be acceptable. Vibrator bearings shall be grease lubricated, double spherical roller type suitable for vibrating equipment. The bearings shall be sized for minimum 8,000 hours of operation. Suitable sealing arrangement shall be provided between the vibrating structure and chute work to avoid dust nuisance in the surrounding area. Proper arrangement to avoid dust ingress into lubricant of eccentric shafts shall be provided. Necessary arrangements shall be provided for maintaining / replacing the complete vibrator assembly.	

	Marker plate to indicate stroke length and stroke angle shall be mounted. In case of V- belt drive, suitable arrangement like taper bush or dobicon coupling shall be provided, to avoid loosening of sheave mounted on eccentric shaft. Dust hood shall be provided over the deck of screening feeder to avoid dust nuisance.	
2.0	**Data Sheet: Vibrating Grizzly Feeder**	
2.1.	Capacity each.	1100tph[rated]/1210tph[design]
2.2.	Type	Vibrating Grizzly Feeder of heavy duty design, Spring supported, Floor mounted.
2.3.	Qty,	Four(4) no
2.4.	Equipment Designation No.	3VGF-1A/ 1B/ 2A/ 2B
2.5.	Feed material/ size	ROM Coal
2.6.	Separation size	(-) 20 mm
2.7.	Physical characteristic of coal	Refer clause no.1.5, Design Criteria
2.8.	Inclination	Suitably selected to ensure proper flowability of Coal without any hindrance
2.9.	Pan Size a) Screen area b) Pan width	 Min. 0.75 sq m per 100TPH feed To match with crusher rotor length without deflector plates
2.10.	Bearings a) Type b) Lubrication c) Life	 Double spherical roller suitable for vibrating screens. Grease 8000 hours minimum
2.11.	Liners on solid deck -Type -Thickness	 Replaceable 16 mm minimum
2.12.	Material of construction	
i.	Solid deck.	ST – 42, IS:2062
ii.	Liner plates.	SAILHARD/ TISCRAL or superior wear resistant plate
iii.	Grizzly Screen Plates.	SAILHARD/ TISCRAL or superior wear resistant plate
iv.	Support Springs.	Spring Steel (Helical only)
M-20	**Vibrating Feeder**	
1.0	Vibrating feeder shall be installed below RCC hoppers of Reclaim Hopper Complex#RHC-1/2/3. These feeders shall be used for drawing coal at uniform rate and discharging the same onto reclaim conveyor installed below.	

1.1	All vibrating feeders shall be of electro – mechanical (brute force) type. Each feeder is driven by two unbalanced vibrators fixed to the feeder trough in a specific angle to the feeding level. Feeders vibrate freely on a support, which is isolated against vibration transmission to base framing.	
2.0	**Data Sheet: Vibrating Feeder**	
a)	Type	Electro-mechanical. Floor mounted provided with frequency control unit for variation of capacity
b)	Location	Below Emergency Reclaim Hopper Complex
c)	Equipment Designation No./Qty	3VF-1A/1B,Qty:2 no
d)	Capacity	Capacity Range: 150 to 300 tph
e)	Material handled	Crushed coal
f)	Lump size	(-)20 mm
g)	Moisture content	Up to 15%[normal] &,up to 20% during rainy season
h)	Bulk density of material	• 0.8 t/m³[for volumetric calculation] • 1.2 t/m³[structural design purpose]
i)	Trough	12 mm thk M.S Lined with 8 thk SS-409M steel plate liner
j)	Trough inclination to horizontal	Adjustable,8-10degree down slope
k)	Amplitude	3mm to 8mm
l)	No. of vibrations per minute	950 (approx)
m)	Type of drive	Unbalanced motor
M-21	**Bidirectional Stacker cum Reclaimer# 3SR-1A**	
1.0	All components of the machine shall be designed & built to operate outdoor continuously at peak loads and under climate & ambient conditions outlined in relevant sections. Stability of machine shall be guaranteed for all operating and non-operating loads. Each machine shall be stable and free on rails under all possible operating conditions. Equipment shall conform to ISO: 5049/1 (Latest)	
1.1.	Stacker cum Reclaimer (M/C) shall be rail mounted travelling, slewing and luffing machines. They shall be bidirectional. The equipment (M/C) shall comprise of a main portal gantry supporting a slewing superstructure with a luffing conveyor boom and bucket wheel etc. Each machine shall be equipped with a self-leveling operator's cabin housing the control console for the machine. Stacker cum Reclaimer M/C SR-1A will operate on bidirectional yard belt# YBC-1A respectively. Anti collision device shall be provided on each M/C considering all possible operating condition including M/C travelling on adjacent track.	
1.2.	Dry Fog (Dual Fluid - air & water) Dust Suppression System shall be mounted on machine covering various transfer points for Stacker cum Reclaimer M/C. All transfer points shall have dust tight enclosure & provided with dry fog type dust suppression application point which shall also include dry fog application at boom discharge (to stockpile).	

1.3.	**Design Criteria:-** The equipment shall be capable of performing all operations for wind pressures corresponding to 20 m/sec wind velocity. The equipment structure shall be stable, free on wheels during wind pressures corresponding to basic wind velocity of up to 50 m/sec. However, anchoring device and suitable storm clamp on the equipment are to be provided, as stand-by for holding the equipment during storm condition and wind velocity up to of 50 m/sec. Further, for parking of boom suitable anchoring device shall be provided for the machine.
1.4.	**Portal/ Gantry/ Super Structure**
a)	The Portal/ Gantry/ Super Structure shall be adequately designed to withstand the load of boom conveyor with drive/ its gallery, bucket wheel assembly, slewing drive unit, hoisting unit, conveyor head section, counter weight etc. The structure (machine) shall be designed as statically determinate three (3) point's supports system with four (4) corners. The structure shall be designed to ensure its static and dynamic stability and shall be fabricated from tested quality structural steel (IS: 2062). It shall be of box type or lattice construction comprising of platform at different elevations, stairways, ladders, walkways etc and complete with carriage and truck frames etc.
b)	The boom supporting the conveyor may be designed as a built up girder or as an open truss and shall include walkways on both sides of the boom conveyor. Boom conveyor return belt and idlers shall be located so that these are accessible for inspection/ maintenance & replacement from the walkway. A belt weigher shall be provided on the boom conveyor.
1.5.	**Long Travel Drives**
a)	Drives shall be electric motor driven mechanical type with gear reducers shaft mounted on the driven wheels. Torque reaction shall be via flexible mounting on bogie. Brakes shall be separate assemblies mounted on motor or reducer high-speed shaft.
b)	At least half the wheels shall be driven.
c)	Drive speed shall be infinitely variable in both travel directions.
d)	The truck assembly shall be fully equalized to ensure all wheels share the load equally.
e)	Hydraulic buffers shall be provided at each corner of the carriage. End buffers shall have sufficient capacity to stop the equipment travelling at higher rated speed.
f)	Rail sweeps shall be provided at the outer end of each bogie to clear the rails of any obstruction. The rail sweeps shall be vertically adjustable.
g)	Provisions shall be made at each corner of the under carriage for jacking to permit the removal of travelling wheels/ bogies. The jacks required for replacement shall be the part of supply.
h)	Travel wheels shall be double flanged having minimum tread width 40 mm more than the rail head. Wheel spacing shall not be less than 800 mm. The top of rail level shall be maintained at 0.7 m above ground level i.e., coal pile base level unless otherwise stated. Suitable number of rail scrappers shall be provided.

	Wheels shall be of forged/cast steel. The tread shall be hardened to in excess of 300 BHN and tested ultrasonically.
i)	All wheels shall be mounted on shaft with self-aligning bearings.
j)	**Rail Track Tolerances**: Following tolerance/better for the long travel track shall be provided. • Max. Permissible variation in rail level, vertical [one rail to another] = ±15mm • Max. Permissible track variation (Rail Centers) = ±10mm • Rail gradient = 1:500
1.6.	**Slewing Drives/ Assembly**
a)	The turn table shall be adequately designed to support the boom conveyor and its drive machinery, boom hoisting machinery, operator's cabin and counterweight etc.
b)	Minimum life of slew bearing shall be 50000 hrs.
c)	Safety devices shall be provided to prevent excessively large lateral forces such as might arise when slewing against stockpile slopes or any fixed structure or surface.
d)	Slewing drive shall comprise two independent, separate drive units, driving pinions meshing with a ring gear, slewing motion shall be infinitely variable in both directions between 0-100% nominal speed. This shall be accomplished with hydraulic motors. Acceleration/ deceleration of slewing drive operation shall be field adjustable. Radial piston-eccentric shaft type motor with planetary gearbox shall be provided.
e)	Hydraulic drives shall include automatic compensation for loads arising out of worst possible pile cutting loads by the reclaiming bucket wheel.
f)	Torque limiting devices shall be incorporated in all drives. These shall be achieved by hydraulic overload circuits. Remote indication of drive overload shall be included.
g)	The ring gear shall be an integrated part of the slewing bearing on the portal (or lower ring beam).
h)	The gear ring and pinions shall be fully enclosed to prevent the ingress of dust, moisture and other contaminants.
1.7.	**Luffing assembly/ Boom Hoist**
a)	The Luffing controls include all sensors which shall automatically reverse the luffing motion for a pre-determined time upon sensing contact of the bucket wheel, boom or counterweight with the stockpile or any other obstruction.
b)	The luffing control shall be capable of following both the longitudinal and transverse slope of the stockpile base during automatic and semi-automatic operation.
c)	Luffing of boom conveyor shall be effected by hydraulic arrangement. Hydraulic boom hoist shall be located between slew platform and bucket wheel boom on bucket wheel side. An access with automatically levelling steps from slew platform to the boom shall be provided.

d)	In Hydraulic arrangement, minimum two double action hydraulic jacks shall be provided one on right and one on left hand side of the pylon. In the event of failure of one of the cylinders, the other cylinder shall be able to hold the boom in position. The luffing movements shall be controlled by solenoid valves. The hydraulic system shall be complete with pump & its drive & tank, oil filter, all necessary valves, oil cooler, pressure switches & fittings. A level switch shall be installed on the oil tank; this will indicate oil level & switches off the equipment when oil reaches to a minimum predetermined level. Brake valves shall be provided for retaining the speed once set and speed should not increase as a result of external forces on the cylinders.
e)	Hydraulic cylinders shall be equipped with non-return valves. Pressure switches shall be provided on all important points of hydraulic system, in case pressure increase a predetermined value, the machine shall be switched off. Distance between the pivot point & lifting cylinder shall be largest to avoid vibration. The hydraulic boom hoist shall be equipped with load measuring and monitoring devices.
1.8.	**Boom Belt**
	During the stacking operation, the boom belt operates in conjunction with tripper. Belt width 1400 mm Belt troughing 35 Deg. Belt speed To suit Capacity 1200 tph[rated]/ 1320 tph [design] Drive 1000 RPM Electric motor with Bevel Helical gearbox complete with couplings etc. Boom Belt Conveyors shall generally conform to Conveyors Specification as specified elsewhere.
1.9.	**Trailing Tripper**
a)	The trailing tripper shall permit transfer of material from the yard conveyor to the stacker boom conveyor in stacking mode. The trailing tripper shall be complete with all conveyor equipment such as idlers, pulleys, discharge chute and travel bogies etc.
b)	Tripper slope shall be such that there is no spillage/ rollback of material under all operating conditions. The tail side of the tripper shall be provided with guide rollers to protect unsupported belt length from swaying. Holding down pulley shall be provided suitably.
c)	Tripper head pulley shall be provided with one belt cleaner (Primary Type).
d)	The design of the trailing tripper shall incorporate walkways and platforms to facilitate ready access for inspection/ maintenance of idler & other components thereof.
e)	Electrical items such as MCC, transformer etc. shall be housed in an Electric House located on Tripper structure.

f)	The Electric House shall be provided with vent fan suitable for 18 air changes per hour. Cable reeling drum shall be located beside above Electric house suitably.
1.10.	**Bucket Wheel Assembly**
a)	Bucket wheel shall be of cell-less design and its buckets shall be designed with good emptying characteristics and with proper cutting clearance. Bucket Wheel Assembly shall be provided with hydraulic motor complete with speed monitor. Drive shall be reversible type so as to facilitate withdrawal of wheel in the event of excessive undercutting and burial of wheel in the stockpile. Wheel RPM shall be adjustable to suit. Hydraulic motor shall be radial piston cam ring design.
b)	Bucket wheel drive unit shall be selected to meet the required duty. The drive shall be shaft mounted onto the bucket wheel shaft and also supported by a single self-aligning torque reaction mounting designed to cater for all tensile and compressive loads. The drive arrangement shall be designed to provide proper alignment under all operating conditions.
c)	Bucket wheel drive shall be provided with a quick response, reliable ultimate torque limiting protection device. Buckets shall be sized for 125% of rated capacity. Rate of bucket discharges shall not exceed 55 per minute.
d)	Bucket wheel body shall be of welded steel construction (IS: 2062) properly stiffened for the required duty and configured to form a rigid support for the buckets. Bucket shall be fabricated from SAILMA 350-Hi or equal and Teeth & tips shall be made out of Manganese steel. (IS: 276, GR-I).
e)	Bucket wheel shall be connected to the drive shaft by alloy-steel shrink disc connection to withstand high torque during reclaiming operation. The drive shaft shall be a forging and shall be ultrasonically tested before machining to certify that it is free from flaws.
f)	Bucket shall be attached to the bucket wheel body by means of pins, or similar connections, to permit convenient removal and replacement.
g)	An automatic lubrication system shall be provided for all principal points on bucket wheel assembly.
h)	Access for inspection, maintenance and replacement of all components of the bucket wheel drive shall be provided.
1.11.	**Buffers/ End stops** Buffers shall be installed at both ends of each long travel track. The buffers shall be rubber/ spring operated and shall be designed in such a way as to ensure that the collision forces are distributed. Buffers installed on the equipment structure (M/C) shall be hydraulically dampened.
1.12.	**Ballast Weight** Ballast weight wherever provided shall be of ordinary cast iron or Concrete. Weight shall be suitably unitized in such weight, size & shape as to be convenient for handling, transport and field erection purpose.
1.13.	**Operator's Control Cabin**
a)	Control cabin shall be of modern & ergonomically designed unit with ample glassed area for optimum visibility of the working area.

b)	Cabin shall be located near the bucket wheel. Cabin shall be of closed type and shall be dust & water proof having adequate number of shatter proof & tinted glass doors and windows ensuring good all round visibility to the operator.
c)	Cabin shall remain horizontal always regardless of boom inclination. It shall have heat insulated walls and roof. Clear height within the cabin shall not be less than 2200 mm and the area enough to install Control Console, annunciation panel etc. & provided with ergonomically designed 360 deg. swivelling operator's seat. Cabin floor shall skid proof surface.
d)	Alarm units, indicators etc. shall be contained in an annunciator fitted at about eye level to enable the operator to simultaneously watch operation of the machine and the control indicators and alarm. In addition, the instruments which are particularly important for proper operation of the machine and have therefore to be continuously watched shall be located laterally in the cabin on an instrument pillar.
e)	Cabin shall be provided with adequate illumination for working in night, sun visors and window wipers with wash unit and a swivelling fan of adequate sweep, hydraulic door closer & an approved type of security lock.
f)	Noise and vibration level within the cabin shall be limited to such level as to ensure operator's comfort and safe and unhampered functioning of all sensitive instruments located within the cabin.
g)	Two (2) Co_2 type 4.5 kg fire extinguisher (IS: 2878) one located inside cabin and the other mounted on outside of cabin shall be provided.
h)	Equipment installed inside the operators cabin shall include, but not be limited to the following: • Light fitting with dimmers • Minimum 2 No. General Purpose Outlet (GPO) suitable for 240V x 5A x 1ph A.C. Supply. • Minimum 2 No. General Purpose Outlet (GPO) suitable for 240V x 15A x 1ph A.C. Supply. • Telephone – 1 No. • Fold down jump seat on the back wall to allow for an instructor • Battery operated mains charged Emergency Lighting. • Handset station for Public Address – 1 no. Equipment installed outside the cabin shall include: • Electrically amplified weatherproof loudhailer. • Emergency lighting head(s), powered by inside (cabin) located power unit.
1.14.	**Cable Reeling Drums**
a)	Separate motorized cable reeling drums for power and control cable shall be provided with arrangements for winding and rewinding of the cables. The trailing cables shall run in a cable tray. Further, the trailing cable arrangement shall be such that the cables run in between the track rails. The Contractor shall provide sufficient length of continuous unspliced cables ensuring that entire travel length is fully covered and include four (4) dead turns and extra length for required terminations and lift

b)	Trailing cable shall be connected to the payout point with suitable anchoring, turning devices and junction boxes. Payout point may be considered in the centre of long travel. Necessary pit or mounting arrangement shall be provided for above.
c)	Cable Reel shall be drum wound, electric stall torque motor (of reputed make) driven, designed for taking up and paying out the composite trailing cable at an adequate controlled tension regardless of the position of equipment or the Travelling speed of equipment. The reel shall be furnished with collector rings, stall torque, slip ring type motor having IP 65 degree of protection. The motor shall be suitable for 415V, 3 Ph, 50 Hz operation and shall be equipped with a brake.
1.15.	Stacker-cum-reclaimer shall be operated as elaborated elsewhere in the specification. Further, limit switches shall be provided to prevent traverse movement, slew and hoisting etc. beyond the respective safe extremities. Interlocking shall also be provided for S/R rail clamps and travel motors. Reversible Yard conveyor can be stopped from control panel of stacker / reclaimer. Provision also be given to trip the stacker/ reclaimer from CHP control room. Travel drive equipment and slew drive equipment shall be suitable for 150 starts/hr with continuous reversals. Speed control of long travel and slew drive motor (in case of electric drive) shall be through Variable Voltage Variable Frequency System (VVVF) with minimum 6 (six) pulse design. Necessary input & output devices to be provided to reduce harmonics, as per IEE 519. All necessary protections e.g. Input Phase Loss, Earth Fault, Over Voltage, Output Short Circuit, Load Loss, Input Transient Protection, Overload etc to be provided. VVVF system shall be capable of generating suitable starting torque with/without encoder. Squirrel cage Induction motor with VPI insulation shall be provided with VVVF system. Hydraulic control shall be provided for (a) Hoisting/luffing (b) Operator cabin level adjustment (c) Equalising arrangement for travel carriage (in case of hydraulic equalising) Axial piston pumps shall be provided for pressurising hydraulic control fluid. All drive equipments shall be selected based on 110% of actual power requirement at specified design capacity. Further for selection and specification of various individual equipments, relevant clauses of specification shall be referred to. In addition to the requirements elaborated above, the structural design of the stacker-reclaimer shall be supplemented by following standards :- ISO 5049/1 : Mobile Continuous Bulk Handling Equipment. FEM : Federation Europeanne De La Manutention Section-I - Rules for Design of Hoisting Appliances, The supplier shall furnish the detailed basis of design (BOD) used for design of the structural components of the stacker reclaimer. The BOO shall be comprehensive & shall account for the various technical requirements of the specification & should include all parameters, assumptions, structural codes adopted, loading conditions and design software used. The supplier shall also

	furnish the basis and computer printout of input and output data of calculations of foundation loads. Manufacture of the stacker reclaimer shall be taken up by the supplier, only after approval of the basis of design (BOD) by HPGCL. Should the slacker reclaimer under go any structural distress / failure during operation or in the anchored condition during the plant life of 30 years, apart from meeting the other contractual requirements specified elsewhere, the supplier shall have to furnish, to HPGCL, the complete structural design document / calculations, pertaining to the equipment.
1.16.	**Belt Weigher**
a)	A belt scale shall be mounted on the boom conveyor having following minimum specifications: • Belt width: 1400mm • Belt Speed: To suit • Troughing angle: 35°
b)	Belt Scale shall cater for all including peak handling rates (tph).
c)	Belt Scale shall be electronic and micro-processor based suitable for outdoor installation and designed for continuous duty under all operating conditions. The guaranteed accuracy shall be ±1% over full weighing range (20% and 130%).
d)	The Belt Scale shall have a local control panel/cabinet complete with flow rate indicator, totaliser, and automatic calibration system. The rate indicator shall be outdoor type or shall be provided with proper enclosure with transparent cover for viewing. The test load shall be supplied with the Belt Scale for calibration.
e)	The Belt Scale's local control panel shall have interfacing with operator's control room PLC for sequence interlocking, indication of status, fault indications and flow rate & totaliser values etc.
1.17.	**Electric House cum Machinery Room**
a)	An all steel construction and weather proof enclosed space shall be provided on the equipment to house the HT Load break switch panel, motor control centre, programmable logic controller, thrustor panels, lighting distribution board, etc.
b)	The structure shall be lined with anti-condensation and fireproof material.
c)	It shall be provided with propeller type Vent fan. Dust tight seals shall be provided for all doors, windows and electric cable entry points.
d)	The room shall be of adequate size to ensure good access to all equipment for maintenance or disassembly.
e)	Rubber insulating carpet in front of Electrical Panels shall be provided. All cable entries to electrical room shall be sealed with fire resistant compound.
f)	Smoke and fire detection system shall be provided including alarm in operator's cabin.
g)	A maintenance electric hoist (Minimum 5t capacity) for lifting components from ground level shall be provided. The hoist shall have sufficient capacity to lift the heaviest single piece of equipment in the machinery house. All equipment shall

	be accessible by the hoist. Hoisting speed in fully loaded condition shall not be less than 4 m/min.
h)	Door shall be provided with heavy-duty latches, hinges, door stop and pad lock.
i)	The following accessories shall be provided in the room at convenient locations:: • Fire extinguishers CO_2, 4.5kg (IS: 2878): 2 Nos. • Telephone - 1 No. • Handset station for PA system - 1 no. • Battery operated emergency light - 1 Nos. • One (1) Socket Outlet, 240V x 15A x 1 Ph A.C. supply. • One (1) Socket Outlet, 415V x 100A x 3 Ph A.C. supply.
1.18.	**Water Dust Suppression and Wash down System**
a)	A common piping system for water for dust suppression and wash down facility with water hose (at suitable location) shall be provided on machine.
b)	For dust suppression, dry fog nozzles shall be provided at all loading/ unloading and material transfer points.
c)	Suitable motorized hose reel drum mounted on machine shall be provided. Water supply will come from a supply pipeline along machine long travel path. This pipeline will be equipped with several quick connect tap points and will be fed with water from nearby pump house.
d)	Locations of Dust Suppression Nozzles (Dry Fog Type) shall be provided but not be limited to the following: • Tripper's discharge point • Boom conveyor receipt point • Boom conveyor's discharge point to stockpile • Boom conveyor receipt point (Bucket wheel side) • Boom conveyor discharge point & yard conveyor receipt point
1.19.	**Safety Requirements**
a)	**Against Drifting:** Minimum Two (2) Manual Rail clamps & minimum four (4) automatic rail clamps of adequate clamping force shall be fitted to prevent the machine from drifting in non-operating/ stormy condition. The automatic rail clamps shall be interlocked with long travel drive. For safety of the equipment, indicating lamps shall be provided to know whether the equipment is locked or not and the machine should not start unless the clamps are released. Operation of automatic rail clamp shall be controlled by anemometer provided on the machine.
b)	**Over-Travelling Switches and End Buffers:** Set of over travelling limit switches and end buffers at both ends of travel zone shall be provided to prevent possibility of overrunning of the machine. End buffers on long travel bogies and buffers at rail stop shall be provided for arresting the motion in case of failure of the safety system.
c)	**Limit Switch for Hoisting/ Luffing** shall be provided to restrict the luffing range from maximum inclination to maximum declination.

d)	**Probe Switch:** Probe sensors shall be provided at the boom part of the boom head end to prevent the boom touching and consequential burial of head end into stockpile material, by providing signal to luff - up the boom as the pile height increases with more discharge of material into the pile.	
e)	**Safety Switches**: Belt sway switches, pull cord switches and zero speed switch on boom belt conveyor & yard belt shall be provided.	
f)	**Anchorage:** Boom or entire machine shall be anchored with ground preferably at parking zone. Provision shall be kept to lock the slewing part of the machine with fixed part while the machine is not operating so that there is absolutely no movement of boom in any direction.	
g)	**Anemometer** shall be installed on top most part of the machine to give the signal/ indication of non-operating condition of the machine and stop all operations of the machine in case of high wind velocity.	
h)	3-D stockpile volume/ Qty measurement device shall be provided on the Machine suitably.	
2.0	**Data sheet: Bidirectional Stacker cum Reclaimer**	
2.1.	Material Handled	(-) 20mm Crushed & Compacted Coal
2.2.	Equipment designation/ Qty.	M/C # 3SR-1A (1no.), Bidirectional Type
2.3.	Stacking Capacity (Guaranteed)	1200 tph[rated]/1320tph[design]
2.4.	Reclaiming Capacity (Peak)	1200 tph[rated]/1320tph[design]
2.5.	Guaranteed Avg. reclaim capacity over four(4) hr. block cutting operation	1000 tph[rated]/1100tph[design]
2.6.	Long Travel Speed	0 - 40m/min infinitely variable in one direction (A.C sq. cage VVFC). Peak speed shall be used for travelling one end of the stockpile to other. While stacking the speed shall be limited to 0 - 20 m/min.
2.7.	No. x Yard Rail Size and Rail Centres	2 x CR-100 (Minimum) and 9.2 m centres.
2.8.	Boom Length (distance between centre line of slew to centre line of bucket wheel)	45m
2.9.	Slewing Speed	0-0.2 rpm (Hydraulic)
2.10.	Slewing Range	± 110° from centreline of yard conveyor
2.11.	Luffing Range (approx.)	+11° above & -11° below horizontal
2.12.	Luffing Speed	3m/min @centre line of Bucket Wheel

2.13.	Boom Conveyor width & Speed	1400mm x 35° Tr. & speed to suit. Deck Plate at loading point only.
2.14.	Yard Conveyor width & Speed	1400mm x 35° Tr. x 2.5m/s (approx.)
2.15.	Long Travel (min.)	To suit, Stockpile Length
2.16.	Wheel Dia. (min.)	630 mm (Tread dia.)
2.17.	Max. Wheel Load permissible with impact	275 kN
2.18.	Operating wind velocity	20 m/sec
2.19.	Non-Operating wind velocity	50 m/sec
2.20.	Stability Factor (min.)	1.3 [for operating condition with max. operating wind velocity] 1.2 [for non-operating condition with max. non-operating wind velocity]
2.21.	Max. Stockpile Height / Width at base	12 m Height x 50m width at base
M-22	**Bunker Level Indicators**	
	Refer Specification of C&I Works	
M-23	**Plain Water Type Dust Suppression System For Crushed Coal Stockpiles**	
1.1	Plain Water Dust Suppression System (designated as PWDS-1) shall be provided for Crushed Coal Stockpiles **# 3CCS-1/2.**	
1.2	Equipment for DS System # PWDS- 1 shall be located in pump house # PMH-3A only. Location of Pump House strictly subject to approval of HPGCL / Consultant.	
1.3	Automatic swivelling type sprinklers shall be provided at suitable spacing along the periphery of each Crushed coal stockpiles. Water distribution all along the Crushed Coal Stockpile shall be sectionalised to enable spraying over selected areas of coal stockpile. Sprinklers are provided along the length of both sides of each stockpile at a maximum spacing of 40 m.	
1.4	**Plain Water Type Dust Suppression System** shall be complete with its one (1) no. water supply tank (RCC) with pumps with drive motor, duplex strainer, pipe work with valves & fittings, sprinklers, solenoid valves etc. RCC water tank complete with inlet, outlet, overflow, drain & necessary instrument/ switches/ valve/ level indicator/ necessary electrical etc. shall be provided located suitably at the Pump House# PMH-3A. Monorail & chain pulley block of suitable capacity shall be provided in Pump House. PWDS system shall be complete in all respects including necessary Electrical / Civil & Structural works.	
1.5	All piping work with necessary fittings, valves and supports etc. shall be of M.S. (ERW) medium conforming to IS: 1239, Part I & II & other applicable Indian Standard.	
1.6	Each Sprinkler is connected to main header pipeline through Globe Valve & Solenoid Valve (Globe Valve for controlling flow & Solenoid Valve for starting/ stopping of flow). The spraying will be started / stopped through Solenoid Valve	

	manually as per requirement to spray water in selected area. One (1) no Globe Valve will be provided at inlet of each sprinkler to By-Pass the Solenoid Valve. Stockpile will be wetted by operating one (1) no. sprinkler on each side of any one stockpile [Two (2) nos. sprinklers will be operating at a time for any one of stockpile]. A pair of sprinklers will be started/ stopped manually as per requirement from control panel.	
1.7	The water level inside the tank will be controlled by a Float Valve provided inside the tank.	
1.8	The tank is also provided with a low level switch, which is interlocked with pump drive motor such that the pump will not run when low level switch indicates low level of water in water tank. Thus it is ensured that pump will always run under flooded water condition (and not without water) pump suction is connected to water tank. A control panel will control the operation of pump.	
1.9	By pass line with a pressure relief valve is connected from pump discharge to water tank. The Pressure relief valve is set for a higher pump head so that it will open beyond a set pressure to bypass the water. Thus during short period, when any of spray point is not operative, there would not be the flow of water & pressure will build up in the line, which will be relieved through a bypass line.	
1.10	Water will be supplied through two (2) no. Centrifugal Pumps (1W+1S) up to sprinklers.	
1.11	Two (2) no. sprinklers shall operate at a time for one stockpile. When both M/C # SR-1A/1B operate four (4) no. Sprinklers shall operate simultaneously.	
2.0	**Data Sheet: Plain Water Type Dust Suppression System**	
i.	Type of dust suppression system	Plain water Spray on stockpile. Designation #PWDS-1
ii.	Location of Pump House # PMH-3A	Refer Layout Plan
iii.	Location of PWDS storage tank	Tank # 3WTK- 3A : Pump House # 3PMH- 3A
iv.	Capacity of each Water Tank	Minimum 60 Cum or ½ hr operation of M/C # SR-1A
v.	Construction:	Circular, RCC construction
2.1	**Centrifugal Water Pump**	
i.	Qty / Tag no	2 Nos. (1W + 1S) / P-3A/3B
ii.	Duty	Continuous Duty of 24 hr/day.
iii.	Pump RPM	1500 (Max.)
iv.	Filter	Duplex filter with stainless steel filter element. Capable to remove suspended particles exceeding 100 microns.
2.2	**Sprinkler**	
i.	Type	180° automatic swivelling type.
ii.	Throw	40 m (maximum)
iii.	Mounting arrangement	Mounted on post complete with pedestal, provided along the periphery of each stock pile.

iv.	Pressure	Min. 4.5 kgf / cm²
v.	Discharge Capacity	Minimum 250 lpm to Maximum 350lpm
vi.	Qty/Coverage	Complete Surface of each stockpile shall be covered by the plain water spray from sprinkler system.
vii.	**Material of Construction**	
	• Body & Flag	Brass
	• Spring	Bronze / Better
	• Base	Forged SS-304/ Better
	• Washer	Teflon
	• Nozzle tip	SS-316
2.3	Necessary field Instrumentation	To be provided as per requirement.
M-24	**Prespray System Plain Water type for waiting wagon [Tippler Complex]**	
1.1	Prespray System having common water tank & common water supply pumps shall be provided. Flow rate & head of each pump shall be based on minimum eight (8) no. waiting wagons being wetted simultaneously.	
1.2	System [designated as 3PSS-1] shall be used for wagon tippler # 3WT-1A/3WT-1B	
1.3	The system shall employ high pressure sprays of small quantity of water at the top of wagons waiting at inhaul side just before the tippler table.	
1.4	The quantity of water to be sprayed on each wagon shall be calculated based on minimum 2.0 lit of water/ tonne of coal contained in each wagon at the application point.	
1.5	The spray will be started by manually operated push button and it will stop automatically after a preset time interval.	
1.6	The system comprises of • Header bar with spray nozzles and galvanized piping for eight (8) no. waiting wagons with flexible connections wherever necessary. • Necessary supporting structure for spray headers with cat ladder ,walkway, handrail etc • Two (2) no water pumps having Tag # 3P-1A/1B [1W+1S], duplex filter (to separate particles >100 microns), Solenoid valves, pressure gauge, globe/gate valves, etc shall be provided to suit. • Water tank # WTK-1A of minimum 10 cum capacity [Approved make].	
1.7	Pumps # 3P-1A/1B and water tank# 3WTK-1A shall be located at pump house #3PMH-1A near Tippler Complex # 3WTC-1. Capacity of each spray nozzle: About 5 lpm at 2.5 kgf/ sq.cm. pressure	
1.8	Spray application point for each wagon will consist of Spray Header with a set of Shower Type Spray Nozzles. Globe Valve & Solenoid Valve are provided at each	

	spray header for regulation of flow. The spraying will be started/ stopped through Solenoid Valve as per requirements.
1.9	Spraying will be carried out on eight (8) no. waiting wagons at a time or on required wagon by Energizing Solenoid Valve of a particular wagon to be sprayed as per the requirement.
1.10	The water level inside the tank will be controlled by a Float Valve provided inside the tank. The tank is also provided with a low level switch, which is interlocked with pump drive motor such that the pump will not run when low level switch indicates low level of water in water tank. Thus, it is ensured that pump will always run under flooded water condition (and not without water). Pump suction is connected to water tank. A control panel will control the operation of pump.
1.11	Bypass line with a pressure relief valve is connected from pump discharge to water tank. The pressure relief valve is set for a higher pump head so that it will open beyond a set pressure to bypass the water. Thus, during short period, when any of spray point is not operative, there would not be the flow of water & pressure will build up in the line which will be relieved through a bypass line.
1.12	Water Tank # 3WTK-1A & pumps # 3P-1A/1B shall be located in Pump House # PMH-1A. Location of Pump House strictly subject to approval of HPGCL / Consultant.
M-25	**Dust Suppression System for Wagon Tippler Hopper Top only**
1.1	One Plain Water Spray Type Dust Suppression System shall be provided for wagon tippler hopper top in Wagon Tippler Complex # 3WTC-1. The system shall be complete in all respects. System shall be designed to control dust nuisance during wagon tipping operation without formation of muck & considering both tipplers operating simultaneously.
1.2	The System would employ high-pressure sprays of small quantity of Plain water applied at the points of dust generation. Nozzle shall have SS-316 tips.
1.3	Spray nozzles would be fitted at the following points from three Header Bars. -Header Bar 'A' would be mounted along the length of the top stop grider. -Header bars 'B' & 'C' would be mounted along the width of the each tippler hopper. The Header Bar 'A' would treat the material as soon as the tipping operation starts and during the actual tipping operation itself. These would be controlled by timers and would be operative only when the material is passing. The Header Bars 'B' & 'C' would also be timer controlled and would come into operation as the material settles in the hopper
1.4	The complete spraying sequence will be started either by a manually operated push button or automatic switch trip from the tippler itself.
1.5	Tippler complex Dust Suppression System shall have suitable sequential start/stop etc. to match with the tippler requirement.
1.6	All piping work with necessary fittings, valves and supports etc. shall be of M.S. (ERW) medium conforming to IS: 1239, Part I & II & other applicable Indian Standard.
1.7	Water will be supplied through two (2) no. independent Centrifugal Pumps (1W+1S) [Tag No.3P-2A/2B] up to nozzles. One water tank (Tag # 3WTK-2A) shall be provided located in pump house # PMH-1A.

1.8	**Data Sheet: Dust Suppression System for Wagon Tippler Hopper Top**	
a)	Type of D.S. System for hopper / Designation	Plain Water Type, Designation as 3DSPW-1 to cater to both Tippler # 3WT-1A/1B
b)	Application	To control dust nuisance during tipping operation of Wagon by tippler
c)	Location of Pumps & Water Tank	In Pump House # 3PMH-1A
d)	Air cleanliness	a)Respirable Dust level shall be restricted to 2mg / Nm^3 over and above ambient dust level in closed area b) Respirable Dust level shall be restricted to 5mg / Nm^3 over and above ambient dust level in open area
e)	Water Tank # WTK-2A	Circular water tank in RCC construction (Capacity = 30 cum water holding capacity) or ½ hr operation of system considering both tippler operating simultaneously.
f)	**Nozzle**	
i	Type	Full cone / Cluster type or better
ii	Capacity of each nozzle	3-5 lpm at ~4.5 Kg/cm^2 to make suitable fogging. However muck formation shall be avoided at all cost
iii	Nozzles spacing	To suit
iv	Necessary Electrical / Control & Instrumentation Work	To be provided complete in all respects
M-26	**Dry Fog Type Dust Suppression System**	
1.0	Dual fluid type [water & compressed air] Dry Fog Dust Suppression System (DFDSS) shall be provided for all transfer points of CHP. Each DFDSS system shall be complete in all respects.	
1.1	Air from the air receiver & water from the water pump under requisite flow and pressure will be taken to the Flow Activation Cum Regulating Station (FARS) located near different application points. The "ON & OFF" control of the system can be done through FARS in both "Manual and Auto" mode of operation by the selector switch. Regulated compressed air & water from the FARS will enter spray bar and fogging nozzles mounted on the enclosures at the transfer points to create the desirable dry fog. Nozzles shall be provided with SS-316 tips.	
1.2	Each DFDSS system shall include following items & shall be complete in all respect.	
a)	Independent Air compressor with accessories, independent centrifugal water pumps with duplex water filter and Monorail & chain pulley block, water tank complete with inlet, outlet, overflow, drain & necessary instrument/ switches/ valve/ necessary electrical etc. shall be provided located suitably in the respective pump house # PMH-1A/2/3B/4	

b)	Spray header assembly, dual fluid air atomized dry fog nozzles, pipes & fittings, hosepipe, bracket & clamps, Flow Activation Cum Regulating Station (FARS) etc. located suitably near the fugitive dust generating point.	
c)	All piping work for water & compressed air complete with necessary fittings, valves and supports etc. All pipes & fittings shall be of M.S. (ERW) medium conforming to IS: 1239, Part I & II respectively.	
2.0	**Data Sheet: Dry Fog Type Dust Suppression System**	
2.1	Type of dust suppression system	Dry Fog
2.2	Location	At all transfer points of CHP / As per flow Diagram
2.3	System Designation no.	i) DFDSS # 1 shall cover discharge & receipt points of underground equipment / conveyors in Tippler complex # WTC-1, discharge & receipts of equipment / conveyors in bldg# 3JT-1. [Pump House # 3PMH-1A] ii) DFDSS #2 shall cover discharge & receipts of equipment / conveyors in bldg# 3CRH-1/ JT-2/JT-3/JT-4 [Pump House # PMH-2] iii) DFDSS #3 shall cover discharge & receipts of underground equipment/conveyors in 3RC-1/RHC [Pump House # 3PMH-3B] iv) DFDSS #4 shall cover discharge & receipts of equipment / conveyors in JT-8/9 & discharge points of Tripper Conveyors. [Pump House # PMH-4]
2.4	Location of Pump House	Refer Layout Plan
2.5	Guaranteed Dust Level (Air Cleanliness)	The respirable dust level of 50 microns should be restricted to within 3m radius of application point: (a) 2mg/Nm³ over and above ambient dust level (in closed area) & (b) 5mg/Nm³ over and above ambient dust level (in open area)
2.6	**Centrifugal Water Pump**	
i.	Qty	2 Nos. (1W+1S) for each Dry Fog D S System
ii.	Duty	Continuous Duty of 24 hr/day.
iii.	Pump RPM	1500 (Max.)
iv.	Filter	Duplex filter with stainless steel filter element. Capable to remove suspended particles exceeding 100microns. Common to 2Nos. (1W+1S) pumps for each Dry Fog DS System.
2.7	**Air Compressor**	
i.	Type	Rotary Screw type, air-cooled directly coupled to electric motor.
ii.	Qty.	Two (2) nos. (1W+1S). for each Dry Fog DS System

iii.	Oil Content	Oil Content in air shall be less than 5ppm.
iv.	Acoustic Enclosure	Shall conform to relevant Standard & code of Practice.
v.	Code for Air Receiver	IS: 7938.
2.8	Dual Fluid Air atomized Dry fog Nozzles and Spray Bar Assembly	The dual fluid air-water fogging nozzle [nozzle tips shall be SS-316] assembly shall be complete with suitable end connection, mounting brackets, pipe & flexible hose as per requirement.
2.9	Flow Activation Cum Regulating Station (FARS)	FARS shall consist of a set of Ball Valves, Pressure Gauge, Solenoid Valves and Pressure Regulators in both air and water line, pressure switch in airline etc. fitted within a corrosion proof powder coated metallic enclosure.
2.10	Air and Water line filter	Air Filter to be provided in the airline & 'Y' strainers to be provided in water line prior to the FARS.
2.11	Necessary field Instrumentation	To be provided as per requirement.
2.12	Air receiver	One no. main of min. 2 cum capacity
2.13	Nozzles	Dry fog type
2.14	Schedule of Water Tanks for dry fog DS system	

S. No.	DFDSS system no.	Tank tag no.	Min. Water Holding capacity,	Pump House No.	Pump tag no.	Construction
a)	3DFDSS-1	3WTK-1C	7500 litre or 1hr operation of the system whichever is higher	3PMH-1A	3P-1E/1F	PVC water tank of approved Make, mounted on RCC pedestal, insulated water Tank, white. Tank shall be complete with all the fittings etc.
b)	3DFDSS-2	3WTK-2	7500 litre or 1hr operation of the system whichever is higher	3PMH-2	3P-2C/2D	
c)	3DFDSS-3	3WTK-3B	7500 litre or 1hr operation of the system whichever is higher	3PMH-3B	3P-3C/3D	
d)	3DFDSS-4	3WTK-4	7500 litre or 1hr operation of the system whichever is higher	3PMH-4	3P-4A/4B	

M-27	**Dust Extraction System including Bin Vent Filters for Coal Bunker**
1.1	Dry type Dust Extraction (DE) System shall be provided for Crusher House # CRH-1 & Coal Bunker. The capacity of D.E System shall be worked out conforming to the requirement of American Conference of Governmental Hygienists (Industrial Ventilation-A manual of Recommended Practice). All material / items required for system completion are to be supplied and installed by the vendor.

1.2	Dust Extraction System for Crusher House
1.2.1	Dust Extraction System shall comprise of Bag Filter Unit, Centrifugal Fan Unit, Dust Extraction hood, duct work with supports necessary dampers, rotary air lock feeder, screw conveyor Air compressor with accessories and control components and panels. Protection against fire / explosion shall be provided. Necessary interlocks hardware and controls shall be provided to suit.
1.2.2	**Bag Filter Unit:**
a)	Pulse Jet Type bag Filter Unit having an efficiency of 99.9% down to 5 microns shall be provided. It shall be complete with supports, maintenance walkway, platform with hand railing and cage ladder etc for access to bags & solenoid valve etc. Sheet metal rain protection hood / canopy shall be provided above bag filter unit, and also for drive unit components / motors of fan / screw conveyor / airlock feeder etc.
b)	The bags shall be made out of Membrane fabric having fireproof and antistatic properties to suit the application and having long working life. The air to cloth ratio of bag filter shall not exceed 100 m3/hr/m2. The fabric weight shall be minimum 550 gm per sq.m.
c)	The casing of the Bag Filter unit shall be made out of 5 mm thk M.S. and dust-collecting hopper shall be made out of 5mm thk SS-409M.Through rotary feeder /screw conveyor system dust collected in the hopper shall be fed back to the corresponding working conveyor.
d)	Bag cleaning system shall comprise of header for compressed air supply and distribution piping and electric operated diaphragm type solenoid valve with timer. Each row of bag shall be served by a solenoid valve and each bag shall have well designed venturi. Filter bag shall be secured to the housing by suitable clamps. The bags shall preferably be grouped in separate compartment to facilitate bag cleaning. The collector shall have air tight access door into each bag compartment and each hopper
e)	Motor of rotary airlock feeder and screw conveyor shall be suitably interlocked with fan motor. Manometer to measure pressure drop across the unit and D P switch for alarm annunciation /cleaning mode operation shall be provided. Necessary gauge and pressure switch shall be provided in the compressed air pipe.
f)	Non-lubricating type air compressor of Elgi / Ingersoll Rand / Atlas Copco / Chicago Pneumatic / Kirloskar Pneumatic shall be provided. To ensure clean & dry air, all accessories viz. suitable filter unit, moisture eliminator etc shall be provided for air receiver / compressed air piping. GI piping shall be used for compressed air.
1.2.3	**Fan Unit**
a)	Adequately sized centrifugal fan with backward curved blade shall be provided for air movement. Fan shall be sized equal to 1.15 times the total dust collection system airflow rate. Fan casing shall be 5 mm thk M.S.
b)	Each Centrifugal fan unit shall be complete with electric drive motor, impeller, casing, supporting structure, pair of slide rails for motor and common base frame with foundation bolts, drive pulley, v-belts, belt guard, vibration isolators, dampers and flexible connection with matching flanges, sheet metal canopy over motor, butterfly damper at fan inlet, fan discharge side ducting with exhaust

	cowl and bird screen. The exhaust air after filtration through Bag filter shall be discharged at a height of 3 m above roof level of adjacent Building / Structure.
c)	Fan Drive -V-belts shall be sized considering minimum service factor of 1.5. There shall be minimum two belts per drive. -Drive Motor HP Rating (minimum) = 1.2 x (BHP of driven equipment + drive loss)
d)	Exhaust duct shall be made out of min. 3.15mm thk MS plate and shall be provided with clean out door at bottom. This duct shall be supported by steel members along wall of Crusher House.
e)	Material of Construction i) Impeller: Fe410W (IS:2062) ii) Fan Shaft: 45C8, IS:1570/equal iii) Fan Scrawl: Fe 410W (IS:2062) iv) Supports frame & structure: Fe 410W (IS:2062) v) Flexible connection for fan inlet & outlet: Rubber impregnated canvass with MS flange & cleats vi) V-pulleys: CI multi grooved (IS:210) vii) V-belts: Reinforced Rubber viii) Slide Rails: CI or MS ix) Bolts & Nuts: IS:1367 x) Vibration Isolation pads: Synthetic Rubber (hardness 40 deg. on shore A)
1.2.4	**Dust Collecting Hood / Dampers / Ducting**
a)	Centerline of the hood shall be located at the point of generation of maximum pressure. Each hood shall be adequately sized to collect all dusty air generated at dust generating point. Velocity in the hood shall be limited to about 1.8 m/sec. The hood shall be made of 3.15 mm thk M.S plate complete with rubber apron and manual damper.
b)	Manual Dampers fusible link type in the individual suction hood as per requirement shall be provided.
c)	Velocity of air in ducting shall be about 18 to 21 m/sec to transport the suspended dust. Ducting & bends of circular cross section shall be made out of minimum 3.15 mm thk M.S. Plate
d)	Ducting shall be supported at max. intervals of 2.5m (for duct dia. of 200mm & less) and at 3 m interval for duct dia. above 200mm. Radius of bend shall not be less than 1.5 times the dia of ducting.
e)	Minimum 5thk MS flange complete with gasket shall be provided for duct size of 500mm dia. and below. For duct dia. above 500mm, 6mm thk. (minimum) MS flange complete with gasket shall be provided. Type / thickness / material of gasket shall ensure air tightness at flange joints.
f)	The duct work shall be properly reinforced to prevent sagging, buckling and vibrations. Duct support wherever required shall be provided.
g)	Duct running on floor / roof shall be adequately fixed in position by MS angles / channels. Vertical duct passing through floor slab shall be supported by means

	of collars (MS fabricated) / brackets securely fastened about girth of duct and resting on floor slab. Suitable bitumastic filler compound shall be filled into the gap between outer surface of ductwork and egde of RCC floor / roof to make it water leak proof.	
h)	Non collapsible type or better flexible connection shall be provided at the duct connection to inlet & discharge of fan.	
i)	All hangers & supports & fixing Arrgmt for ductwork shall be approved by Owner / Desein	
1.2.5	**Electricals / Control & Instrumentation** The scope of work includes supply and installation of all the necessary Electricals / Control & Instrumentation items required for successful operation.	
a)	Electric motors, power & control cables, cables trays, cabling accessories, MCC, Local control panel, Local push buttons complete with accessories, starter, switch fuse unit, start / stop push button necessary interlock hardware, indication lamps (LED type)-for remote indication of DE system "ON/OFF" shall be provided	
1.2.6	**Technical Data : Dust Extraction System for Crusher House**	
a)	Type	Dry Type having Pulse Air Jet Type bag Filter Unit, having "ONLINE" cleaning arrangement.
b)	Designation No.	• System # 3DE-1A shall cater to grizzly feeder # 3VGF-1A/2A / Crusher # 3CR-1A/2A / receipt point of reversible belt feeder # 3BF-1A • System # DE-1B shall cater to grizzly feeder # 3VGF-1B/2B / Crusher # 3CR-1B/2B / receipt point of reversible belt feeder # 3BF-1B • Each DE system shall be independent including its compressor • Both system shall operate simultaneously
c.	Location of D.E Point	a) On hood of Grizzly feeder / On Discharge chute from Grizzly feeder to Crusher b) Receipt points (skirt) of Conveyor below Crusher. [One D.E. point shall be provided for each loading point of above conv.]
d.	Air extraction Volume The minimum quantity of air sucked from various points shall be as follows or as per ACGH (refer cl. 1.1 above) whichever is higher	
i)	Grizzly Feeder	915 m^3/hr per m^2 of screen area
ii)	On each loading point on skirt board	(i) 2800 m^3/hr per metre of belt width
		(ii) Add 1700 m^3/hr in case fall is greater than 1 meter
e.	Dust Content in clean air exhaust	Less than 50 mg/Nm^3 or as per stipulation of Pollution Control Board whichever is less.
1.3	Dust Extraction System for Coal Bunkers of Unit 10	
a.	General	• For venting bunker, minimum two (2) no Vent filter shall be provided on top of each bunker (hopper)

		Total Qty: 2 x 4 + 2 x 4 = 16no. • Each unit shall be provided with programmable sequential controller to ensure automatic cleaning • One (1) air compressor shall be provided for each bunker row
b.	Type	Insertable type, vertically mounted pulse jet bag filter
c.	Capacity	Minimum 2600 cum / hr for each unit
d.	Make	Thermax /RIECO/ approved equal
e.	Construction	(i) Bag & cage: Overlapped triple stitched bags with integral collar with heavy duty cage. Bags shall be sufficiently strong and made out of fire resistant material. Flared tube sheet to be provided to prevent bags from tearing during cleaning. (ii) Pulse valve: Pressure die cast with neoprene or better synthetic rubber diaphragm. (iii) Solenoid valves: With special steel plunger with NEMA- 4 housing for protection against dusty atmosphere prevailing within the coal bin. (iv) Clean air side clamping and access shall be provided to facilitate bag removal.
f.	Air Compressor	Air compressor complete with piping (as per IS: 1239, Part-1) shall be provided to cater to the requirement of Bin Vent filter. Compressor shall conform with following requirements. (i) Air Compressor Capacity equal to 1.25 times air flow rate required for all the vent filters. (ii) Type: Rotary Screw Type, air cooled directly coupled to electric motor (iii) Acoustic enclosure to confirm to relevant standards and code of practice (iv) Receiver: IS:7938/better (v) Qty : 2no (one no. per bunker row)
M-28	**Tunnel Ventilation System**	
1.0	Ventilation system shall be provided for Underground Areas of WT Complex / Track Hopper Complex / Reclaim Hopper Complex / associated Junction Towers, Conveyor Tunnels of Conv. # BC-1A/1B/2A/2B/3RC-1 & associated pent house # 3PH-1. Fresh air supply as well as exhaust air system shall be provided. Both supply air & exhaust air system shall be complete with all accessories / ducting grills etc.	
1.1	Fresh air shall be drawn through a rain protected opening and shall pass through filter. Fan shall be complete in all respects. The air shall be carried through by supply air ducting The air shall be distributed into tunnel through grills provided at suitable spacing to ensure uniform distribution of air. Supply air fan/filter units etc shall be housed in canopy or better for protection from rain.	

1.2	Multiple fans if required shall be provided for each system and maximum fan capacity shall be limited to 60000 cum/hr. No of vent shafts shall be provided so as to limit the fan capacity to 60000 cum/hr	
1.3	Tunnel ventilation shall be complete with Supply & Exhaust air fan with drive unit, Air Intake louvre , Dry type HDPE filter box at supply air fan, G.I. ducting, Aluminium construction grills with volume control damper, electrical for local control/operation, support frame work/brackets, bolts nuts etc. as per requirement. All equipment shall be of reputed, proven & approved make	
2.0	**Data Sheet: Tunnel Ventilation System**	
2.1	Type	Dry Fresh filtered air supply type along with exhaust system
2.2	Designation no. /location	a) System # 3VS-1A for underground areas of tippler # 3WT-1A b) System# 3VS-1B for underground areas of tippler # 3WT-1B c) System#3 VS-1D for underground Tunnel for conv. #3BC-2A/2B & 3JT-1 including pent house # PH-1 d) System# 3VS-3A for underground areas of Reclaim hopper complex#RHC-1 and Junction towers#3 PH-2/ associated tunnel for conv. # RC-1
2.3	Filters	HDPE mesh filter with 5 ply having efficiency not less than 90 % for particles down to 10 microns (BS-2831/6540 With AC Fine Dust). Filter media shall have 18g GI sheet frame with handle on one side and Aluminium sheet frame on other side.
2.4	Louvers	Sand trap louver of 80% efficiency on AC coarse (20 to 200 microns) and 50% efficiency on AC fine test dust (1 to 70 microns)
2.5	Air Velocity shall not exceed	a) 10 m/sec (through fan outlet and in ducting) b) 3.8 m/sec (through grills) c) 2.2 m/sec (filter face)
2.6	No. of air changes	15 air changes /hr (for supply) and 7 air changes / hr (for exhaust)
2.7	Fan	Centrifugal, Backward Curved Type.
2.8	Ducting	GI sheet ducting (IS:655 & IS:277)
2.9	Grills	Aluminium sheet construction with volume control dampers and double directional louvers. Spacing of grills: 5m (max.)
M-29	**Ventilation System**	
1.0	Ventilation system shall be provided in all HVAC areas. Refer HVAC chapter for further details	
2.0	**Data Sheet: Ventilation System**	

2.1	Type of system	As per HVAC Chapter
2.2	Location	a) MCC Room area in bldg.# 3ER-1A/1B b) MCC Room area in bldg.# 3ER-2 c) MCC Room area in bldg.# 3ER-3/4 d) All other MCC Rooms
M-30	**SUMP PUMP**	
1.0	In each Sump Pit, two (2) no. (1W+1S) sump pump shall be provided The pump shall be of vertical submerged type, grease lubricated, single stage, above floor discharge, ball/roller bearings fitted, and having non-over loading characteristics. The bearings shall be suitably housed and protected from contaminated water.	
1.1	Each sump pump shall be provided with electrode type or equivalent high / low level switches for automatic starting and stopping of the pump. The electrode mechanism shall be adjustable over entire depth of the sump. Pump shall be started when the sump level starts rising above a predetermined level and shall continue to operate till water reaches low level in the sump, when it shall trip off automatically.	
1.2	Suitable strainer at the inlet side of the impeller shall be provided.	
1.3	The pumps shall be capable to pump coal dust contaminated water of fairly high viscosity. The pump shall be lubricated through a built-in lubricator.	
1.4	The vertical motor driven pumps shall be driven by a suitable motor located at proper position for smooth, safe and efficient operation.	
1.5	The piping system shall be designed to suit operation of both pumps i.e including standby pump simultaneously.	
1.6	Discharge pipe up to the nearest drain shall be provided.	
1.7	Local starter panels consisting of auto/ manual selector switch, isolating switch fuses, start stop push buttons timers level controller, auxiliary relay etc. shall be provided.	
1.8	The sump pit shall be covered with grating after erection of pump.	
1.9	The pumps shall be capable of handling slurry, the max. Concentration of solids will be 20%	
1.10	Impeller [open or semi open] shall be dynamically balanced.	
2.0	**Data Sheet: Sump Pump**	
2.1	Type	Vertical submersible non-clog type
2.2	Pump Designation No./location/qty	Refer flow diagram
2.3	Type of fluid handled	Coal dust laden water
2.4	Discharge Capacity (m^3/hr)	40
2.5	Total head m. W.C.	30
2.6	Sump size [approx.]	2 m(W) x2m(L) x1.8 m (Deep)

2.7	Type of drive	Motor operated, flanged mounted motor
2.8	Type of mechanism for automatic starting/ stopping	Level switches
2.9	Sump level for Stopping [approx.]	(-)1.5m from floor level
2.10	Type of bearings	Antifriction
2.11	Method of lubrication	Grease
2.12	Strainer at the impeller inlet side provided	Yes
2.13	Piping, valves and accessories	Provided up to nearest plant drainage.
2.14	Piping valve and accessories size shall be designed and selected based on both sump pumps working simultaneously.	Yes
2.15	Electric motor kw Rating	Vendor to furnish kW Rating provided.
2.16	Necessary steel supports/ removable grating, handrails etc. for sump pump and piping, provided	To be provided by Vendor.
2.17	Local start/ stop control	From next higher floor or away from sump where water accumulation does not occur.
2.18	Local Panel, necessary start/ stop push button, auto/ manual selector switch etc.	To be provided
2.19	Type of mechanism for automatic starting/ stopping	Electrode type / eqvt.
2.20	Hours of operation/ day	24 Hours/ day
2.21	**Material of Construction**	
a)	Casing	Ni-CI/better
b)	Impeller	Ni-CI/better
c)	Pump Shaft	EN-8
d)	Line Shaft	EN-8
e)	Support Pipe	MS
f)	Cover Plate	MS
g)	Strainer f	MS with SS-304 wire mesh/ or equal
h)	All other submerged parts including nuts/ bolts	As per reputed manufacturers standard
2.22	Indication for on/off	To be provided suitably

M-31	**COAL SAMPLING SYSTEM**	
1.0	Auto coal analyser shall be installed for instant GCV monitoring of coal being fed into the units.	
M-32	**AIR CONDITIONING UNIT**	
1.0	HVAC shall be provide as per details spelt out in HVAC chapter	
2.0	**Data Sheet: Air Conditioning Unit**	
2.1	Location	a) Operator's Control Cabin in bldg # 3ER-1A/1B (for Tippler) b) Central Control Room & O&M office at 1st floor of Building # 3ER-2 c) Any other area as applicable d) Weigh Bridge Control Room # 3WBCR-1A/1B e) Operator's cabin in Crusher House # 3CRH-1 f) Operator's cabin in Compressor House #3ACH-1 g) Operator's cabin on Tripper Floor in Bunker Row #1 i) Operator's cabin on Tripper Floor in Bunker Row #2
M-33	**Exhaust Fans**	
1.1	General	All exhaust fans shall be provided with back draft shutter, bird screen and shall be rain protected.
1.2	Type	a) Propeller Type for Toilet b) Bifurcated type tube axial for Battery Room with flame proof motor c) Tube axial flow fan for Pump House/compressor house#ACH-1
1.3	Location	- Battery Room [if applicable] located in Electrical Building # ER-2/3/4 - All Pump House/ compressor house#ACH-1 /all toilets.
1.4	Air changes / hr	20 (For Battery Room & All Toilets) 15 (For all Pump House Buildings)
1.5	Construction	Aerofoil design mounted on stream lined hub fastened to the motor shaft. The complete assembly with motor shall be statically and dynamically balanced. Impellers shall be of cast aluminium construction. Louver shutter / wall cowl as applicable shall be made out of MS epoxy painted sheet steel of sufficient strength.
1.6	Fan RPM / motor	RPM shall preferably be limited to 1450. Motor shall be of totally enclosed type with class `F' insulation complete with wire mesh guard having Energy efficient level 1. For Battery room, Fan motor shall be of flame roof design.
M-34	**Bull Dozer**	
1.0	Four (4) nos. self - propelled crawler dozers shall be provided with a minimum of Net Power 242 kW (324HP) (ISO: 9249). Each dozer shall be equipped with all the necessary components and controls to provide a complete and independent unit as specified herein and as delivered to the Project. Each dozer	

	shall be fully assembled and ready for production when delivered, blade mounted; fuel tank full of fuel; coolant system filled with heater/ engine coolant; and crankcase, transmission, differential and final drives (each), hydraulic system and windshield washer reservoirs filled.
1.1	Each dozer shall have a rollover protective structure (ROPS) which meets SAE / ISO standards. Each cab shall meet requirements for operator sound exposure limits when tested according to ANSI/ SAE J116. Each cab shall be sound suppressed and have an air conditioner. Each cab shall include an adjustable suspension seat, seat cover, and seat belt; tilt steering wheel; air filter; rear view mirrors; and front and rear windshield washer and wiper.
1.2	Each Machine shall be provided with matching large Coal Blade for stockpile management. Further one earth blade shall also be supplied for each machine.
1.3	Each dozer shall have the following or equivalent equipment:
1.4	Lighted instrument panel: Monitoring systems for alternator charging and voltmeter; fuel level and pressure; transmission oil temperature and filter service; coolant flow and temperature; pilot system filter service; hydraulic oil level, temperature, and filter system service; engine oil level, temperature and pressure, air cleaner service; brake oil pressure and parking brake application; and clock hour meter. Monitoring systems can include lighted gauges and/ or electronic monitoring system with warning horn.
1.5	Vandalism protection group, cap locks, and key start. Muffler & Safety glass in windshield Backup alarm & Warning horn 50 amp alternator and heavy-duty batteries Lighting system, six forward lights, two rear mounted lights and rear mounted stop lights Electrical diagnostic connector and diagnostic tool Fast oil change system & Fast fuel system Fire suppression, Draw bar & Front counterweight & Power shift transmission Supplemental steering & Guards on power train & Heavy-duty crankcase guard Tool kit Multiple row module radiator All other standard equipment
1.6	**Parts and Supplies** Spare parts shall be delivered (in addition to those installed on the machine) with each machine for 2,000 hrs operation of each Machine.
M-35	**Payloader**
1.1	Machine shall be suitable for removal of oversize pieces of shale/sandstone/other extraneous material from bar grid at tippler hopper. These M/c shall also be for housekeeping/coal dosing etc.
1.2	Three (3) nos. self-propelled Payloader (Tyre Mounted) shall be provided with a minimum power 113 kw (152hp) (SAE-GROSS) / (Min.) 1.91cum bucket capacity, SAE Rated (nominal heaped). Each Payloader shall be equipped with all the necessary components and controls to provide a complete and independent unit as specified herein and as delivered to the project. Each Payloader shall be fully assembled and ready for production when delivered, bucket mounted; fuel tank full of fuel; coolant system filled with heater/engine

	coolant; and crankcase, transmission, differential and final drives (each), hydraulic system, and windshield washer reservoirs filled.
1.3	Each Payloader shall have a rollover protective structure (ROPS) which meets SAE / ISO standards. Each cab shall meet requirements for operator sound exposure limits when tested according to ANSI / SAE J732. Each cab shall be sound suppressed and have an air conditioner. Each cab shall include an adjustable suspension seat, seat cover, and seat belt; tilt steering wheel; air filter; rear view mirrors; and front and rear windshield washer and wiper.
1.4	Each Payloader shall have the following or equivalent equipment:
1.5	Lighted instrument panel: Monitoring systems for alternator charging and voltmeter; fuel level and pressure; transmission oil temperature and filter service; coolant flow and temperature; pilot system filter service; hydraulic oil level, temperature, and filter system service; engine oil level, temperature, and pressure, air cleaner service; brake oil pressure and parking brake application; and clock hour meter. Monitoring systems can include lighted gauges and/or electronic monitoring system with warning horn.
1.6	Vandalism protection group, cap locks, and key start. Muffler Safety glass in windshield Backup alarm Warning horn 50 amp alternator and heavy-duty batteries Lighting system, six forward lights, two rear mounted lights, and rear mounted stop lights. Electrical diagnostic connector and diagnostic tool. Fast oil change system Fast fuel system Fire suppression Draw bar Front counterweight Power shift transmission Supplemental steering Guards on power train Heavy-duty crankcase guard. Tool kit Multiple row module radiator All other standard equipment
1.7	**Parts and Supplies** Spare parts shall be delivered (in addition to those installed on the machine) with each machine for 2,000 hrs operation of each Machine.
M-36	**Passenger cum Goods Lift (Elevator)**
1.0	Passenger cum Goods lift shall be provided for Crusher House # CRH-1 & Junction Tower Building # JT-7. Lift shall be installed at location where least dust generation occurs & is subject to approval of HPGCL.
2.0	**Technical Data – Refer Volume III – Chapter 29 of specification**

M-37	**Belt Sealing Arrangement (for Coal Bunker)**	
1.0	For Belt Sealing Arrangement, one end shall be fixed end and the other end shall be adjustable type with tension arrangement. The adjustable end of sealing belt shall be held between top and bottom end plates by bolts and nuts. By rotating the screw on either direction the belt can be tightened / made loose.	
1.1	Needed guide rollers, bearings, brackets, anchor bolts etc. shall be provided.	
1.2	Sealing belt shall pass over suitable guide rollers, mounted on side discharge chute of travelling tripper. The rollers shall be of suitable size with anti-friction bearings.	
1.3	The belt shall rest on steel grating provided over the bunker slot on tripper floor. Steel grating for bunkers shall be provided. Bunker slop opening shall be of adequate width.	
1.4	The belt sealing arrangement shall be provided on slot opening along the bunker filling tripper conveyors.	
2.0	**Data Sheet: Belt Sealing Arrangement (for Coal Bunker)**	
2.1	Type	Single flat belt sealing
2.2	Qty/Location	Lot/Over Coal bunkers slots for tripper conveyor
2.3	**Sealing belt specification**	
i.	Rating & type	Minimum Heavy Duty, 630 / 3, Nylon-Nylon belt
ii.	Width of belt(minimum)	At least 100 mm more than the bunker slot
iii.	Number of plies	3 (Minimum)
iv.	Cover Grade	F.R. Grade
v.	Top/ Bottom Cover Thickness	5 mm/ 5 mm
vi.	Guide rollers	As per requirement
2.4	**Bunker slot grating**	
i.	Material of construction	MS Fabricated, out of MS flats & Ø 20 MS rods
ii.	Opening size(minimum)	800 mm continuous
iii.	Cross bars over the slot opening	16 mm thk X50 mm MS Plates
M-38	**Potable Water (PW) And Service Water (SW) System**	
A.0	**Potable water system (PW)**	
A.1	One (1) no. Sintex/ equal approved insulated PW water tank, white complete with piping work & fitting/ valves etc. shall be provided located on top of CHP buildings listed below. Necessary access ladder shall be provided for cleaning of tank. Each Tank shall be mounted on RCC pedestal. Capacity of each tank shall be 500 litres minimum	

A.2	Each potable water outlet/ tap point[i.e. dispensing unit] complete with suitable filter for removal of fine solids and one RO water purifier unit of approved make shall be provided at locations given below.		
S.No.	**Building no**	**No of potable water tank [located on top of building]**	**No of Potable Water Dispensing Unit required**
1	Bldg# 3ER-1A	1no	1no
2	Bldg# 3ER-1B	1no	1no
3	Bldg# 3ER-2	1no above Central Control Room and 1no above O&M office [both areas at 1st floor]	Two(2)+Two(2)
4	Bldg# 3ER-3	1no	1no
5	Bldg# 3ER-4	1no	1no
6	Bldg# 3WBCR-1A/1B	1no (for each building)	1no (for each building)
7	Pump house# 3PMH-1A/1B/2/3A/3B/4	1no for each pump house building	1no for each pump house building
8	Compressor House # 3ACH-1	1no	1no
9	In Operator's Cabin a) Crusher House #CRH-1 b) On Tripper Floor in Bunker Row #1 c) On Tripper Floor in Bunker Row #2	1no (for each cabin)	1no (each)
10	Junction Tower # 3JT-7/8	1no for each building	1no
B.0	**Service water system (SW)**		
B.1	Each SW water outlet/ tap point for CHP buildings shall be provided with one (1) no. 32 NB globe valve and quick release coupling and One (1) no. hose pipe (minimum 10m long) with nozzle.		
B.2	Each SW water outlet/ tap point in conveyor gallery & tunnel shall be provided with one (1) no. 32 NB globe valve and quick release coupling and One (1) no. hose pipe (minimum 30m long) with nozzle. SW water outlet/ tap point shall be provided in conveyor galleries and tunnels at 50m intervals.		
B.3	Flow at each service water outlet /tap point : 5 m^3/hr Minimum discharge pressure : 2 kg/cm^2 No. of valves operated simultaneously : 2no [for any location]		
S.No.	**Building No.**	**No. of SW water tap points required**	
1.	Gr level tippler complex# 3WTC-1	2no [diagonally opposite] for WTC-1	

2.	Building# 3ER-2	1no at first floor and 1no at ground floor
3.	Pump house# 3PMH-1A/1B/2/3A/3B/4	1no for each pump house building
4.	All Junction Towers/Sampling Tower including underground Junction towers	1no for each floor including gr floor [for all buildings]
5.	Underground floors of Tippler complex	2 no. (Diagonally opposite) for each underground floor.
6.	Crusher house	2no for every floor including gr floor
7.	Building# 3ER-1A/1B and ER-3/ 4	1no at ground floor for each building
8.	Tripper floor [bunker building, row-1],	1no at each end of floor
9.	Tripper floor [bunker building, row-2],	1no at each end of floor
10.	In Operator's Cabin in Crusher House	1no

1.11	**Maintenance Tools & Tackles** A set of maintenance tools & tackles shall be supplied (as listed below) for testing / commissioning / dismantling/ overhaul/ servicing of the equipment of the proposed CHP. All tools & tackles shall be furnished neatly arranged in special portable tool cabinets. Items supplied shall be of best & approved quality and especially protected against rusting in tropical climate.	
1	6 inch & 4 inch dia. wheel AC motor driven portable grinding machine	1 no of each
2	Hydraulic platform trolley for transportation of spare parts, Capacity: 2 T	1 no.
3	Hydraulic Jack,50 tonne & 10tonne	1no of each
4	Extendable aluminum ladders.	2 no
5	10-inch size- flat, round, half round, bastard, fine files.	2 no of each
6	Outside micrometer, range 0 to 150 mm	2 no
7	Inside micrometer, range 0 to 150 mm	2 no
8	Vernier Calipers	4 no
9	Dial gauges (0 to 10 mm with least count 0.01).	8 no
10	Steel tapes (3m& 6m)	6 no of each
11	Steel Scales (1m, 0.5m & 0.3m)	6 no of each
12	External Caliper (0.15m, 0.3m, 0.5 m & 1m)	4 no of each
13	Internal Caliper (0.15m, 0.3m, 0.5 m & 1m)	4 no of each
14	Hacksaw frames with one dozen hacksaw blades.	2 set
15	Tri-squares (200mm size)	6 no

16	Screw operated couplings	4 no
17	Bearing pullers (300mm)	4 no
18	Rope Pull Lift, Capacity: 2 T & 5T	4 no of each
19	Oil Seal Extractor	4 no
20	Screw Driver (size:150mm & 300mm)	6 no of each
21	Pair of Slings with eye bolts & D-shackles : length (2m, 4m& 6m),)	6 set of each
22	20mm Φ. Steel wire rope,6x19 construction with hemp core,Gr.1570 [IS:2266]	30m
23	Belt pullers.	4 no
24	Pliers With Insulation Covered Arm [size 180mm]	6 no
25	Adjustable Pliers.	6 no
26	External Circlip Pliers	6 no
27	Internal Circlip Pliers	6 no
28	Allen Key Set	6 no
29	Ball Peen hammers(in different sizes)	6 no
30	Nylon faced hammers	2 no.
31	Sledge hammers of 5 kg. & 10 kg.	4 no. each
32	Feeler Gauge	4 no
33	Universal Spirit Level	2 no
34	Torque wrenches to suit CHP equipment	2 no
35	Standard Ring Spanners Set (Full Range) complete with box (10-11 to 40-42) (Make: Taparia or Mekastar)	8 set
36	Standard DE Spanners Set (Full Range) complete with box (10-11 to 40-42) (Make: Taparia or Mekastar)	8 set
37	Adjustable spanner Set (Full Range) complete with box	4 set
38	Tubular Box Spanner Set (Full Range) complete with box	4 set
39	Socket head spanner set complete with box	4 set
40	Gas cutting torch with standard regulators for oxygen cylinder and acetylene cylinder and 30m flexible hose	1 set
41	Portable Welding Machine, single phase	1 no.
42	Vice Grips (suitable for up to 50mm/up to 150mm/up to 300mm).	2 no of each

43	Three legged tripod stand, 4m height	2 no
44	Cable Jointing Kits	2 set
45	Marking Punches	4 no
46	Scribers	6 no
47	Grease guns with flexible hose & grease nipple	4 no
48	Bucket Grease Gun With Flexible Hose & Grease Nipple	4 no
49	½ inch dia portable wolf drilling machine	4 no
50	Avometers	4 no
51	Digital Multimeter with 4 ½ digits display.	4 no
52	Insulated Tester - Hand operated [500 V (2nos.), 10000V (2nos.) & 6.6kV(1nos.)]	5 no
53	Plumb bob	8 no.
54	Vibration Monitor Equipment.	4 no
55	Tong Testers	4 no
56	Portable Emergency Light	8 no
57	Hand lamp set with flexible wire 50 m long	12 no
58	Chain pulley blocks, Capacity :3T & 5T	1no of each
59	HT cable fault locating kit for 6.6KV with Accessories.	1 set
60	Crimping tool Hydraulic type upto 640 Sq.mm.	1 no
61	Bearing mounting kit	1 no

M-39	**In-Motion Weigh Bridge**		
1.0	One (1) nos Pit less type In-motion rail weigh scale for weighment of all types of Indian Railway Wagons, shall be provided at entry & exit of each wagon tippler in the wagon tippler complex.		
1.1	Unmanned type weighbridge system of reputed and proven make shall be provided.		
1.2	Rail including sleepers of suitable length and for mounting the weighing system are included in the scope of bidder.		
1.3	Weigh bridge shall be suitable for bidirectional weighment.		
2.0	**Data Sheet: In Motion Weigh Bridge**		
2.1	Weigh bridge designation no	3IMWB-1A	3IMWB-1B
2.2	Qty, no/location	One(1)/ at entry	One(1)/ at exit

2.3	Application	To weigh loaded rake	To weigh empty rake
2.4	Capacity [minimum]	150 tonne [Rated]	150 tonne [Rated]
2.5	Weighing speed	Max 15 km/hr	
2.6	Weighing system	Hermitically sealed shear beam type load cell/ embedded rail mounted strain gauge sensors. Protection: IP-68 Safe overload capacity=150% of rated capacity Ultimate overload capacity=300% of rated capacity	
2.7	Over speed indication	Audio/ Visual/ Print out-over speed indication facility shall be incorporated in the system	
2.8	Track switches	Non-contact track switches	
2.9	Accuracy	±0.5% for individual wagon and ±0.2% for full rake	
2.10	Calibration	Digital Calibration System shall be provided for Tare, Zero, Gain, Auto Zero, and Auto Gain Check	
2.11	Electronic	High Precision and Microprocessor Based Modular Weighing Electronics with high speed Signal Processing	
2.12	Other Technical Features	a) Facilities for types of Loco elimination, roll back detection, auto/manual operation, rake wise periodic report generation on daily, weekly, monthly basis. b) Weigh scale shall be suitable for weighing a rake having wagons of different tare weights and payload capacity arranged in random order. c) On the recording units, weight tickets shall be printed automatically in triplicate with dates, hours & minutes. d) Arrangement shall be made to transmit the record of each rake instantaneously to the Wagon Tippler control room and Central Control Room	
2.13	Computer	i7 Intel processor or latest available at time of supply	
2.14	Software	Windows-11 or latest available at time of supply	
2.15	Battery power	Back up for minimum 60minutes	

M-40	**Diesel Locomotives**
1.0	Three (3) – Diesel hydraulic locomotives of 800 HP capacity shall be furnished for handling of coal and yard shunting in the marshalling yard. The diesel hydraulic locomotives shall have the following features
a)	The power unit shall be a Multi cylinder, 4 stroke, direct starting on diesel with overhead valves, turbo-charged or natural aspirated, water cooled diesel engines. The engine block shall be cast free from defects, cracks and blow holes. The cylinders shall have replaceable liners. The positons, piston rings connecting rods, crank shaft, inlet and exhaust valves shall be adequately designed for the service intended having the material of construction to applicable ISS/BSS or SAE Standards.
b)	The Loco shall be provided with the needed accessories but not limited to the following: a. Mechanical variable speed operation hydraulic type Governor with variable settings, selected from engine cab. b. Automatic, mechanical type overspeed safety trip. c. For Engine starting and adequately sized lead acid storage battery bank. d. Self-contained Turbo-charger composed of gas turbine driven by exhaust gases wherein the suction air is compressed by a centrifugal blower mounted on a common shaft. e. Oil bath type air filters at engine air intake.
c)	**Fuel Oil System** Heavy gauge sheet steel construction fuel oil tank of 2000 litre (min.) capacity shall be provided with ample baffles in short hood compartment as provision against surge, filling points and contents gauge. The fuel shall be high speed diesel oil (HSD) to IS:1460:1974. The fuel oil system shall be complete with pump, filters, pressure control valve etc. The tank shall be provided with inspection door (for cleaning during maintenance); necessary pipe connections for supply, return vent and drain. Provision for measuring the quantity of fuel oil from 200 litres onwards in the tank shall be provided.
d)	**Lubricating Oil System** Special quality flexible pipes shall be used for lubrication to withstand tropical climatic conditions. Grease nipples to ISS shall be provided. The lubricating oil pump shall be positive displacement type, driven directly by the engine crank shaft.
e)	**Cooling Water System** Adequate capacity cooling water system equipment designed for the most adverse ambient temperature prevailing at site shall be provided to match with Diesel engine maker's recommendations. Water shall be circulated through engine radiator and lubricating oil cooler thru a gear driven pump integral with Diesel Engine. The radiator shall be forced cooled by fan (s) drawing air from atmosphere.

	The engine temperature shall be controlled by adjusting the air flow through the radiator by means of variable speed radiator fan. There shall be alarm for high temperature. Engine shall be stopped in case of low cooling water level in the expansion tank.
f)	**Sanding** Four (4) pneumatic sanders shall be provided for Loco for sanding in either direction of travel. The sand ejectors shall be provided with suitable deice to adjust the optimum rate of sand flow. The system complete with sand conveyor system for sanding and wheels of Loco shall be provided with either hand-operated or pot operated push-pull valves.
g)	**Pneumatic System** The Loco pneumatic system shall primarily supply air for Loco air brake arrangement and to auxiliaries such as pneuophonic horn, sander etc. The pneumatic system also shall supply air for actuation of transmission control. The Loco air brake system shall be fed from the air compressor (of standard make) driven by the diesel engine and the compressor rating should suit the Loco air requirement. The system shall include reservoir, filter, unloader, auto drain valve etc.
h)	**Brakes** The installed power and the weight of the Loco shall be so adjusted that the starting load on level limited by adhesion can be hauled on level at about 10 to 15 km/h. The Loco shall be provided with independent and automatic compressed air brake system on all wheels thru suitably designed brake rigging and vacuum brake provided with liners and links. Hose connections shall be provided at front and rear. Compressed air shall also be used for operating auxiliaries such as controls, horns, sanding, wind screen wipers etc. The brake blocks shall be of non-metallic type. The brake rigging shall be designed such that with full brake pressure, the total brake force on shoes shall be approximately 80% of max designed weight of working Loco. All wheels shall be braked; slack adjusters shall be designed with adequate range to achieve max lift from brake shoes to cater for wheel and shoe wears and slackness in rigging. The rigging should ensure correct holding of the brake shoe against the wheel rim for which guiding device shall be provided. Lever operated hand brake shall be provided in the cab to hold Loco on grade in emergency; and for parking. It should act on 2 wheels thru the same set of shoes end rigging provided for power brake. The air brake system consisting of self lapping brake valve, relay valve & other valves with fittings for effective and trouble free running of Loco shall be provided for use in multiple operation and/or for train brake. The compressor exhauster shall be driven from the engine. The main reservoir/s shall be mounted below the underframe. The brake hanger arrangement shall be designed so that clasp type of braking is used with brake blocks actuating on either side of the wheel. The brakes shall have the provision to adjust slack manually to cater wear of shoe, wheel and slackness in brake rigging.

	Head lights 12 inch glass reflector lights, 250 watts, 32 V DC shall be provided on both sides of the engine. Heavy duty pneumatically operated wind screen wipers shall be provided at front and rear lookout fixed windows. Pneumatic hoses shall be fitted operable from either side of the control desk.
i)	**Diesel Locomotive Duty** The Loco shall be used for handling partial rake of oil/coal wagons as well as equipment carrying wagons etc from the exchange point at Project site. The Loco shall be adequate to haul partial rake of 3120 tonnes at a maximum velocity of approximately 5 KMPH over the gradient of 1:175. Also the Loco shall be capable of starting and accelerating to the speed of 8 KMPH over the track with partial rake. The Loco shall be provided with 4 driven axles fitted with roller bearings suitable for a nominal axle load of 20 tonnes + 3 percent. Considering the adhesion factor of 0.3 with normal track/wheel conditions and dry rails, the Loco shall be suitable for a max starting tractive effort of 24000 kg approx. The Loco shall be suitable to negotiate 75 M min radius of curve and 1 in 8½ turn out. The Loco shall have max geared speed of 5 KMPH on shunting gear; and 8 KMPH on main line gear.
j)	**Transmission** The power transmission from the engine shall be through Voith turbo reversing, fully automatic hydrodynamic transmission. The torque converter shall provide automatically the necessary multiplication of the engine torque required for starting, accelerating and hauling upgrade.
k)	**Electrical Equipment** Main Generator shall be 500 V DC machine, self ventilated directly coupled to the Diesel engine. Provision shall be made in the Generator startor for series/shunt/differential field windings. In addition, there shall be a provision to feed power from storage batteries to the Generator while starting the engine. The auxiliary generator shall supply power to battery charging, lighting and control circuits and operates at constant voltage under control of a regular. The exciter shall be designed for use with the power plant regulator and provides excitation to the main generator. **Drive** Robust construction final axle drive designed for long and trouble free service shall be provided incorporating helical spur pair and spiral bevel pair. Alloy steel forged gears shall be used for heavy duty application while helical spur gears shall be hardened & ground; and bevel gears shall be hardened and lapped. Final drives shall be coupled to the transmission thru carden shafts of adequate strength. **Storage Battery** Suitable number of lead acid type storage batteries shall be housed in two (2) separate fabricated steel boxes located conveniently for access, inspection and topping up together with adequate ventilation & drainage. 24 Volt electrical system shall be complete with batteries, alternator/ rectifier and starter motor. Electrical system shall consist of 4 head lights two at each end; 4 parking lights 2 at each end; one cab light; control desk light; one light in engine hood; one electric fan in cab; 2 plug points at each side underneath the running board for use of a portable inspection lamp; one portable inspection lamp with flexible cables; switches for lights & fan etc.

	Suitable instrumentation for measuring the charging current shall be provided on the panel board. Necessary switches, circuit breaker for controlling the lights and protection of the electrical system shall be provided.
l)	**Fire Extinguisher** Two (2) – 2 kg capacity dry power type Fire Extinguisher shall be provided one in the driver's cabin; and the other in engine hood.
m)	**Control Equipment & Instruments** Adequate controls including gauges, instruments and safety devices not limited to the following shall be provided for safe and satisfactory operation. Two (2) control standards, one on each side of the operating cab, containing throttle selector and reverser handles, brakes, valves, switches for generator field, fuel pump control, switch for engine/cab lights, engine start/stop sanding valves and horn shall be provided. These shall be so arranged on the stands that it should be within easy reach and sight of the driver from both driving positions. There shall be provision for detection of wheel slip by speed sensing method and automatic reduction of generator excitation or engine speed until slipping ceases. A warning buzzer shall also be provided to warn driver for taking also manual throttle control. Controls, gauges and safety devices shall be complete for safe operation and not limited to the following: A. For driver's use, the control for engine acceleration control or throttle (master controller) including start-stop; forward/reverse direction control; driver's brake valve for loco; horn operating valve; sander operating valve; emergency brake valve; engine start push button; engine stop push button; battery isolation switch; wiper control etc. B. Instruments and gauges on driver's desk for Engine rpm-cum-hour counter; fuel oil temperature/pressure/flow; engine oil pressure gauge; engine water temperature/pressure gauge; transmission oil pressure gauge; transmission oil temperature gauge; ammeter for battery; air pressure gauge for brake system; battery charger; brake-air pressure & vacuum; water level gauge on radiator; main air reservoir pressure gauge; control air pressure gauge etc. C. Indication/warning lights for low lube oil pressure; low brake pressure; transmission on; head light and parking lights on; battery discharge; high water temperature; low air pressure. D. Safety devices for low lubricating oil pressure – diesel engine shut down; high water temperature – diesel engine shut down. E. Reliable protection devices shall be provided in respect of the following connected to a relay logic circuit such that under fault conditions, a switch shall be operated to deenergize/stop the engine: - High engine water temperature - High lube oil temperature in transmission - Low expansion tank water level - Engine overspeed (mechanical) - Low lube oil pressure - Low air pressure in brake system

	- Low oil pressure in transmission
n)	**Constructional Features** **Underframe** The Loco shall consist of a sturdy fabricated welded construction underframe with cross members and bracings to withstand the heavy draft and buffing loads encountered during shunting operation. The power pack components such as diesel engine, transmission shall be mounted on the underframe. The ballast weight to achieve the working weight of the Loco shall be provided into the pockets of underframe. The ballast weights shall be added at selected locations to ensure the center of gravity of the Loco is maintained closer to designed location so that the weight distribution to the axles is uniform. The ends of the undergrame shall be designed to accommodate IRS full wire CB coupler type of draft gear, IRS screw coupling with side buffers. Provision shall be made: a. For lifting the complete Loco with a crane and lifting points clearly marked. b. For tandem operation of Loco. c. For suitable hand rails and foot steps at convenient locations. d. Rail guards at each end of the Loco. **Bogie Arrangement** The bogie shall be of 2 axle, center pivot type with primary suspension. The bogie frame shall be of welded construction with rolled steel sections and plates; and cast steel bogie center pivot shall be welded on to the Bogie frames provided with mild steel liners at the bottom on which the pivots of the main frame rest. The bogie pivot seats shall be provided with friction liners to dampen rotary motion. Side bearers shall be provided on either side of each bogie to limit swivel and roll. Oil film lubrication shall be ensured between the pivot of main frame and pivot seat of bogie. **Axle Drive System** a. Monoblock multiwear heavy duty disc type steel wheels to IS:2702 Gr.2 having standard tread flange contour or composite design wheels consisting of disc type wheel centers with renewable tyres shunk on the center fitted shall be furnished. The wheel profile shall be made to IRS profile applicable to standard board gauge. The wheel shall be provided with an extraction hole for connecting high pressure oil injection system so that wheel extraction is carried out easily during maintenance. b. The output from the transmission shall be connected to the axle gear box. The axle drive gear box housing shall be of fabricated steel plate design of adequate thickness. The flange joints shall be hand scrapped and lapped to avoid use of gaskets as well as to maintain perfect leak proof joints at accurate center distance. The fabricated housing shall be stress relieved and accurately bored to ensure proper mounting distance for gears. c. The axle drive shall be bevel cum helical speed reducer; and the bevel gears shall be spiral bevel type made out of EN36C alloy steel. The bevel gears shall be case carburised, hardened and lapped for proper contact pattern for long life. The bevel gear and pinion shall be mounted on the respective shafts using oil injection equipment. The helical gears shall be

generated accurately on blanks of En36C and case carburised hardened and profile ground.

d. The gear box bearings shall be of double row spherical roller type to provide adequate thrust load and radial load capacities. The gear box shall be lubricated by splash system for which lubricating oil pump shall be provided. The input and output shafts shall be provided with oil seals for prevention of dust entering gear box. The output oil seal shall be mounted on output cover with oil seal carrier. Special canvas backed split oil seal shall be provided on the output axle for easy replacement.

Wheels & Axles

a. High grade steel forged axles (EN-8 or equal normalized and ultrasonically tested) machined all over with seats of driving gear, road wheels, axle journals and bearing seats and wheel seats shall be finished ground to close tolerance. Grease lubricated roller bearings shall be provided on axle journals. Bearings shall be located in robust cast steel housings with renewable wear resistant steel liners.

b. The cast steel axle boxes shall house grease lubricated roller journal bearings for smooth running of Loco. All sliding surfaces on axle boxes shall be fitted with adequate thick Manganese steel liners.

Loco suitable for operation on 1676 mm rail gauge shall be fitted at each end with Indian Railways Standard transition type automatic centre buffer coupler with side buffers to allow Loco coupling with Wagons fitted with hook type as well as center buffer couplers.

Cabin

a. The driver's cabin shall be of fabricated steel plates for the full width enabling driving of Loco in either direction of travel without having to turn the Loco. The cabin should conform to overall moving dimension of Indian Railway Standards for broad gauge. It shall be double walled construction to reduce radiation of heat inside the cabins; and heat insulating material shall be used between the outer and inner walls of cabin.

b. The cabin shall be provided with -

i. Two (2) diagonally opposite opening outside lockable doors.

ii. Two (2) upholstered revolving and vertically adjustable driver's seats. The sides of driver cabin shall be so designed to enable the driver to look outside the cabin without leaning.

iii. Antiskid chequered steel plate construction floor.

iv. Front and rear of the cabin provided with large glasses and sunvisors to have good visibility from the driver's seat during operation.

v. The side panels provided with sliding type glass windows.

vi. Pneumatically/electrically operated wipers in the front and rear glasses improve visibility during rainy seasons.

vii. A small wardrobe type locker in the cabin for the use of the driver.

viii. Windows shall be of plate glass type fixed in sun and heat resistant synthetic rubber sections. Heavy duty sliding windows shall be provided on cabin side walls. Roof shall be so shaped as to act as visor against the sun glare. The cabin shall be well ventilated and insulated and insulated with non-hygroscopic material. Upholstered adjustable seats shall be provided in the cab for the driver.

Engine Hood

The engine and transmission shall be housed in the engine hood compartment of the Loco. The hood shall be provided with easily removable doors. Suitable hatch frame of special split design shall be provided to enable the top overhaul of engine performed without removing the engine.

Suspension System

The loco shall rest on the axle boxes through suspension system comprising of semi-elliptic springs which shall be designed to achieve required deflection on load and also to ensure good riding qualities. The springs shall be made out of Silicon Manganese Steel and heat treated by oil quenching. The spring seat shall be designed in such a way as to freely slide and rotate overt the axle box so that the spring takes the proper position during longitudinal and transverse movements of the axle. Approved lubrication arrangement of suspension brackets in service shall be provided.

Engine and equipment compartment shall be of hood type structure with running board on either side and shall be braced and secured to the frame. Large removable service hatches on roof and doors on sides of the hood shall be provided with adequate access for repair/maintenance of the equipment. Side doors shall be of robust construction secured thru loose pin hinges for easy removal. Non-skid steel plates shall be welded to the deck plate all round the hood compartment forming the walkway. Approved handrailing shall be provided along the sides of the hood, across ends and near foot steps to ensure safety of operating personnel. Foot steps of non-skid plates shall be provided at 4 corners of the frame and at the entrance doors as necessary.

2Adequate capacity air compressor shall be furnished with an unloader; intake filters, air reservoir and other accessories to Engineer's approval.

Approved safety brackets shall be provided underneath the components of running gear to prevent them from falling off on to the track in the event of their failure.

Special attention shall be paid to V-belt drive arrangement to permit easy and quick replacement when needed and its adjustment in service. Belts shall be of Fenner or approved equal to ISS.

High quality workmanship pipework shall be used locating them suitably to have neat accessible layout free from stresses. Care shall be taken for cleanliness, drainage, straightness, accessibility and sealing thus providing standard connections avoiding sharp bends. Anticorrosive treatment and protection shall be given on internal and external surfaces of pipework. Identification of pipework thru different colours shall be made as per approved practice.

Flexible hose connections shall be provided at locations where relative movement occurs between 2 pipe ends. It should be ensured that hoses do not rub against any part of the frame; and shall be so arranged as not to be in tension

M-41	**Dumpers**
1.0	Two (2) – BEML Make BH 35 Rear Dump Truck for handling coal in the yard. The dump truck shall have the following features
a)	The engine, power train, steering system, brake system, Tyre & rims, frame, hydraulic system, suspension, body, system refill capacities, mass and cabin shall be provided as per standard features of the manufacturer.
b)	Each dumper shall be provided with following standard accessories : **1. General** • Vandalism protection caps (Radiator & fuel tank) • Head & Tail lights • Emergency power steering • Road condition valve • Windshield wiper • Wheel brake lock • RH & LH mirror • Sunvisor • Co passenger seat • Operator's seat belt • Portable fire extinguishers • Standard tool kit • Mud flaps (front & rear) • Parking brake valve • Tilt steering wheel & column • Fuel tank provided with fuel gauge indicating ½, ½ & full level • Led type rear/ brake lights • Circuit breaker **2. Gauges** • Ammeter • Air Pressure gauges • Engine cooled temperature & oil pressure gauges • Tachometer • Speedometer • Air cleaner restriction indicator • Transmission oil temperature & pressuire guages • Electrical hour meter **3. Lighting** • Head light hi beam indicator • Back up light • Turn signal lamp • Low lubrication oil pressure indicator • Parking brake indicator • Emergency steering lamp • Filter clogging indicator • Alarm

c)	Following Equipment attachments shall also be provided for each dumper : • Suspension charging kit • Auto emergency steering • Tyre inflation kit • Radiator coolant level indicator • Cold weather starting aid • Transmission oil temperature alarm • Transmission oil pressure alarm • Auto lube system • Auto fire suppression system • Air conditioner & Cab healer • Heated type body • 100 AH zero maintenance battery

CHAPTER – 20

MILL REJECT HANDLING SYSTEM

CONTENTS

CHAPTER – 20

MILL REJECT HANDLING SYSTEM

20.1 SYSTEM DESCRIPTION

20.1.1 Mill Reject System shall include collection of mill rejects from mills on continuous basis and transportation of the same to mill reject silo through pneumatic pressure conveying system. Each mill reject discharge hopper shall be fitted with a mill reject conveying vessel, which shall discharge the mill rejects through pipe line to a storage silo. The mill reject vessel shall operate on level probe with timer back-up. From storage silo the mill rejects shall be disposed off in trucks.

20.1.2 The scope of supply shall include:

- One (1) no. pyrite hopper with discharge chute, emergency chute work etc for each mill as required.
- One (1) no. pneumatically operated isolation gate complete with compressed air pipework, solenoid valves & supporting arrangement, at inlet of each pyrite hopper.
- One (1) no. pneumatically actuated material (mill reject) handling valve complete with compressed air pipework, solenoid valves & supporting arrangement at inlet of each Mill reject/ transport vessel.
- Conveying pipework from individual mill reject vessel equipment to the mill reject silo with all accessories like bends, fixtures, flange joints, structural steel supports, anchors/ inserts/ trestles, walkways etc. as required.
- Two (2) Mill Reject silos, one (1) for each mill bay shall be provided for the proposed side mill arrangement.

  Each mill reject silo shall have an effective storage capacity of sixteen (16) hours considering each mill in the bay rejecting @ 3% of mill capacity corresponding to unit operation at 100% BMCR with worst coal firing. Necessary supporting steel structurs, platforms, staircase, manual operated unloading gate, 3 mm thick SS plate liners covering straight length portion and conical portion of mill reject storage hoppers (bunkers), level switches, air relief devices etc shall be provided.
- Mill reject silo shall be designed to provide a clear access of 5 M for trucks to come under the silo and receive the rejects using suitable chute work.
- Suitable spray quenching, to cool the mill reject in pyrite hoppers. Quenching water shall be provided from the service water pump discharge.
- Two (2) (1W + 1S) oil free screw compressors, with drives & accessories, to cater to the conveying air requirements of mill reject handling system.
- Four (4) 10 M^3 capacity air receivers (one installed at each compressor discharge and one installed in Bunker Bay) with all accessories, interconnecting pipework, support etc shall be provided.

- Necessary lifting devices of adequate capacity to handle the mill reject handling equipment.
- Complete control & instrumentation complying with Volume V.
- Electrical equipment as required complying with Volume IV.
- Civil structural works associated with mill reject handling system including foundation bolts, pockets, grouting, underpinning etc.
- One (1) drain sump of 5 M^3 capacity shall be provided for each mill bay.
- One (1) fixed type sump pump of 10 M^3/hr capacity for each mill bay

20.1.3 Each mill shall be provided with collection and transportation equipment comprising of one (1) pyrite hopper with water spray arrangement, valves at inlet and outlet and one (1) mill reject vessel. Each mill reject vessel shall be connected to mill reject silo through conveying pipeline. Mill reject silo shall be of MS construction with SS liners and shall be provided with discharge gate at its outlet to discharge rejects into a truck. Two (2) (1W+1S), oil free, rotary, screw air compressors shall be provided for conveying mill rejects from mill reject vessel to storage bunker. The instrument air required for operation of various pneumatic valves shall be drawn from plant instrument air header. The water required for cooling of valves and for spraying in pyrite hoppers shall be drawn from service water system. Radio Frequency (RF) type level probes shall be provided in pyrite hopper to start/stop evacuation cycle or for indication.

The conveying velocity of reject shall not be more than 6 M/sec and number of cycles shall not be more than 6 per hour.

The orientation of Mill Reject Pyrite hopper of all mills shall be located in such a way that the Pyrite Hoppers shall not face each other.

20.2 EQUIPMENT DESCRIPTION

20.2.1 Pyrite Hopper

One (1) pyrite hopper shall be provided below each pulveriser. The pyrite hopper shall be made of minimum 10 mm thick steel plates conforming to IS: 2062. The pyrite hopper shall be provided with one pneumatic cylinder operated plate valve on upstream which will be normally kept in open position. Grid shall be provided in the hopper to prevent passage of over size material to mill reject vessel. One (1) chain/manual operated plate valve shall be provided to remove rejects collected on the grid manually. Pyrite hopper shall be provided with by pass chute with cylinder operated plate type valve to unload the pyrite hoppers on the ground in case of emergency. Pyrite hopper shall be provided with manual operated plate valve on downstream side which is normally kept in open position, as it is a maintenance valve. Pyrite hopper shall be provided with level probes and temperature switches. RF type level probe in the Pyrite hopper shall pick up the signal when the hopper is full to a preset level. Arrangement of nozzles to spray water by operating the solenoid valve in the spray water line shall be provided when temperature goes beyond the preset value.

There shall be sufficient vertical height between elevations of coal mill reject outlet & Pyrite hopper inlet that coal mill rejects get slides in Pyrite Hopper easily. The elevation of coal mill and pyrite hopper shall be designed accordingly for easy discharge of coal mill reject on auto as well as on manual mode in case of any emergency/non-operational of auto system.

20.2.2 Mill Reject Vessel

One (1) mill reject vessel shall be provided for each pyrite hopper to transport mill rejects to Mill reject Silo by means of pressure conveying system. Mill reject vessel shall be provided with one pneumatic cylinder operated inlet valve, outlet valve and air inlet valve. Level probe in Pyrite hopper is set to pick up the signal when mill rejects reach a preset level (evacuation cycle start permissive level) in the hopper. Whenever such a signal is picked up by the probe, the inlet valve is actuated to open and allow gravity feed of rejects into the mill reject vessel. After lapse of predetermined time, the inlet valve closes and compressed air is injected through air inlet valve and the vessel gets pressurized. At predetermined pressure, the outlet valve of the mill reject vessel opens and rejects are conveyed to mill reject silo through pipeline. As evacuation proceeds, vessel pressure drops and at a predetermined pressure, air inlet valve and outlet valve closes and the system gets ready for the next batch evacuation, commencement of which is signaled by level probe in the pyrite hopper.

20.2.3 Mill Reject Silo

Considering side mill arrangement, two (2) mills reject silos; one (1) for each mill bay shall be provided. Effective capacity of each silo shall be as mentioned in clause 20.1.2. The mill reject silo shall be provided with stainless steel liners on inner walls (vertical/sloping). Adequately sized bag filter to vent the conveying air to atmosphere, terminal boxes, level probe and pressure relief valve shall be provided on the top of mill reject silo. Manual operated discharge gate shall be provided at outlet of mill reject silo to unload the rejects into trucks. If necessary, adequately rated chute vibrators shall be furnished to ensure easy unloading of rejects. Each mill reject silo shall be provided with 3D radar type level sensing device mounted on silo roof.

20.2.4 Air Compressors

Two (2) - oil free, multistage, rotary screw type air compressors, one working and one standby shall be provided to supply air required for conveying mill rejects from mill reject vessel to mill reject silo. The compressors shall be of continuous indoor duty complete with air coolers, necessary valves with vent pipe work ducted to a safe discharge outlet. At least 10% margin shall be provided on compressor capacity and discharge pressure over and above the maximum flow requirement.

Technical requirements of screw compressors shall comply to the requirements mentioned in Volume III: Chapter 23: Compressed Air System.

20.2.5 Air Receiver

Four (4) 10M^3 Capacity Air receivers shall be provided for mill rejects handling system. Air receivers shall be designed in accordance with ASME Section-VIII or IS: 2825. Corrosion allowance of 3 mm shall be considered for the design. The air receiver shall be of vertical cylindrical design with dished ends. Out of 4

air receivers, one shall be provided at each compressor discharge and one each shall be installed in each bunkey bay.

The air receiver shall be designed for 1.5 times the compressor discharge pressure.

The air receiver shall have inlet/outlet connections, safety relief valves, fusible plugs, pressure transmitters, temperature transmitters, pressure gauges, temperature guage, flanged pipe connections, inspection manholes with automatic drain traps. Pressure gauges shall be provided at each air inlet line and on air receiver. The air receiver shall have structural platforms for maintenance of safety relief valves and instruments.

20.2.6 **Mill Rejects Conveying Pipe**

Mill Rejects conveying pipeline shall be MS ERW heavy grade to IS: 1239/3589. Pipes shall be joined by welding and all fittings, bends etc., shall be alloy cast iron (minimum 500 BHN hardness) and the radius of bends shall be not less than 3D.

20.2.7 General margin on selection of all equipment shall be 10%.

DATA SHEET

MILL REJECT HANDLIMG SYSTEM

S. No.	Item	Units	Description
1.0	**MILL REJECT SYSTEM**		
a	Duty		Continuous
b	Max Lump size of mill rejects	mm	(-) 40*
c	**Operation condition**		BMCR with worst coal firing
d	Rate of Rejects Generated per mill	TPH	3% of mill capacity or maximum actual whichever is higher
e	Total No. of Coal Mills	Nos.	As specified by Boiler manufacturer [minimum eight (8) nos.]
f	Temperature of Mill Rejects	Deg C	As specified by Boiler/Mill manufacturer
g	Storage Required for mill rejects	Nos.	One no. for each mill bay (for the proposed side mill arrangement)
h	Bulk Density of mill rejects		
	i) for volume considerations	T/m^3	1.6
	ii) for structural considerations	T/m^3	2.4
2.0	**MILL REJECT ISOLATION VALVES**		SS 410
a	Type		Knife gate
b	Material of construction		
	i) Body		Cast Iron FG 260 BHN
	ii) knife gate		10 mm SS – 304 nitriding to 500 BHN
	iii) Seat		Replaceable type alloy CI or SS smooth finished with 250 BHN hardness
c	Method of operation		Solenoid operated pneumatically actuated with provision for manual override facility
d	Emergency discharge chute ** with knife edge gate valves		Yes
e	Sizing Grid		Yes (To separate oversize rejects/ to give control feed to crushers, if proposed)
3.0	**MILL REJECT VESSEL**		
a	Location/ Quantity		Below Pyrite hopper
b	Type		Suitable for dense phase conveying
c	Material of Construction		Cast Iron/ fabricated out of MS plate construction will be as per ASME code for unfired pressure vessels or IS 2825
d	Conveying Pipes		IS: 1239/ IS:3589 Heavy Grade
e	Bends/ Fittings/ Laterals		Alloy cast iron, minimum 500 BHN hardness
4.0	**MILL REJECT SILO**		
a	Quantity		One no. for each mill bay (for the proposed side mill arrangement)
b	Construction		Steel Construction (MS IS 2062) with 3mm Thk SS 304 lining in

S. No.	Item	Units	Description
			conical as well as vertical portion
c	Type of level measurement and indicator		Continuous/ RF Type
5.0	**AIR COMPRESSOR**		
a	Type		Oil Free Screw type
b	Service		Mill Reject Conveying Air
c	Cooling		Water Cooled (DMCW)
d	Quantity		2 nos (1W+1S)
	For other technical details of screw compressor refer Chapter 23, Volume III.		
6.0	**BAG FILTER**		
a	Location/ Quantity		1 no. per silo
b	Type		Reverse pulse jet type
c	Material of Bags		suitable for prolonged operational temperature of 200 deg. C.
d	Air to cloth ratio	m/min	1.0 with isolation of 10% bags
e	Conveying air piping		MS ERW as per IS 1239 Heavy Grade upto 150 NB and IS 3589 above 150 NB.

NOTE:

1. *In case the bidder expects higher size from pyrite hopper outlet, then suitable capacity crusher shall be provided to bring down size of reject to (–) 40 mm for pneumatic type system offered, which shall be included in the base offer.

2. ** The wearing parts of all the valves shall be provided with abrasion resistant material of hardness of 350-400 BHN.

3. The capacity/capacities specified herein are the minimum requirements and any increase in the capacity/ capacities during detail engineering shall be taken care of by the bidder without any price implication.

CHAPTER 21

ASH HANDLING SYSTEM

CHAPTER – 21

ASH HANDLING SYSTEM

21.1 SCOPE

Ash handling system scope shall include bottom ash system, coarse ash system, fly ash system (wet & dry) and ash disposal system.

21.2 SYSTEM DESCRIPTION

21.2.1 Ash formed due to combustion of pulverized coal in the steam generator shall be collected as bottom ash in the bottom ash hopper or coarse ash in Economiser, SCR, air preheater, duct hoppers or fly ash in ESP hoppers.

21.2.2 Bottom ash shall be collected in the water impounded '3-V type' bottom ash hopper and conveyed to ash slurry sump through jet pumps. Ash collected in the economiser hoppers shall also be routed continuously to the BA hopper through flushing apparatus. The ash slurry from BA Hopper shall be conveyed to ash slurry sump and further pumped to ash disposal area by means of Ash disposal pumps.

21.2.3 Coarse ash from SCR hoppers, air preheater hoppers and duct hoppers shall be extracted by means of feeder ejectors and conveyed to coarse ash tank. The slurry collected in the coarse ash tank shall further be conveyed to the ash slurry sump by means of coarse ash pumps. Coarse ash from ash slurry sump shall be further conveyed to ash disposal area by means of ash disposal pumps.

21.2.4 Fly ash from Electrostatic Precipitator hoppers shall be extracted through vacuum system and conveyed to buffer hoppers and subsequently from buffer hoppers to fly ash silos through pressure conveying system. Fly ash shall be further disposed in dry form through closed tankers or in moistened form through open trucks.

In addition to the dry fly ash collection system to silos, fly ash collected in ESP hoppers shall be automatically and sequentially extracted in dry form to the collector tanks (located above to buffer hoppers) for wet disposal through vacuum created by vacuum pumps. Dry fly ash while routed to the collector tank shall pass through wetting head where water shall be mixed with the dry fly ash and resultant ash slurry shall be discharged in to collector tank. One air washer shall be provided on each collector tank to clean the air passing to mechanical exhauster. Adequately sized jetting nozzles shall be provided below each collector tank to further convey the slurry to the ash slurry sump by gravity.

21.2.5 Fly ash slurry from collector tanks shall be routed to ash slurry sump under gravity through pipes. Ash slurry collected in the ash slurry sump shall be pumped to the existing ash disposal area through Ash disposal pumps.

21.3 BOTTOM ASH SYSTEM

21.3.1 Bottom Ash System shall consist of 3-V shaped, water impounded, storage type, water-cooled refractory lined bottom ash hopper located directly below the bottom water wall header of boiler. Bottom ash (BA) shall be collected continuously. The effective storage storage capacity of BA hopper shall be minimum eight (8) hours ash generated while firing worst coal measured upto

600 mm below maximum water level of the BA hopper. Bottom ash shall be evacuated once in a shift of 8 hours.

21.3.2 BA hopper shall consist of three sections, each section provided with two clinker grinders & electric drives installed directly below the feed gate assembly to limit the size of clinkers to maximum 25 mm. Two clinker grinders shall be provided for each V section. Out of two clinker grinders provided for each section, one grinder shall operate while other is standby. Operation of the grinder motor shall be electrically interlocked with the grinder seal water pressure, jet pump inlet water pressure and BA disposal line pressure. Electrical interlocks shall be such as not to permit operation or to stop the motor in case grinder seal water pressure or jet pump pressure happens to be below the minimum required value. If the clinker grinder roll jams or grinder gets overloaded owing to big clinkers or otherwise, the grinder motor shall automatically reverse its direction immediately. After a preset time, the grinder motor shall move forward automatically. Jet pumps shall carry bottom ash slurry from clinker grinders to ash slurry sump through MS ERW pipes.

21.3.3 Bottom Ash Hopper overflow shall be routed through overflow seal box to bottom ash over flow sump for onward disposal to clarifier located adjacent to ash water sump for reuse in ash water system.

21.3.4 The bottom ash hopper associated equipment shall be located above ground for ease in maintenance. Jet pumps and piping may be below FFL in a trench in bottom ash hopper area. Further the pipes shall be routed on a pipe rack.

21.3.5 Ash collected in economiser hoppers shall be extracted and conveyed to bottom ash hopper continuously by means of flushing apparatus located below each economiser hopper. Necessary water seal type expansion joints shall be provided in the upstream of the flushing apparatus. Flushing apparatus shall create momentum required for continuously removing the economiser ash from hoppers and mixing ash falling under gravity. The removal rate of each Flushing apparatus shall be 4 TPH. The resultant slurry shall be conveyed to bottom ash hopper.

21.4 COARSE ASH HANDLING SYSTEM

21.4.1 Coarse ash collected in SCR hoppers, Air pre-heater hoppers and Duct hoppers shall be automatically extracted and conveyed through the feeder ejectors located below each hopper. Necessary vacuum/momentum required for extracting the ash from the hoppers shall be created by the feeder ejectors. The coarse ash slurry thus produced shall be routed to coarse ash tank located in boiler area. The slurry collected in the coarse ash tank shall be conveyed to the ash slurry sump through coarse ash pumps.

21.5 DRY FLY ASH HANDLING SYSTEM

21.5.1 Fly ash collected in various ESP hoppers shall be extracted and conveyed to buffer hoppers automatically and sequentially by means of vacuum generated by Vacuum pumps and shall be transported to fly ash silos by means of pressure conveying system through buffers hoppers. Adequately rated oil free, lobe/helical type Conveying Air Blowers shall be provided to supply compressed air required for conveying fly ash from buffer hoppers to fly ash silos. Two (2) buffer hoppers (1W+1S) shall be provided for each vacuum stream. Adequately sized bag filters with air to cloth ratio not more than 1.0 M/min shall be

mounted on each buffer hopper. Eight (8) fly ash conveying streams shall be provided to convey dry fly ash from buffer hoppers to fly ash silos as shown in the flow diagram.

The cycle time of each ash vessel (which include opening/closing of associated valves, venting and transporting of fly ash from ash vessels installed below buffer hoppers) shall not be more than twenty (20) cycles per hour.

21.5.2 Two (2) fly ash storage silos in RCC construction with RCC staircase shall be provided, each having an effective storage capacity of 2500 M^3. Each silo shall be provided with four outlets; two for unloading ash in dry form into closed trucks through telescopic chute; one for unloading ash in conditioned form into open trucks through ash conditioner and fourth outlet with blind flange for future use. Each fly ash silo shall be provided with adequately rated vent filters with air to cloth ratio not more than 1.0 M/min mounted over top of silo. The vent filters shall be sized for conveying dry fly ash from all the fly ash streams into one silo. Air quality at filter outlet shall be less than 30 mg/Nm^3. Each storage silo will be provided with the following:

i. One (1) 3D Radar/acoustic type sensing device for Ash Level detection. Display of level shall be available at local weigh bridge room and ash handling control room.

ii. One (1) Vacuum cum Pressure relief valve to take care of any positive or negative excrusion of pressure in the silo.

21.5.3 Two (2) (1W+1S) adequately rated, low speed, oil free, lobe type fluidizing air blowers with heaters shall be provided for fluidizing ESP Hoppers and buffer hoppers to maintain the temperature of fly ash at 120^0 C above minimum ambient temperature at site. Temperature of 80^0 C of fly ash at silo outlet/loading end shall be ensured and demonstrated at the time of performance test.

21.5.4 Three (3) (2W+1S) adequately rated, low speed, oil free, lobe type fluidizing air blowers with heaters shall be provided for fly ash silos; one working per silo and one common standby to maintain the temperature of fly ash at 120^0 C above minimum ambient temperature at site.

21.5.5 Two (2) (1W+1S) adequately rated, oil free, screw type Instrument air compressors with air driers and air receivers shall be provided for supplying instrument air for all needs of ash handling system. Minimum capacity of the instrument air compressors and air driers shall be 1300 M^3/hr @ 8.5 kg/cm^2 (g). Air compressors and Air Dryers shall be as specified for main compressors as per Chapter 23, Volume III.

21.5.6 Six (6) (4W+2S) rotary oil free lobe type conveying air blowers of suitable capacity with necessary accessories shall be provided for conveying fly ash from the ash vessels (below buffer hoppers) to Fly Ash silos. Temperature of 80^0 C of fly ash at silo outlet/loading end shall be ensured and demonstrated at the time of performance test.

21.5.7 Sixteen (16) (8W+8S) vacuum pumps shall be provided to create necessary vacuum required to convey dry fly ash from ESP hoppers to buffer hoppers.

21.6 Wet Fly Ash Handling System

Fly ash collected various ESP hoppers along the flue gas path shall be automatically and sequentially extracted and pneumatically conveyed in dry form to the proposed collector tanks through vacuum created by Vacuum Pumps. Dry fly ash conveyed to the collector tank shall pass through wetting head where water will be mixed with dry fly ash and resultant ash slurry shall be discharged into collector tank. One air washer shall be provided on each collector tank to clean the air passing to mechanical exhauster. Flow of air to the Vacuum Pumps shall contain negligible dust. Air washer drain shall be connected to collector tank discharge pipe.

Adequately sized jetting nozzles shall be provided below each collector tank to further convey the slurry to the ash slurry sump through pipes by gravity. Adequately sized fly ash slurry pipe lines shall be provided to convey fly ash slurry from collector tank discharge to ash slurry sump as shown in the flow diagram.

21.7 Ash Disposal System

21.7.1 Bottom ash, coarse ash and fly ash slurry collected in the ash slurry sump shall be pumped to ash disposal area. Three (3) ash disposal pumping series with associated pipes and valves as shown in the flow diagram shall be provided. Out of the three (3) slurry pumping series; one series shall be operating for bottom ash & coarse ash disposal, one series shall be operating for wet fly ash disposal and one series shall be stand by. Each pumping series shall be provided with a disposal pipeline up to ash disposal area incluing garlanding. Each disposal pipe length shall be considered as 7 KM from the pump house.

21.7.2 First stage ash disposal pump shall be provided with variable speed fluid coupling and gearbox. Variable speed fluid coupling shall be designed for (+) 10% and (-) 40% speed variation of the rated pump speed. Balance pumps in the series shall be provided with belt drives.

21.7.3 The existing ash dyke is located around 5.2-6 km from the proposed ash disposal pump house. Ash slurry pipes shall shall be routed from proposed ash disposal pump house on pipe rack/RCC pedestals.

21.7.4 Nearest ash dyke i.e., Ash dyke A is 5.2 KM from ash slurry pump house and farthest ash dyke i.e., ash dyke B is approx 7 KM from ash slurry pump house. Each ash dyke shall be having 3 discharge point for all the three lines. A total length of 24000 M shall be considered in the scope of supply for 3 ash disposal pump series.

21.7.5 Sleeve type couplings shall be provided at a maximum distance of 36 M interval for periodic rotation of pipes. Pipes and fittings shall be joined by sleeve couplings.

21.7.6 Ash disposal pipes shall be interconnected after the ash disposal pump house as shown in the flow diagram.

21.8 Water System

The water requirement of the ash handling system shall be met from Cooling Tower blow down, raw water system and ash water recovery system. Connection from raw water system shall be used for slurry sump make up, fast fill and emergency makeup purposes. Clarified water as necessary for equipment sealing shall be tapped from service water system. To cater the needs of water requirements of ash handling system, following pumps shall be provided.

21.8.1 Bottom Ash Water Pumps

Two (2) (1W+1S) Bottom Ash water pumps shall be provided to meet the water requirements of jet pumps, feeder ejectors and jetting nozzles in coarse ash tank.

21.8.2 Eco Water Pumps

Two (2) (1W+1S) Eco Water Pumps shall be provided for flushing apparatus below economiser hoppers. These pumps shall be located in Boiler area and tapped from LP water pumps header.

21.8.3 LP Water Pumps

Two (2) (1W+1S) LP Water Pumps shall be provided for refractory cooling, BA hopper cooling, BA hopper and coarse ash tank make up and water requirement of flushing apparatus below Economiser hoppers.

21.8.4 Fly Ash Water Pumps

Two (2) (1W+1S) Fly Ash Water Pumps shall be provided to meet the water requirements of wetting heads, air washers, jetting nozzles below collector tank.

21.8.5 HP Seal Water Pumps

Two (2) - (1 working + 1 standby) seal water pumps shall be provided for sealing of ash disposal pumps. For sealing the coarse ash pumps, the water shall be tapped from service water tank system.

21.8.6 LP Seal Water Pumps

Two (2) (1W+1S) LP Seal Water Pumps shall be provided for sealing of drain pumps, sludge pumps, vacuum pumps, clinker grinders and slurry sump/coarse ash tank agitation.

21.8.7 Dust conditioner water pumps

Three (3) (2W+1S) dust conditioner water pumps shall be provided for conditioning of ash before unloading of ash in to open trucks.

21.8.8 Drain pumps

Eight (8) Drain pumps shall be installed for the ash handling system. Out of 8 drain pumps, two (2) pumps shall be installed in BA hopper area sump, 2 drain pumps in drain sump of vacuum pump room, 2 drain pumps in ash disposal pump house and 2 drain pumps in fly ash silo area. Out of 2 pumps in each

sump, one shall be working and one shall be standby. The discharge of BA hopper area sump shall be routed to BA Overflow tank. The drains of Vaccum pump house shall be routed to clarifier located adjacent to ash water sump, while the drains from fly ash silo area shall be routed to ash slurry sump.

21.9 System Capacities

21.9.1 Bottom Ash Handling System

The bottom ash and economizer ash shall be evacuated once in a shift in two hours fifteen minutes considering 3 jet pumps working simultaneously.

21.9.2 Coarse Ash Handling System

The coarse ash shall be evacuated once in a shift in one (1) hour considering 3 or 4 feeder ejectors working simultaneously.

21.9.3 Fly Ash Handling System (both wet and dry mode)

Fly ash system shall be designed to remove fly ash in maximum five (5) hours per shift of 8 hours while firing worst coal and considering six (6) streams operating simultaneously.

21.9.4 Ash Disposal System

Capacity of ash disposal system shall be minimum 850 M^3/Hr. Number of pumps in each series shall be decided based on the frictional losses and static rise in the ash disposal system. The number of pumps in each series shall be selected as per system requirement. A static rise of 15 M shall be considered for pump head calculations.

Eachpipe on the ash dyke shall be provided with 6 dyke end valves (3 for each dyke). In addition, 6 valves shall be provided for selection of Dyke A or Dyke B for each stream. .

21.9.5 Fly Ash Unloading System

Telescopic chute (below FA Silo)	: 180 TPH
Ash conditioner (dry ash basis) (below FA Silo)	: 180 TPH

21.10 General Requirements

21.10.1 General

Ash collection at various points expressed in percentage shall be considered as follows for ash handling system design:

Bottom ash collection including economizer ash	: 25%
Ash collection in SCR, APH/Duct hoppers	: 5%
Ash collection in ESP hoppers	: 85%

21.10.2 Density of Ash

(a) Bottom ash

(i) For volume calculation : 850 kg/M^3
(ii) For design of structures & supports : 1600 kg/M^3

(b) Fly ash

(i) For selection of pneumatic handling system (for vessel sizing) : 750 kg/M^3
ii) For sizing of silo capacity : 750 kg/M^3
iii) For design of structural supports : 1600 kg/M^3

(c) Particle density of ash in water : 2000kg/M^3

21.10.3 Frictional Factors for calculating pressure drop

(i) Friction factor 'C' for Ash slurry lines : 140
(ii) Friction factor 'C' for Sludge lines : 120
(iii) Friction factor 'C' for Recovery Water lines : 100
(iv) Friction factor 'C' for BA overflow lines : 120
(v) Friction factor 'C' for Water Lines : 100

Basis for selection of capacities of various tanks/sumps

(i) Bottom ash overflow sump : 10 min
(ii) Slurry sump (each compartment) : 5 min
(iii) Ash Water Sump (based on water balance): 60 min
(iv) Drain sump (ADPH & blowerroom) : 10 min
(v) Sludge pit : 10 min

21.10.4 The ash concentraction (w/w) for ash disposal system shall be as follows:

i) For bottom ash slurry disposal : 25% max.
ii) For fly ash slurry disposal : 30% max.
iii) For combined ash slurry disposal : 28% max.

21.10.5 All water pumps, vacuum pumps, fluidizing/conveying air blowers, instrument air compressors shall have 15% margin over capacity and 10% over pipe frictional losses. BA Overflow pumps, Coarse ash pumps and Ash disposal pumps shall have 10% margin over pipe frictional losses.

21.10.6 Pollution Considerations

a) Liquid Effluent: For liquid effluent generated in the Ash Handling Plant, the provisions of MINAS (Minimum National Standard)-COINDS/21/ 1986 shall be followed before discharging water to the recipient environment. In case there is any specific requirement of the state pollution authorities over & above MINAS stipulations, the same shall be taken care of in the Effluent Treatment Plant.

b) Thermal Pollution: The system design shall be such that a large surface area (provided in the ash dyke) shall adequately cool the recovery water. Besides, it shall be noted that there is, as such, no direct discharge of water to the recipient environment without treatment. Therefore, the stipulations of thermal pollution shall be met.

c) Particulate Emission: Vent filters, Air scrubbers shall be provided at

logistic locations to arrest any sort of particulate emission in the ambient to restrict the SPM within permissible limit.

d) Noise Pollution: Average evaluated sound pressure levels shall be within 85 dBA measured at a distance of 1 M from the equipment concerned as per Noise Rating Curve ISO 85.

21.11 **General requirements**

21.11.1 The fly ash from buffer hoppers to Fly Ash Silo shall be through pressure conveying system and the pickup velocity of air ash mixture shall not exceed 15 M/second.

2111.2 The velocity of ash slurry (bottom ash, coarse ash & ash slurry) in the pipeline shall not be less than 2.3 M/sec and shall not exceed 2.8 M/sec.

21.11.3 All fittings (bends/laterals, etc) for ash conveying (wet and dry) shall be integral wear-back alloy cast iron with minimum 450 BHN hardness. The radius of bends for ash conveying pipes (dry/wet) shall be minimum 3 times the pipe diameter.

21.11.4 Fluidizing elements in ESP hoppers, fly ash silos, and ash vessels shall be ceramic tiles and shall withstand temperatures up to 200^0 C. Two (2) Fluiding tiles shall be provided for each ESP hopper. The hoppers which are under evacuation shall be fluidized.

21.11.5 Fly ash silos, buffer hoppers etc shall be provided with access ladders, Pressure/vacuum relief doors, staircase from ground level to top. Intermediate platforms as required in buffer hopper area and collector tank area to carry out routine maintenance activities shall also be provided.

21.11.6 The emission levels at the outlet of the bag filters (buffer hoppers, silo roof) shall be limited to 30 mg/Nm^3.

Adequate anti-static protection shall be taken in design to prevent any possibility of dust explosion within the silo/bag filters. The performance of the bag filters shall not get affected with 10% of the bags plugged.

21.11.7 **Mechanism to unload extra ash from overloaded vehicles to other empty vehicles with the help of vacuum pump/blowers shall be provided.**

21.11.8 **Automatic water spraying arrangement for cleaning the ash from loaded vehicles body before going out of the plant shall be provided.**

21.12 **Layout and Maintenance Requirements**

21.12.1 **Layout Requirements**

21.12.1.1 The layout of water pumps/ash disposal pumps shall be such that it shall be possible to maintain any pump without disturbing the operating pump set and also it should not be necessary to dismantle the discharge piping for removing any water pump.

21.12.1.2 The layout of water piping for the ash handling system shall ensure that all valves are located so as to be conveniently accessible. All the water piping to

bottom ash hopper area, coarse ash, fly ash area and silo area from the pump house shall be routed in the overhead pipe rack.

21.12.1.3 The overhead piping shall be routed on pipe rack with clear height of 6 M from Finished floor level (FFL). At road crossings, the clear height shall be 8 M.

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

21.12.1.5 A minimum clear head room of 6M shall be provided below the fly ash storage silos platform floor for the movement of trucks.

21.12.1.6 Access walkways/steps in the pump houses, control rooms, etc., shall be minimum 1M wide. Suitable galvanized hand railing shall be provided for personnel safety, wherever required. Access/ maintenance platform of 1M width with chequered plate all around the BA hopper shall be provided.

21.12.1.7 All local panels, distribution boards, lighting panels, junction boxes, terminal boxes, marshalling boxes, push button stations, etc., shall be located in accessible locations permitting maintenance.

21.12.1.8 Minimum rear space for local panels and distribution boards shall be 1000 mm from the nearest obstruction. Cabling shall be done clearing any interference between collars, greasing points and dust collection. There shall be minimum 2 M headroom below runoff cable trays.

21.12.1.9 Local control panels requiring operator's attention shall not be located in dust prone areas. Local panels in each area shall be housed in a dust proof cabin to minimize dust nuisance.

21.12.2 **Maintenance Requirements**

21.12.2.1 Facilities for carrying out online and off-line maintenance of ash handling system shall be provided. In general, this shall include adequate handling equipment, working space, platforms and safety devices.

21.12.2.2 Inspection windows shall be provided for bottom ash hopper and feed gate housing. Water jet connection shall be provided for each of the glass windows for cleaning.

21.12.2.3 Manual poke holes and access door (with hinged cover) at bottom ash hopper shall be provided. Access hand-hole (with hinged cover) shall be provided for feed gate housing.

21.12.2.4 Maintenance platform of minimum 1 M width with handrails and access ladders shall be provided below economiser, SCR, air pre-heater and duct hoppers.

21.12.2.5 Isolating valves for water lines shall be provided at an easily accessible location on the lines going towards bottom ash hopper area and to the equipment located below fly ash storage silo for easy maintenance.

21.12.2.6 All pump houses and buildings shall be provided with adequately rated single girder EOT cranes. Underslung cranes are not acceptable. Monkey ladders etc shall be provided to reach EOT crane for maintenance. Suitable maintenance

platforms (2Mx2M) shall be provided at one end of the building at EOT crane level.

21.12.2.7 Adequately sized electric hoist shall be provided on Silo roof for maintenance of equipment. The lift of the hoist shall be considered for lifting equipment from ground level to roof top. Both Silos shall be inter connected at operating floor and Silo roof top.

21.12.3 The following criteria shall be considered for sizing various buildings:

21.12.3.1 Ash slurry pump house

a) Ash slurry sump shall have three compartments with one common trough with 3 nos. 600 dia manual gear operated plug gates. Each compartment shall be sized for five (5) minutes storage capacity of slurry flow (between high & low level). Independent sump for each pumping stream shall be provided. Hand railing shall be provided all around the sump top. 600 mm wide access ladders shall be provided to access bottom of each compartment.

b) 1 M wide RCC platform shall be provided along the length of slurry pump house, before first stage pump and after last pump in each stream. Stairs shall be provided at both ends of the platform and between 2 ash disposal pump series.

c) Two rolling shutters of 5 m wide x 6m height (min) size shall be provided.

e) Ash slurry sumps shall be clear of intermediate columns. Further the pump house shall also be provided with columns only at periphery without any intermediate columns.

f) One maintenance bay shall be provided in the pump house for equipment maintenance

21.12.3.1 Ash Water Pump House

a) The pump house shall also be provided with columns only at periphery without any intermediate columns.

b) 1 M wide stair case shall be provided for access to the top of the sump.

c) Access ladder of 600 mm wide shall be provided to access bottom of each compartment and common bay.

d) One maintenance bay shall be provided in the pump house for equipment maintenance.

21.13 **Clarifier**

21.13.1 One adequately sized clarifier shall be provided for treating ash laden water recovered from BA Overflow and drains from vacuum pump house. The specification of clarifier shall be same as specified in chapter 4.0 (Pre-treatment Plant). Needed chemical dosing system shall be provided. Clarifier outlet water quality shall be 20 ppm maximum.

21.13.4 The sludge from the clarifier shall be pumped to the common sump of ash slurry sump.

DATA SHEET

ASH HANDLING SYSTEM

S.No.	Item	Unit	Description
1.0	**Bottom Ash Hopper**		
1.1	Numbers required		One (1)
1.2	Type of Hopper		Water impounded, refractory lined, 3-V shaped hopper
1.3	Storage capacity of ash 600 mm below operating water level		8 hours bottom ash generated while firing worst coal (minimum)
1.4	Material of construction and Minimum thickness of hopper plate	mm	MS to IS 2062 Grade B and 10mm. Top 1100 mm of the hopper including seal trough shall be constructed of minimum 6 mm thick stainless steel plates
1.5	Type of lining and thickness		230 mm thick Monolithic castable refractory
1.6	Material of construction of wear plates		Ni-Hard Cast Iron (min 350 BHN)
1.7	Material of housing wear plate		25 mm thick CI IS-210 Gr. FG-260
1.8	Seal trough material thickness	mm	Minimum 6 mm thick Stainless steel 316 integral construction
1.9	Refractory holding anchors		SS 304, min 3 mm thk
1.10	No & size of Poke Doors		6; 150 mm diameter.
1.11	No & size of inspection windows		6 (150 mm diameter)
1.12	No of access doors and size		3; 600 x 1050 mm
1.13	Material of construction of Nozzles		SS (min 500 BHN)
2.0	**Feed Gate**		
2.1	Quantity and Size		6 nos. and 900 x 900 mm (min)
2.2	Material of construction of gate		CI as per IS 210 Gr FG 260
2.3	Feed gate housing material and thickness		MS to IS 2062 Grade B; 10 mm thick (min)
2.4	Liner/wear strip		SS 316; 6 mm thick
2.5	Gate operation method		Air Oil convertor tank
2.6	Access doors with inspection windows		Required; 450 mm dia.
2.7	Material of housing wear plate/impingement plates		25 mm thick CI IS-210 Gr. FG-260
3.0	**Air Oil Converter tank**		
3.1	Type of operation		4 way solenoid valve
3.2	Location		Near BA Hopper
3.3	Material of construction		MS to IS 2062
3.4	Corrosion Allowance		1mm
3.5	Accessories		Relief valve, drain valve; all air & oil pipe works with four way Solenoid Valves, isolation valves, pressure hoses etc
4.0	**Clinker Grinder**		
4.1	Quantity &Type		6 (3W+3S); Heavy duty Double Roller

S.No.	Item	Unit	Description
4.2	Type of drive unit		Chain and sprocket driven through gear box and fluid coupling. Drive motor speed not to exceed 1000 rpm and shall be sized for frequent start stop reverse stop & start duty
4.3	Speed		clinker grinder speed shall not exceed 40 rpm
4.4	No and type of bearings per roller		2; spherical roller bearings
4.5	Interlocks to grinder drive		Required
4.6	Material of construction		
4.6.1	Housing		MS to IS 2062; 10 mm thk
4.6.2	Grinder Rolls & teeth		Manganese Steel, 12-14% Mn to IS 276
4.6.3	Wear Plate		10 mm thick Manganese steel 12-14% Mn
4.6.4	Liner		ACI to IS 4771; 400 BHN
4.6.5	Shaft		EN 8
4.6.6	Shaft Sleeves		SS 400 series hardened to 500 BHN
5.0	**Jet Pumps**		
5.1	Quantity/location		Below BA Hopper
5.2	Maximum size of ash particle	mm	25
5.3	Ash removal capacity	TPH	By bidder
5.4	Discharge point		Ash slurry sump
5.5	Material of construction		
5.5.1	Inlet piece, throat, tail piece		Hi chrome as per ASTM A 532 class III 550 BHN
5.5.2	Nozzle		SS 400 series, hardened to 550 BHN
5.5.3	Feed sump		10 mm thk MS-IS 2062 Grade B
6.0	**Hopper Isolation Valves**		
6.1	Location		Below SCR/Economiser/APH/ Duct/ESP hoppers
6.2	Method of operation		Manual
6.3	Material of construction		
6.3.1	Body		ACI 230 BHN
6.3.2	Gate		10 mm thick MS hard chrome plated
7.0	**Fly Ash Extraction Valves**		
7.1	Location		below ESP hoppers
7.2	Type & Method of operation		Slide plate type; Air Electric operated
7.3	Material of construction		
7.3.1	Body		ACI 230 BHN
7.3.2	Valve Seat		ACI 350 BHN
7.3.3	Valve Plate/Slide Gate		SS 400 series hardened to 500 BHN
7.3.4	Valve outlet piece		ACI 350 BHN
8.0	**Branch Isolation Valves**		
8.1	Quantity		As per system requirement

S.No.	Item	Unit	Description
8.2	Type & Method of operation		Air Electric operated
8.3	Material of construction		
8.3.1	Body		ACI 230 BHN
8.3.2	Gate/slide		SS 400 series hardened to 400 BHN
8.3.3	Replaceble seat (inlet/outlet)		ACI 350 BHN
9.0	**Air intake valves**		
9.1	Location		Ash conveying lines
9.2	Type		Spring loaded
9.3	Material of construction		
9.3.1	Body		CI as per IS 210 FG Gr 260
9.3.2	Disc		SS 316
9.3.3	Spring		Spring Steel
9.3.4	Spring seat, spring rest, spring stop guide		M.S
10.0	**Vacuum Breaker**		
10.1	Quantity		One per fly ash stream
10.2	Type & Method of operation		Air Electric operated; automatic
10.3	Material of construction		
10.3.1	Body		ACI 230 BHN
10.3.2	Gate/slide		SS 400 series hardened to 400 BHN
10.3.3	Replaceble seat (inlet/outlet)		ACI 350 BHN
11.0	**Vacuum Pumps**		
11.1	Quantity and Type		12(6 W+6 S); Low speed Liquid Ring Type driven by electric motor
11.2	Vacuum		Minimum 16” Hg
11.3	Material of construction		
11.3.1	Casing, heads		CI to IS 210 FG Gr 260 with SS-316 lining/cladding
11.3.2	Cones		SS-410
11.3.3	Shaft		EN 24
11.3.4	Rotor		Stainless Steel-410
11.3.5	Shaft Sleeves		Stainless Steel- 316
11.4	Type of drive		Belt/direct driven
11.5	Max Tip Speed of Impeller		15 m/s
12.0	**Bag Filter**		
12.1	Quantity and Location		16 Nos. ; On top of each Buffer hopper
12.2	Type		Reverse Pulse Jet Type
12.3	Material of Filter Bag		Nomex
12.4	Air to Cloth ratio (max)		1.0 M^3/minute/M^2
12.5	Efficiency Maximum outlet dust emission		99.9% 30 mg/NM^3
			Vent fans shall be provided with drive motors and accessories
			The performance of the bag filters shall not be affected with 10% of bags plugged.

S.No.	Item	Unit	Description	
13.0	**Fly Ash Inlet/Outlet Valves (below buffer hoppers)**			
13.1	Type		Swing Disc/ Dome Valve	
13.2	Location		below buffer hopper	
13.3	Quantity		1 per Ash Vessel	
13.4	Operation		Solenoid operated pneumatically actuated with provision of manual override facility.	
13.5	Material of construction			
13.5.1	Valve Body		ACI with 230 BHN	
13.5.2	Disc		Minimum 10 mm thick; ACI 500 BHN	
13.5.3	Seat		Hi chrome ASTM A 532	
14.0	**Ash Vessel**			
14.1	Location		Below Buffer Hopper	
14.2	Type		Top/Bottom discharge as per manufacturer's design	
14.3	Body material		10 mm thk MS/IS 2062 Grade B	
14.4	Fluidizing arrangement		Required	
14.5	No. of cycles		20 per hour (max)	
15.0	**Instrument Air Compressors**			
15.1	Quantity		2 (1W+1S)	
15.2	Capacity & pressure		Minimum 1300 m^3/hr @ 8.5 kg/cm^2(g) (10% margin shall be provided on compressor capacity over and above the maximum flow requirement)	
15.2	Type		Oil free rotary screw type	
15.3	Material of Construction			
15.3.1	Compressor casing, gear casing/rotor housing		CI coated with corrosion resistant material	
15.3.2	Rotor		Forged Carbon Steel coated with corrosion resistant material	
15.3.3	Timing Gears		Low Alloy Steel	
15.3.4	Inlet Throttle valve & housing		Aluminium/SS	
15.3.5	Drive shaft		low Alloy Steel	
15.3.6	Oil cooler		Plate type – SS 304	
15.3.7	Inter cooler/ After cooler tubes		SS 304	
15.3.8	Cooler casing		CI / MS	
15.4	Noise Level	max	85 dBA from 1M	
16.0	**Fluidising Air Blowers**		**ESP**	**SILO**
16.1	Quantity		2 (1+1)	3 (2+1)

S.No.	Item	Unit	Description
16.2	Location		Near ESP | Silo operating floor
16.3	Type		Oil free Rotary lobe (positive displacement type to meet the aeration air requirement of buffer hoppers & silos. 10% margin on capacity shall be provided over and above the maximum requirement)
16.4	Type of drive		Belt/direct
16.5	Medium of cooling		Air / Water
16.6	Material of construction		
16.6.1	Casing		CI to IS 210 FG Gr 260
16.6.2	Sliding vane/rotor		CI to IS 210 FG Gr 260
16.6.3	Shafts		EN-24
16.6.4	Bearing housing		SG Iron
16.6.5	Spur Gears		EN-353 to BS 970
17.0	**Conveying Air Blowers**		
17.1	Type		Positive displacement helical
17.2	Type of drive		Belt/direct
17.3	Medium of cooling		Air / Water
17.4	Material of construction		
17.4.1	Housing		CI to IS 210 FG Gr 260
17.4.2	Lobes		CI to IS 210 FG Gr 260
17.4.3	Shaft		High tensile Alloy Steel EN-19
17.4.4	Timing Gears		EN-353 BS 970
17.4.5	Base Plate		MS Fabricated epoxy painted
18.0	**Fly Ash Storage Silo**		
18.1	Quantity & construction type		2 Nos.; RCC
18.2	Capacity	M^3	2500
18.3	Accessories to be mounted on each Silo		
18.3.1	Vent Filters		Polyester; effiency 99.9 %; with air to cloth ratio of 1.0 (max)
18.3.2	Pressure/Vacuum Relief Door		Required
18.3.3	Level Probe		3D Radar/Acoustic type Level Scanner
18.3.4	Access ladder Silo Ash Level Transmitter Telescopic Chute with Level Switch Diff. Pr. Gauge & Diff. Pressure		Inside silo 1 no. per Silo 2 no. per Silo 1 no. per Silo

S.No.	Item	Unit	Description
	Switch across the Vent Filter Air Slides Particulate Emission at Ventfilter Outlet Free Board		CeramicTiles/Woven SS Mesh Below 30 mg/NM^3 750 mm
19.0	**WATER PUMPS**		
19.1	Quantity (working+ standby)	Ash per spec clause no. 21.8	
19.2	Type	Horizontal centrifugal split casing type	
19.3	Material of construction		
19.3.1	Casing	2% Ni CI to IS 210 FG 260	
19.3.2	Impeller	Stainless Steel CF 8M	
19.3.3	Shaft	SS 410	
19.3.4	Shaft Sleeve	SS 316	
19.3.5	Bearings	Antifriction	
19.3.6	Couplings	Cast/Forged Steel	
20.0	**Ash Disposal Pump, BA Overflow & Coarse Ash Pump**		
20.1	Type	Horizontal, centrifugal, Single Stage, double casing	
20.2	Duty	Continous	
20.3	Parameter (Head & Flow)	To be sized for maximum level of ash dyke. 10% margin shall be considered over and above the total straight pipe length and bends.	
20.4	Type of Coupling	Hydraulic/V-velt Type of coupling: Variable speed Hydraulic coupling with speed reduction by means of speed reduction gear box in first stage. Speed variation +10%/ - 45% with respect to rated design point in case of ash slurry disposal pumps and + 20% in case of B.A. slurry transportation pumps and B.A. over flow water transfer pumps.	
20.5	Fluid handled	Ash Slurry/BA Oveflow Water	
20.6	Suction Condition	Flooded	
20.7	Type of Drive	Belt/ direct drive through Fluid Coupling	
20.8	Gland sealing	Forced external water	
20.9	Material of construction		
20.9.1	Outer casing	CI IS:210 Gr. FG 260/SG Iron A 536	

S.No.	Item	Unit	Description
20.9.2	Inner casing, casing liners & impeller	ACI to IS 4771 Type 1(a) with 4.5% Ni with 500 BHN hardness; 24% Chrome alloy as per ASTM A532, 550 BHN	
20.9.3	Shaft	EN-24	
20.9.4	Shaft Sleeve	SS-400 series 500 BHN	
	Bolts & Nuts		
21.0	**Knife Gate valve**		
21.1	Body	Cast iron IS 210 Gr FG 260	
21.2	Plate/Gate	SS 316 (minimum 10 mm thick) with minimum 500 BHN surface hardness	
21.3	Stem	SS 304	
22.0	**Buffer Hoppers**		
22.1	Quantity	16 (8W+8S)	
22.2	Material of construction	10 mm thick MS plate as per IS 2062	
22.3	Aeration pads	As per requirement (Ceramic tiles/ woven SS mesh)	
22.4	Vent/ equalizing valve	2 Way Plug Valve/Dome Valve	
22.5	Lining	3 mm thick SS 400 series upto a height of 750 mm from discharge nozzle	
22.6	Bag filters	Nomax	
23.0	**Flushing Apparatus**		
23.1	Quantity and Location	1 no per hopper; below economiser hoppers	
23.2	Removal capacity	By bidder	
23.3	Material of construction		
23.3.1	Body	10 mm thick MS plate to IS 2062 Gr.A with 6 mm thick SS 400 series liner	
23.3.2	Nozzle	SS 400 series hardened to 550 BHN	
24.0	**Feeder Ejector**		
24.1	Ejector Head	Cast Iron IS 210 FG 260	
24.2	Discharge throat/inlet/tail pipe	High Chrome Alloy CI 550 BHN	

25.0 **Coarse Ash Tank**

25.1 One (1) – 50 M^3 capacity 10 mm thick mild steel to IS: 2062 fabricated coarse ash tank shall be provided to collect coarse ash slurry from feeder ejectors.

26.0 **Collector Tanks**

26.1 One adequately sized 10mm thick MS fabricated collector tank shall be provided for each fly ash stream. Collector Tanks shall be located above Buffer Hoppers at a height adequate to seal system vacuum and ensure slurry flow by gravity to the ash slurry sump. The tank shall be designed to withstand high pressure. It shall be provided with 20 mm thick replaceable alloy CI liners inside.

26.2 All accessories like access holes, manhole doors etc, shall be furnished. All pipe connections to collector tanks shall be flanged. All required staircases, grated platforms etc. shall be furnished.

27.0 **Wetting Head**

27.1 One adequately sized wetting head shall be provided for each fly ash stream for wetting dry fly ash and separating dust from transporting air. Wetting Head shall be mounted on collector tank.

27.2 Ejector haed shall be Cast Iron to IS 210 FG 260. Parts of the wetting head coming in contact with fly ash or ash water mixture shall be of alloy cast iron (225 BHN Hardness). Nozzles shall be stainless steel 400 series hardened to 550 BHN.

Three (3) flanged connections for air fly ash mixture inlet, water inlet and ash water mixture outlet shall be provided. One flanged connection with blind flange shall be provided for cleaning nozzles without removing wetting from position.

28.0 **Air Washer**

28.1 One (1) air washer shall be provided for each fly ash transport line for scrubbing away any carry over dust in air. It shall be fabricated out of 10 mm thick mild steel plates. The nozzles shall be fog jet type to have mist like flow and shall be easily renewable. Nozzles shall be stainless steel 304 fitted in cast bronze body.

28.2 Three (3) flanged connections shall be provided one for fly ash air mixture inlet, one for air outlet to Vacuum Pumps and other for ash water mixture drain. One screwed water/flanged inlet connection to fog jet nozzles shall be provided. Provision shall be made to remove the nozzles for cleaning purpose.

29.0 **Pipework**

	Description	**Fly Ash**		**Ash Slurry**	Water/ Conveying air/ fluidizing air	Instrument air (50 NB & below)
		ESP Hoppers to Buffer Hopper/ collector tank	Buffer hopper to Silos	Collector tank to slurry sump/ BAH/coarse ash tank to Slurry sump		
	Material of Pipe and thickness	CI to IS:1536/ BS:1211 Class D thickness	CI to IS 1536 class D/BS:1211 Class D	MS ERW to IS:3589; 9.52 mm thick	MS ERW to IS:1239(H)/ IS:3589 (thk 6.3 mm). Fluidizing air pipework shall be insulated	SS 304 Sch 10S
	Material of fittings	Alloy CI, integral wear back (min 450 BHN)/			Fabricated	-

	Type of joints	Sleeve type coupling	Sleeve type couplings	Welded/ flanged	Couplings (max 36M interval)	Screwed/flanged	Screwed/ flanged

30.0 FLUIDISING AIR HEATER

One (1) no. for each Fluidizing blower to be provided to maintain the discharge temperature of the air at least 120^0 C above minimum ambient temperature.

1.00	Application	Fluidizing Air Heating (ESP/ Buffer Hopper and Silo)
2.00	Working Atmosphere	Heavily dusty, tropical, power plant atmosphere.
3.00	Design ambient dry bulb Temperature	As per Project Data
4.00	Type	Electrical, (heating elements shall be segregated into two banks).
5.00	Quantity	As per Single line flow diagram
6.00	Rate of Air Flow	As per Blower parameter
7.00	Air Pressure	Based on Blower parameter.
8.00	Type of Duty	Continuous operation

31.0 ASH VESSEL

a) The vessel shall be designed for not more than one lakh cycles of operation annually for the specified ash evacuation rate.

b) Ash transporter /air locks/pump tanks shall be provided with necessary inlet and outlet valves of the type specified elsewhere in the specification.

c) The ash transporter /air locks/pump tanks vessel shall be constructed with tested quality mild steel plates as per IS:2062. They shall be able to withstand the abrasive action and hot condition of fly ash. The Ash transporter /Air locks/pump tanks shall be supported independently on steel columns or hanger support.

d) A full explanation to the air lock/pump tank operation cycle shall be supplied with the tender, listing all operations i.e. loading, fluidizing, and discharging. Calculation justifying size of venting connection is to be provided by Bidder.

e) Aeration pads, if felt necessary by the bidder to assist the flow of ash through the air-lock valves shall be provided.

CHAPTER – 22

FUEL OIL HANDLING SYSTEM

CONTENTS

CHAPTER – 22

FUEL OIL HANDLING SYSTEM

22.1 Introduction

The Fuel Oil Handling System as specified in this specification shall meet the requirements of the steam generating unit installed for the project.

22.1.1 Light Diesel Oil (LDO) shall be used for initial ignition, warm-up, coal flame stabilization and low load operations of the Steam Generating unit.

22.1.2 The light diesel oil (LDO) is being received at site in road tankers for the existing 2 x 300 MW units.

LDO from road tankers is unloaded to the existing unloading header by gravity which shall then be pumped to the existing LDO storage tanks through existing unloading pumps. The LDO from the existing LDO storage tanks is pumped to the existing day oil tanks through LDO forwarding pumps. It is proposed to tap the LDO required for the proposed 800 MW unit at Unit # 2 day LDO tank inlet header. Necessary booster pumps shall be installed in the existing Unit # 2 day farm area to transfer the LDO from the existing LDO forwarding header to the proposed 800 MW LDO Day tank.

22.2 Scope

The scope of the equipment to be furnished & erected under this specification is detailed hereunder. The items though not specifically mentioned but are needed to make the equipment / system complete and safe from operational view point, shall also be treated as though included and the same shall also be furnished and erected unless otherwise specifically excluded.

22.2.1 Tanks and Accessories

(a) One (1) 250 M^3 capacity LDO day tank. The tank shall be located in the proposed boiler area.

22.2.2 Pump Sets

(a) Two (2) (1W+1S) LDO Booster pumps each of 50 M^3/hour capacity (or matching the capacity of existing LDO transfer pump) each complete with all the accessories of drive and mounting as specified for forwarding the LDO from existing header to LDO day tank.

22.2.3 Piping System consisting of pipes, valves, fittings, supports etc.

(a) LDO piping and LDO drain pipe lines complete with all supports, hangers, strainers, bends, flanges, counter flanges, gaskets, valves, fittings, etc. All piping required to complete the system shall be furnished by contractor as specified.

(b) One (1) flow meter.

(c) LDO tanks shall be provided with fixed fire protection system using foam and medium velocity water spray system in line with requirements indicated in Volume III, Chapter 24.

(d) Adequately sized pipe rack to accommodate the pipes and power/control cables etc., from transfer line near existing LDO day tank to the proposed LDO Day tank shall be provided.

22.2.4 Other Services

(a) Approval is required from statutory authorities for the entire LDO storage and pumping installation. The bidder shall prepare all necessary drawings /data/documents as per the requirements of the statutory authority and obtain necessary approvals from the authorities.

(b) Interconnecting the existing LDO forwarding system to the proposed LDO day tank is included in scope of work. Necessary modification in the existing day tank farm area for carrying out the interconnection shall be done by the bidder.

22.3 Design and Construction

22.3.1 LDO Storage Tanks

22.3.1.1 Tanks shall be designed, fabricated, erected and tested in accordance with theIS:803, latest edition. Supporting framework wherever required, shall be in accordance with IS: 800, latest revision or equivalent.

22.3.1.2 The tanks shall be "Non-pressure" fixed roof type with atmospheric vents and shall be designed for an internal pressure of 66 kgf/cm^2.

22.3.1.3 Light Oil Storage tanks along with the associated facilities for the entire installation shall be in accordance with the requirements specified in the existing rules of Chief Controller of Explosives, Government of India.

22.3.1.4 Tanks shall be made from IS: 2062 mild steel plates of tested quality. The plates shall be cold rolled through plate bending machine by several number of passes to true curvature. The tanks shall be of welded construction.

22.3.1.5 Vessel seams shall be so positioned that they do not pass through vessel connections.

22.3.2 Tank Connections

22.3.2.1 All pipe material required for the tank connection shall be as specified.

22.3.2.2 Unless otherwise specified, for all flanged connections, Contractor shall furnish suitable counter flanges and necessary nuts, bolts and gasket materials. The flanges and counter flanges shall be fabricated from plates.

22.3.2.3 Flange faces of all nozzles shall be machined and shall be square with the vessel centerline.

22.3.3 Vent Line

22.3.3.1 The vent for LDO tank shall be of proven design.

22.3.3.2 The design shall be such as to offer adequate areas for venting. Venting area shall be such that over pressure/vacuum is not created in the tank during maximum filling / draw-off rate.

22.3.3.3 The vent sizing shall be done as per API Standard.

22.3.3.4 The open end of the vent line shall be covered with two layers of fine copper wire gauge of not less than 11 mesh/cm. and fitted with hood.

22.3.4 **Lightning Protection**

Bidder shall install a lightning protection system conforming to the requirements of IS-2309 (as per Clause 14 for protection of vessel tanks containing flammable liquids). System shall constitute suitable number of horizontal and vertical air terminals. All the air terminals shall be connected to the risers of underground earth mat provided 300 mm above ground. Connection of lightning down comers to the risers shall be in the scope of the Bidder.

22.3.6 **Precautionary Measures**

22.3.6.1 No oil connection shall be made to any tank for any purpose until the tank is ready to be filled with oil.

22.3.6.2 After oil connections have been made to a tank, no welding or any other hot work shall be carried out on the tank for repairs or any other purpose until all lines connected to the tank have been disconnected, the open ends of the pipelines blanked off and the tank and its vicinity tested and found gas free.

22.3.6.3 When a tank has once contained oil, no welding or other hot work shall be done on it for any purpose until the tank has been completely emptied and the Employer issues gas free and written authority for the work.

22.4 **Technical Specification & Datasheet for Tanks**

22.4.1 **LDO Storage Tanks**

i)	Type of Construction	Vertical Cylindrical, non – pressure, fixed roof type with atmospheric vents
ii)	Codes	Design & Construction as IS 803
ii)	Design Pressure	
	a) Internal Pressure	66 kgf/cm^2
	b) Vacuum	63.5 kgf/cm^2
iv)	Design Temperature	Atmospheric
v)	Effective Capacity	250 M^3
vi)	Material of Construction	
	a) Tank Shell, Bottom	IS 2062 Tested Quality Plates
	b) Structural	IS 2062 Tested Quality Plates
vii)	Corrosion allowance (minimum)	3 mm

viii)	Shell joint efficiency factor	0.85 with 10% radiography
ix)	Vent	Tank shall be provided with open & free flow type atmospheric vent, which allows unimpeded flow of vapors out of and allows air into tank and at the same time prevents rain and air borne duct from getting into the tank.
x)	Nominal Venting capacity	Shall be obtained by reference to API guide for tank venting (API-2000)

22.5 **Piping**

22.5.1 Piping for 65NB and larger size shall be butt-welded and small piping 50 NB and below shall be socket welded.

22.5.2 Piping shall be capable of withstanding the maximum pressure as follows:

a) Fuel oil : 10 kg/cm^2 (g); 90^0 C
b) Instrument air : 8 kg/cm^2 (g), 45^0 C

22.5.3 The minimum thickness of the pipe as detailed in this specification shall be adhered to.

22.5.4 Outdoor support shall be provided with sliding movement of pipe over the support. All steel sliding support faces shall be covered with stainless steel plates with counter sunk screws on both top and bottom sliding faces of support.

22.5.5 All guides anchors braces, dampers, expansion joint and structural steel to be attached to the building/structure trenches etc.

22.5.6 The oil piping material shall conform to API-5L Grade B ERW pipe or site fabricated from min. 8 mm thick steel plates to IS:2062 Gr.B / IS:3589 Gr. Fe410 for size 450NB and above. For sizes 400 NB and below the pipe material shall be conforming to API-5L Gr.B ERW. The pipe thickness (min.) for oil service shall be as under.

a) 250/200 NB : 6.35 mm
b) 150 NB : 5.4 mm
c) 100 NB and below : As per IS 1239 (H)

22.5.7 Pipe sizes shall be selected as per following criteria of velocity of the fluid in the pipeline.

a) Suction side of the pump for oil & water application 0.6-1.2 M/sec.
b) Discharge side of the pump for oil & water application 1.0-1.5 M/sec.
c) Pipes for compressed air 15 M/sec. (max.).

22.5.8 Fittings for oil service shall be Butt welded fittings, conforming to ANSI B16.9 and material to ASTM-A-234. Fittings of 50mm size and below shall be socket welded conforming to ANSI B16.11, material to ASTM-A-105. Fittings for steam and condensate service shall be Butt welded fittings, conforming to ANSI 16.9 and material to ASTM A.234 Gr. WPB (forging). Fitting of 50mm size and below shall be socket welded conforming to ANSI B-16.11, material to ASTM-A-105 (Forging).

22.5.9 Vents at the highest point and drains at the lowest point shall be provided.

22.6 **Valves**

22.6.1 All valves shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate. The valves shall be full bore and sizes of valves shall be the same as that of the parent pipe.

22.6.2 All manually operated valves shall be provided with gear operator of proven quality, reputed make and conforming to internationally accepted standard, if the effort required to operate the valve exceeds 25 kgf.

22.6.3 All valves shall be provided with hand wheels, extension spindles and floor stands or any other arrangement wherever required so that they can be operated manually with ease by a single operator from the nearest operating floors either at a lower or higher elevation as the case may be. Wherever necessary for safety purpose, locking devices shall be furnished with valves.

22.6.4 **Gate Valves**

22.6.4.1 Gate valves shall be used for isolation purpose for all sizes in steam and condensate lines and for sizes above 300 NB for oil lines. The gate valves shall be provided with hand wheel, position indicator and draining arrangement.

22.6.4.2 Gate valves for sizes 50 NB and smaller, shall be of class 800, forged carbon steel valves with solid wedge, OS & Y rising stem, bolted bonnet with deep stuffing box and lantern ring. Trim shall be of 13% chrome steel. Body material shall conform to ASTM A 105 and ends shall be socket welded.

22.6.4.3 For sizes 65 NB and above, valves shall be of class 150/300 (depending on service), Cast Carbon Steel gate valves. Face to face dimensions shall be as per ANSI B 16.10. Body material shall be ASTM A 216 Gr. WCB and ends shall be flanged to ANSI 150/300 lbs rating with raised face. Other particulars shall remain same as above.

22.6.4.4 The valves shall conform to API-600/API-602 and shall be tested to API 598/IS: 6157 requirements. IBR certificates as necessary shall also be provided.

22.6.5 **Globe Valves**

22.6.5.1 Globe valves shall be used for regulation purpose for all sizes in steam condensate and oil lines. They shall be provided with hand wheel, position indicator and draining arrangement.

22.6.5.2 Globe valves for sizes 50 NB and smaller shall be of class 800 forged carbon steel valves with plug type disc. Other particulars shall be same as 22.6.4.2 above.

22.6.5.3 For sizes 65 NB and above, valves shall be class 150/300 (depending on service) Cast Carbon steel globe valves with plug or ball type disc. Other particulars shall be same as 22.6.4.3 above.

22.6.5.4 The valve shall conform to BS: 1873/BS: 5352 and shall be tested to BS:6755/ BS: 5146 requirements. IBR certificates as necessary shall also be provided.

22.6.6 **Check Valves**

22.6.6.1 Check valves shall be used for non return service for all sizes in steam, condensate and oil lines.

22.6.6.2 For sizes 50 NB and smaller, check valves shall be of class 800 forged Carbon Steel horizontal lift type, with bolted cover. Valves shall have 13% Chrome Steel trim and body material to ASTM A 105. Ends shall be socket welded.

22.6.6.3 For sizes 65 NB and above, check valves shall be of class 150/300 (depending on service) Cast Carbon Steel valves of swing check type having bolted cover. Trim shall be of 13% Chromium Steel and body material to ASTM A 216 Gr. WCB. Ends shall be flanged to ANSI Class 150/300 lb rating with raised face.

22.6.6.4 The valve shall conform to BS: 1868/BS: 5352/ANSI B16.34 and shall be tested to BS: 5146 / BS: 6755/API 598 requirements. IBR certificates as necessary shall also be provided.

22.6.7 **Oil Line Plug Valves/Ball Valves**

22.6.7.1 Plug/Ball valves shall be used for isolation purpose in oil lines for sizes up to and including 300 NB. Valves shall be wrench or gear and hand wheel operated and shall have `port' position indicators with CLOSE/OPEN indications marked on valve body.

22.6.7.2 Ball valves for sizes up to and including 300 NB shall be of class 150 full bore type. Body material for plug/Ball valves shall be ASTM-A-216 GR. WCB. The ball shall be of SS-AISI-316 quality and plug material (for plug valves) shall be hardened steel to ASTM-A-216 Grade WCB with suitable heat treatment. Plug valves shall be self lubricated taper type of proven design.

22.6.7.3 LDO storage tanks Inlet/fill line shall be provided with electric actuator operated Ball valves.

22.6.7.4 All ball valves shall conform to BS: 5351 and fire safe test shall conform to BS: 6755 part-2/ API 607. All plug valves shall conform to BS: 5353 and fire safe test shall meet the requirements of BS:6755 part-2. Fire safe certificates shall be submitted for approval. In absence of the certificates, the fire test shall be carried out by valve supplier

22.6.8 **Strainers**

The strainers at the suction of various pumps shall be simplex type basket strainers. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least six (6) times the internal area of the connecting pipe lines. The strainer element shall be 40 mesh. Pressure drop across the strainers in new connection shall not exceed 1.5 MLC at full flow. The material of construction of various parts shall be as follows:

(a)	Body	:	MS to IS: 2062 (8mm thick) or Pipe to IS: 3589 (min. 6.35 mm thick)
(b)	Strainer Element:		Stainless Steel (AISI 316)
(c)	End connection	:	Flanged

PUMPS

S. No.	Description	LDO Booster Pumps
1	Type of Pump	Twin Screw external bearing with Mechanical Gear
2	Type of fuel to be handled	LDO
3	Pump Design/ construction code	API 676
4	Design Viscosity	2-20 CST
5	Temperature of Fluid	Ambient
6	No. of pumps	2
7	Rated Capacity in design viscosity range	50 M^3/hr (or match the existing LDO forwarding pumps)
8	Design Temperature of Fluid	Max Ambient
9	Max Temp to which the pump may be supplied	Max Ambient
10	Pump Speed (max)	1500 rpm
11	Drive Motor	Flame proof IPW 55
12	Material of Construction	
a	Casing	Cast iron IS 210 Gr FG 260
b	Rotor/ Impeller	SS to AISI 431
c	Shaft	SS to AISI 431
d	Pump motor Base Plate	Fabricated steel IS 2062

CHAPTER – 23

COMPRESSED AIR SYSTEM

CONTENTS

CHAPTER – 23

COMPRESSED AIR SYSTEM

23.1 INTENT

23.1.1 This chapter is intended to cover the Design, Engineering, Manufacture, Fabrication, Assembly, Inspection, Testing at Manufacture's works, Packing, Transportation, Delivery, Receipt, Unloading, Storage and handling at site, supervision of Erection, Testing, Commissioning and Field Acceptance / Performance Guarantee test of Compressed Air System consisting of air compressors and their motor drives, receivers and air drier units with all associated accessories and auxiliaries as specified herein after and as required for safe trouble free operation and maintenance.

23.1.2 It not intended to specify completely herein, all details of design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation.

23.1.3 Compressed Air is mainly required in the following areas:

a. Pulverized coal sampling.
b. APH soot blowing.
c. Boiler Area
d. Turbine Generator (TG) and Auxiliaries.
e. CPU Area
f. DM Plant & Water system area.
g. TG & SG area cleaning and maintenance.
h. Fuel oil pump house area
i. LDO atomization
j. Station C & I area
k. CHP area
l. AHP Area
m. Mill Reject System area
n. FGD Plant
o. ETP
p. SCR
q. Ammonia Handling
r. H2 Plant
s. Lime Slurry Preparation
t. Gypsum Dewatering
u. Chlorine Dioxide system
v. STP
w. Absorber
x. Any other area (if required) which is not covered above.

Besides, dedicated Compressed Air Systems as described in respective Chapters shall be provided for each of the following areas:

(a) Coal Handling System
(b) Ash Handling System

23.2 System Description

23.2.1 The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying Plants (ADPs), Service Air compressors & their motor drives, air receivers, instrumentation and control, control panels, interconnection compressed air piping, Instrument air piping network and service air piping network.

23.2.2 The air compressors & drives, instruments, control panels and ADPs shall be located indoor inside the compressor house and the air receivers shall be located outside the compressor house. The compressor house shall be provided with an electrically operated, overhead traveling type (EOT) crane as specified in Volume III, Chapter 28.

.

23.2.3 The IA system shall supply required quality air to various pneumatically operated valves and instruments of SG, TG and all BOP systems (except coal handling system and ash handling system. The SA system shall meet the service air requirement of the unit.

23.2.4 The compressors shall be arranged such that all the service air compressors shall be able to supply air upstream of each ADP through an isolation valve and a non-return valve and control valve so that in event of failure of instrument air compressor, instrument air is ensured continuously from service air compressor. The valves and piping arrangement for such interconnection shall also be provided.

23.2.5 All the piping works for IA & SA system including all accessories shall be provided.

23.2.6 Air from Instrument air compressors shall be dried in respective Air Drying Plants in compressor house and delivered to the Air receivers. From the Compressed air piping header at the downstream of Air receivers, one instrument air piping header for main plant and one for balance of plant shall be provided. A separate service air header shall be tapped off from the pipe header at Service Air receiver outlet header and distributed to respective areas.

23.3 Codes & Standards

The equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations as applicable, including all its latest amendments subsequent to the year of publication as mentioned below:

- BS-726 : Measurement of Air Flow for Compressor
- IS-2825 : Code for unfired pressure vessels.
- IS-4503 : Shell and Tube Type Heat Exchanger
- IS-5456 : Code of Practice for testing of positive displacement type air Compressors and exhausters.
- IS-5727 : Glossary of terms relating to compressors and exhausters.
- IS-1239 Part-1 : Mild Steel tubes, tubulars and other wrought steel pipes.
- IS-1239 Part-2 : Mild steel tubes, tubulars and other wrought steel fittings.

- IS-6206 : Guide for selection, installation and maintenance of air compressors/plants with operating pressure up to 10 bar.
- ANSI-B16.5 : Steel Pipes Flanges and Fittings.
- IS-7938 : Air Receivers for Compressed Air Installations.
- IS-10431 Part-I : Measurement of Air Flow of Compressor and Exhausters by nozzles.
- ASME PTC-9 : Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers.
- BS-5169/1975 : Fusion Welded Steel Air Receiver.
- ISO-7183 : Compressed Air Dryers -Specification and Testing.
- ISO-7183 (Part-II): Compressed Air Dryers - Performance rating.
- IS-12258 : Technical supply condition for Screw Air Compressor.
- BS-1571 : Simplified Acceptance Test for Air Compressor and Exhausters.
- IS-2062 : Steel for General Structural Purpose-Specification.
- IS-11989 : Compressed air dryer.
- ISO 8753.1 : Filter quality classes.

23.4 Design Requirements & Performance Guarantee:

23.4.1 Air Compressors shall be identical and all equipment shall be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Data Sheet enclosed with this section. Frequent start/ stop of the system shall not result deterioration in performance nor damage to the equipment.

23.4.2 The compressors and Air Drying Plants shall operate under the following ambient conditions.

a) Minimum Temperature : 3^0 C
b) Maximum Temperature : 50^0 C
c) Design Condition (Temp & RH) : 45^0 C & 85%

23.4.3 The capacity of each IA compressor and SA compressor shall be 50 NM^3/min (minimum) or as computed by procedure for capacity determination of IA and SA in clause 23.4.10 below, whichever is higher. The discharge pressure at the outlet of after cooler shall not be less than 8.5 Kg/cm^2 (g).

23.4.4 Compressed Air System shall ensure a reliable supply of adequate quantity and quality of oil free dry air on continuous and intermittent basis. It consists of two sub systems namely,

i) Instrument Air (IA) for Instrumentation and Control purposes.

ii) Service Air (SA) for some boiler equipment, general house cleaning and other miscellaneous usage.

23.4.5 The normal pressure of Instrument Air supply at the outlet of Air Dryer shall be minimum 8.0 kg/cm^2 (g) (minimum). Corresponding to the normal pressure at the outlet of dryer, the rated discharge pressure of IA compressor shall be worked out, allowing for pressure drops in system piping, equipment and all other accessories. The rated discharge pressure of IA compressor shall be computed as per guidelines specified above or 8.5 kg/cm^2 (g) (minimum) at the

outlet of after cooler, whichever is higher. Each Service Air compressor shall be designed to deliver service air at a rated discharge pressure equal to the rated discharge pressure of each Instrument Air Compressor. The maximum expected pressure in the system shall be computed by considering 20% overpressure over and above the rated discharge pressure of each air compressor as computed above.

23.4.6 Noise level shall not exceed 85 dBA when measured at a distance of 1.0 M from the compressor. Acoustic enclosures as required shall be provided to meet the above condition. The discharge blow-off silencer and intake silencers shall be designed to meet the above noise limitation level.

23.4.7 Service air compressors and instrument air compressors shall be interconnected for flexibility in operation, designed for continuous operation with high efficiency to satisfy the system requirements. The compressors shall be of indoor duty complete with air coolers necessary valves with vent pipe work ducted to a safe discharge outlet.

23.4.8 Compressors shall be identical oil free, rotary, dry screw type, water cooled, horizontal and multistage. Each compressor shall have an inlet filter and silencer unit having inlet area large enough to ensure that frequent filter changes are not required. The silencer unit shall comply with the statutory noise requirements specified for which necessary acoustic enclosure shall be provided for housing the compressors. Drive motor shall comply with standard specification for induction motors enclosed with the specification and shall be connected directly to the gear box of the compressor.

23.4.9 Each air compressor shall have its own control panel with indication lights for power on; service hour-run meter; load hour-run meter; inlet air filter differential pressure high; outlet air pressure & temperature (analogue gauge); oil filter differential pressure high; separator element differential high; motor overload; low oil level; compressor temperature high; oil temperature before and after oil cooler (analog gauge). The compressor shall trip on motor overload; low oil level; and compressor temperature high.

23.4.10 Total Instrument Air requirements shall be assessed by the following guidelines:

Z = {(A+B)+C+D} x [1+ (mw+ml)/100] where,
A = Instrument Air requirement for SG & auxiliaries (continuous).
B = Instrument Air requirement (continuous) for TG & auxiliaries
C = Instrument Air requirement (continuous) for WTP and other facilities
D = Station C&I requirement (continuous).
mw = Wear & tear margin (10%)
ml = Leakage margin (10%)
Z = Total Instrument Air requirement

The total Service Air requirement shall be assessed by considering the following guideline:

Y = {(E+F)+G+H} x [1+ (mw+ml)/100] where

Y = Total service air requirement (continuous)
E = Service Air requirement (continuous) for SG, TG & auxiliaries.
F = Service Air requirement (continuous) for WTP and other facilities.
F = 2.5 NM^3/min (minimum)

G= Service Air Requirement for AHP
H= Service Air Requirement for CHP
mw = Wear & tear margin (10%)
ml = Leakage margin (10%)

Each Service Air Compressor shall have capacity identical to that of each IA compressor but in no case less than the value Y as computed above.

While calculating the air requirement of bidder's equipment/ plant/ systems for continuous requirement of service air, no diversity factor shall be considered and they are assumed to be of "Simultaneous Requirements". The intermittent requirement of service air, if any, shall be converted into continuous requirement by considering frequency of such requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.6.

23.4.11 Equipment operating on Instrument Air and Service Air System shall be designed for a pressure of 120% of rated discharge pressure of each air compressor.

23.4.12 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 Micron.

23.4.13 Compressed air system equipment requiring DMCW cooling water shall be capable of operation at design capacity with DMCW cooling water inlet temperature subject to a maximum of 38^0 C (indicative). The above equipment shall also be capable to withstand a pressure not less than the shut off head of each DMCW pump.

23.4.14 After cooler outlet air temperature shall not exceed 8ºC above the cooling water inlet temperature.

23.4.15 As more than one (1) compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, and keeping noise level within permissible limits for the number of compressors working simultaneously.

23.4.16 Each Air Receiver shall be so sized that even in the event of total stoppage of air inflow to the same, the pressure in the Air Receiver shall not fall below 5.5 kg/cm^2 (g) within two minutes of such stoppage, while maintaining an out flow of air at a rate equal to the rated capacity of a single compressor, during the aforesaid period. In no case, the size of each Air Receiver shall be less than that arrived from IS: 7938.

23.4.17 Air receivers shall be provided for service air and instrument air separately as shown in the flow diagram.

23.4.18 Air receivers shall be designed in accordance with ASME Section-VIII or IS: 2825. Corrosion allowance of minimum 3 mm shall be considered for the design. The air receiver shall be of vertical cylindrical design with dished ends.

23.4.19 The air receiver shall have inlet / outlet connections, safety relief valves, fusible plugs, pressure gauges, pressure switches, temperature gauges, flanged pipe connections, inspection manholes with automatic drain traps. The air receiver shall have access platforms for maintenance of safety relief valves and instruments.

23.4.20 Three (3) HOC type air drying plants shall be provided (2W +1S) and shall be designed to deliver continuous instrument air. The capacity of each air drying plant shall be provided to match the corresponding 1.10 times capacity of each Instrument air compressor. Discharge pressure available at the outlet of Air Drying Plant shall be minimum 8 Kg/cm^2 (g) or more as per requirement.

23.4.21 The air drying plants receiving compressed air saturated with moisture shall be capable of operating continuously to provide reliable moisture free compressed air. Dew point of the outlet air measured at the stated operating pressure shall be as mentioned in Data Sheet or lower throughout the operation. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet shall be taken as 100% & 50°C respectively. (Suitable to handle inlet air temperature of 60°C).

23.4.22 The drying process shall employ heat of compression type air dying plant using adsorption process through a desiccant medium drying to remove moisture from air. The air drying plant shall be considered to remove the moisture and dry air shall have following quality:

(a) Dew point at atmospheric pressure (-) 40° C.

(b) Oil content 0.01 ppm (maximum tolerable) or oil free.

(c) Dust – Practically dust free but maximum particle size 1 micron. Air quality after air drying plant shall be in accordance with ISA – 57.3 (Instrument Society of America) quality standards for instrument air.

(d) Contaminants - No corrosive hazardous, toxic or flammable materials.

23.4.23 Air Driers shall be suitable for part load operation while maintaining the air outlet dew point as specified above. Necessary instruments and controls shall be provided to ensure that the specified dew point is maintained irrespective of input variations.

23.4.24 Air Dryers shall include at least the following:

a) Pre-filters with condensate discharge trap stations.

b) After-filters with condensate discharge trap station.

c) Inter connecting piping, fittings, specialties, drain trap station etc. complete with isolation valves, solenoid valves, check valves, pressure relief valves etc. Including all drain piping as required.

d) Complete control and instrumentation including control cabling from instrument to junction boxes including junction boxes, tubing, wiring inside plant.

e) Terminal counter flanges with nuts, bolts, gaskets, etc.

23.4.25 Compressed air piping shall be sized for minimum pressure drops and considering velocity range as specified elsewhere in Volume III as per IS: 6206. All pipelines shall have butt welded connections with flange joints for connection

to vessels and equipment. All pipelines shall be suitably supported and routed such that there shall be minimum hindrance for the operating personnel.

23.5 Scope of Supply

23.5.1 The Instrument Air System shall include but not limited to the following:

a. Three (3) (2W+1S), oil free, dry screw type, water cooled, horizontal multistage rotary screw compressors. Each IA compressor capacity shall be 50 Nm^3/min (minimum) or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 above, whichever is higher, at pressure 8.5 kg/cm^2 (g) (minimum) at the outlet of after cooler.

b. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps

c. Suction filter along with blow off valve and silencer

d. Three (3) (2W+1S) Heat of Compression (HOC) type Air Drying Plants along with Pre-filter & After-filter in the air inlet & outlet of Air Dryer respectively to ensure dry moisture free Instrument quality air. Capacity of each drier shall be 1.1 times to capacity of each IA compressor.

e. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, mass flow meters, control panels etc.

f. Three (3) vertical Air Receivers each of minimum 15 M^3 capacity complete with supporting structure, pressure gauges and switches, safety valves, drain traps etc.

g. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc.

h. Instrument air distribution piping as required with all valves and instrumentation.

23.5.2 The Service Air System shall include but not limited to the following:

a. Three (3) (2W+1S), oil free, dry screw type, water cooled, horizontal multistage rotary screw compressors. Each SA compressor capacity shall be 50 Nm^3/min (minimum) or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 above, whichever is higher, at 8.5 kg/cm^2 (g) pressure minimum at the outlet of after cooler.

b. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps

c. Suction filter along with blow off valves and silencer

d. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels

e. Three (3) nos. vertical Air Receivers [of capacity 15 M^3 (min)] complete with welded supporting stand and foundation bolt, pressure gauge and

switch, safety valves, drain cock as minimum.

f. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc.

g. Service air distribution piping as required with all valves and instrumentation.

23.5.3 EOT crane for handling of air compressors and air drying plants shall be provided as detailed in Volume III, Chapter – 28.

23.6 **Design & Construction:**

The minimum requirements of design and construction features of various components of compressed air system are described below.

The motor drives shall be as per electrical specification.

23.6.1 **Air Compressors**

Compressors shall be multi stage oil free screw type.

Multiple compression chambers shall be designed to ensure minimum un balance and arranged in compact manner suitable for easy accessibility and maintenance of the compressors.

The compression chamber, housing two precision made screw type rotors, for each stage shall be designed with large port for fast filling and low velocities.

The stator (casing) shall be of Cast- Iron IS-210 construction with integral jacket cooling. Suitable arrangement for cleaning of the cooling jackets during maintenance of compressor shall be provided.

The Rotors and shaft shall be of single piece of construction made of forged steel (AISIC 1141 or equivalent) Rotors shall be dynamically balanced, design with asymmetric profile, to keep leakage losses to a minimum and ensure high efficiency.

Highly precise timing gears to maintain rotors in correct relative position shall be shaft mounted, oil lubricated and designed to counteract the axial forces incurred in compression.

Bearing shall be high precision antifriction type IS-25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement and minimum operating life of 40000 running hours.

Shaft seals of floating restrictive ring type design to prevent air and oil leakage along the shaft into the elements. The shaft seals rings and retainers shall be of stainless steel construction and be free for radial self-adjustment on the rotor shafts.

The safety valves shall be provided on low pressure and high pressure stages to safeguard low pressure & high pressure circuit. Inlet throttle valve shall be provided to throttle the incoming air during idling period.

A direct shaft driven positive displacement type oil pump or a separate motor driven oil pump shall be provided. The lubrication system shall consist of lube oil reservoir, lube oil pumps, suction strainers for pumps, supply & return system, oil cooler and twin two full-flow (2 x 100%) of filters, required instruments etc. the filters with replacement and re-pressurizing during operations.

The motor rating (at the design ambient temperature specified for the electric drive in the electrical specification) shall be sized as specified in the electrical volume.

Couplings shall be of non-lubricated flexible element spacer type and coupling guards shall be provided.

The inlet air filter & silencer shall be located at the downstream of discharge blow off valve.

The instrumentation, controls and panels shall conform to the requirements specified in Volume V.

Each compressor shall be provided with name plate, base plate, anchor bolts and shim packs, anti-vibration pads, eye bolts, operation & maintenance tools.

23.6.2 Lubrication System

The compressor package shall include a lubricant management system which shall lubricate the bearings and seal and the compressor chamber (screw rotor housing) shall be totally separated from bearing/ gear chamber.

The lubricant pump shall be shaft driven. An auxiliary motor driven pump shall be provided, if required by the manufacturer to supply pre start and shut down system. All lube oil pumps shall be rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system shall be protected by a relief valve.

The heat exchanger of the lube oil cooler shall be water cooled. The heat exchanger shall be located within the compressor skid.

The fouling factors shall be considered as per recommendation of TEMA.

The lube oil cooler shall be designed for a heat duty corresponding to the peak power demand of the compressors.

The cooler shall be designed in accordance with the requirement of IS 2825.

Due consideration for the differential expansion of shell and tube shall be given in the design of the coolers.

23.6.3 Gear Box

Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position. Gears shall have rating of AGMA-12 rating or equivalent.

23.6.4 Intercoolers, aftercoolers & oil Coolers

Intercoolers, after coolers and oil coolers shall be of water cooled & shell and tube type with water on the tube side. Intercoolers & aftercoolers shall be designed in accordance with Section VIII of ASME code or equivalent.

Outlet temperature of air from aftercooler shall be suitable to suit the equipment and outlet temperature of air from compressor house outlet header shall be limited to 45^0 C. However, the instruments or the pneumatic devices requires air temperature less than 45^0 C, the same shall be achieved at the outlet header.

Coolers shall be provided with removable tube bundle design in accordance with design code TEMA Class C and shall be constructed with removable shell cover.

The coolers shall be constructed and arranged to allow removal of tube bundles without dismantling piping or compressor components.

Oil coolers shall be equipped with vent & drain connections on oil and water sides. Oil temperature control valve with manual override feature or bypass construction shall be provided to maintain constant temperature. Vent & drain connections for intercoolers and aftercoolers shall be provided.

Design pressure shall be minimum 8 kg/cm^2 (g) based on shut-off head of DMCW pumps.

The coolers shall be designed for maximum heat load and at least 10% design margin shall be provided in the number of tubes.

Adequately sized safety valves shall be provided for both intercoolers and aftercoolers.

Each intercooler and aftercooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge with isolating cock.

Electrically operated automatic drain trap stations with bypass and isolating valves shall be provided for moisture separators for automatically draining of condensed moisture. The drain trap may be of full bore ball valve operated by capacitance type level switch. Manual draining facility shall also be provided in the drain trap.

Cooler shells, channels and covers shall be of steel (SA 285 Gr or Equivalent). Tube sheet shall be of SS and the tubes shall be of admiralty brass or Aluminium brass or Copper or SS 304.

23.6.5 Air Receivers

One air receiver for each compressor outside Compressor house shall be provided.

Capacity of each of the air receiver outside the compressor house shall be minimum 15 M^3 (nominal). Air Receivers shall be located outdoor and shall be vertical cylindrical with dished ends.

The design pressure and temperature shall be minimum 10 kg/cm^2 (g) and 50^0 C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME code or equivalent.

Air receivers are to be provided with gasketed inspection manhole of minimum 500 mm diameter with cover plate, lifting handle, davit cap etc. Opening shall not pierce any seam & shall be as far as possible away from any welded seam.

Receivers shall be of welded construction with minimum number of joints. Longitudinal seam in adjacent sections shall not be in same line. Welding shall be as per relevant codes. Filter material to have composition and structure as that of the material welded. Electrodes to be dried before use.

Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be at least 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure.

Each air receiver shall be provided with drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valve.

23.6.6 Intake Air Filter & Silencers

Filters with multiple elements and quick removal type for easy cleaning to be provided at suction of each air compressor and shall also be of heavy duty dry type.

The filters shall be complete with integral silencers. Separate silencers, if specified shall be provided and all other accessories. The filtering elements shall be easily removable for cleaning or for replacement.

The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.

The silencer shall be of very high efficiency type to adequately dampen the operating noise as per the requirement.

Pulsation dampener of approved design shall be provided on the compressor suction and discharge manifold.

23.6.7 Air Drying Plants

Three (3) HOC type air drying plants shall be provided (two working and one standby) for instrument air. The capacity of each air drying plant shall be same as that of the Instrument air compressors.

23.6.7.1 Codes and Standards

The design, manufacture, testing and performance of the various components of Air Drying Plant shall comply with at least the requirements of one or more of the following codes, as applicable:

i.	IS-11989	:	Specification for Air Dryers.
ii.	IS-2825	:	Code for Unfired Pressure Vessels.
iii.	IS-11327	:	HOC type units.
iv.	ISO 8753.1	:	Filter quality classes.

23.6.7.2 **Technical requirements**

The capacity of air drying plant shall be equal to the capacity of the individual air compressors. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40^0 C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3

"Quality Standard for Instrument Air".

Discharge pressure available at the outlet of Air drying Plant shall be minimum 8.0 Kg/cm^2 (g) or more as per the requirement.

The compressors and Air Drying plants shall operate under the following ambient conditions.

(i)	Minimum temperature	:	3^0 C
(ii)	Maximum temperature	:	50^0 C
(iii)	Design condition (temperature & Relative humidity)	:	45^0 C & 85 %
(iv)	Height above MSL	:	270 M

Air Drying (ADP) Plant shall be of "Heat of Compression (HOC) type".

Drying shall be by adsorption process through a desiccant medium.

Regeneration of desiccant shall be achieved by "Heat of compression" method without any air purge loss. Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in "Heat of compression type ADP".

Each ADP shall be provided with two adsorber towers each sized for design drying cycle of minimum 8 hours. After this period the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.

The reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant.

Each ADP shall be provided with 2 nos. 100% capacity pre-filters and 2 nos. 100% capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand at least 50% of static pressure as differential pressure. The pre-filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.

The adsorber tower shall be designed with sufficient cross sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Persplex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.

The coolers/heat exchangers/dehumidifiers shall be designed & constructed as per the requirements specified for "Intercoolers, after coolers & Oil coolers" above.

Required sample connections to piping be provided for sampling of air at desired locations.

Non lubricated two way/three way/four way ball valves with pneumatic actuators be provided.

All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, and heat exchangers/de-humidifiers/coolers etc., associated with ADP shall be designed in accordance with Section VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketted manholes/hand holes and relief valves

Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.

Adsorption capacity and density to be considered for silica gel shall not be more than 10% and 550 kg/m^3 respectively. In case of activated alumina the same shall be 8% (max) and 900 kg/m^3 (max) respectively.

Adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.

Complete ADP equipment shall be mounted on a skid.

Required sample connections in piping be provided for sampling of air at desired locations.

Non-lubricated two way/three way/four way ball valves with pneumatic actuators shall be provided.

23.6.8 Interconnecting Piping, Fittings and Valves

The interconnecting piping & valves within compressor house for compressed air & cooling water etc shall be designed in line with layout requirements indicated in Chapter : Layout Requirement of Volume III.

23.6.9 Moisture Separator

Moisture separator shall be of high efficiency design and provided with vent nozzle and auto drain trap system.

23.6.10 Solenoid Valves & Multi way Valves

The solenoid valve shall be of approved make. The solenoid valves shall have heavy duty, double impregnated tropicalized coils (single or double solenoid as

required) and shall be suitable for the operating temperature and for operation continuously energised in a tropical climate.

The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be of continuous duty and of epoxy moulded type, Class F. The enclosure shall be water tight, dust tight weather proof and shall conform to NEMA 4X standard. The valves shall be suitable for mounting in any position. Solenoid coils shall be Class H high temperature construction and shall be suitable for continuous operation. Type of operation and electrical ratings shall be subject to owner's approval.

23.7 Control Philosophy

23.7.1 General

The minimum requirements are specified herein and the same shall be elaborated by the bidder. The bidder shall include controls & instrumentation to facilitate safe, reliable and efficient operation of the system. The controls, protection, interlock and instrumentation system offered by the bidder shall be subjected to approval of the owner during post award engineering stage.

Any of the compressor and air drying plant may be selectable for "shutdown", "working" or "standby" duty.

On tripping of working equipment, standby equipment shall come into operation automatically in case of very low air pressure in the system

All abnormal conditions used for tripping the compressor or any other equipment shall be provided with pre-trip audio visual indication/ annunciation in the control panel.

An electrically operated automatic valve shall be provided on cooling water supply line of each compressor & dryer (if applicable) which will automatically shut off the cooling water supply in case any of the compressor/ dryer is not running for more than the set time duration. Suitable interlock shall also be provided for opening the valve before starting of any of the compressor.

The following indications shall be made available in the control panels for repeating the same in main plant control system/ panels.

a. Status of each compressor
b. Instrument air pressure low/ high
c. Service air pressure low/ high
d. Dew point of instrument air
e. Status of each ADP

Lube oil pressure and temperature on the oil circuit of compressor shall be automatically controlled.

Unless otherwise mentioned in Volume IV, automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.

23.7.2 Screw Compressors

23.7.2.1 Each compressor shall be in the control panel to operate either in base duty (Auto Load/ unload) or Standby duty (Auto On – Off) mode.

23.7.2.2 In "Base duty", whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unload condition. When system pressure drops due to more demand, the load – unload circuit shall operate again to bring the compressor to 100% load after closing the blow off valve.

23.7.2.3 In "Standby" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a preset lower limit, the compressor shall be started in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to preset high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a preset time.

23.7.2.4 The control system shall provide warning to the operator that a hot start condition exists for the motor driver and adequate cool down period has not occurred after the motor was shut down.

23.7.2.5 The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the sage operational requirement of the equipment/ system of each compressor:

a.	"Air temperature high" at inlet stage	Alarm & trip
b.	Low Lube Oil Pressure	Alarm & trip
c.	High Lube Oil Supply temperature	Alarm & trip
d.	High Oil filter differential pressure	Alarm & trip
e.	Low Lube oil level in lube oil sump	Alarm & trip
f.	High inlet air filter differential pressure	Alarm & trip
g.	Low cooling water flow to air compressors	Alarm & trip

23.7.3 **Air Drying Plant**

23.7.3.1 The control system shall provide the (as minimum) alarms, "High Reactivation air temperature"," Low Reactivation air Temperature", "Low Cooling Water Flow", "Low Air pressure at the outlet of ADP" and " High dew point at the outlet of ADP". Adequate number of temperature elements etc shall be provided for measurement and monitoring the same.

DATA SHEET

AIR COMPRESSOR AND AUXILIARIES

S. No.	ITEM		DETAIL
1.0	**PERFORMANCE DATA**		
1.1	Free Air Delivery	:	Bidder to compute and indicate as per guidelines specified
1.2	Capacity	:	50 Nm^3/min (minimum), 8.5 Kg/cm^2
1.3	Noise level	:	Noise level shall not exceed 85 dBA when measured at a distance of 1M from the compressor. Acoustic enclosures as required shall be provided to meet the above condition.
1.4	Vibration limit (measured at top and bottom of main bearing)	:	40 microns
2.0	**CONSTRUCTION FEATURES**		
2.1	Location	:	Indoor
2.2	Number of compressors	:	Three (3) IA compressors (2W+1S) and Three (3) SA compressors (2W+1S) connected on a common discharge manifold
2.3	Type	:	Oil-free, dry screw type, water cooled, horizontal, two (2) stage, rotary screw compressors
2.4	Service	:	Instrument Air and Service Air
2.5	Duty	:	Continuous
2.6	Type of Drive	:	Electric Motor
2.7	Design ambient temperature for drive	:	50^0C
2.8	Number of starts per hour	:	8 (equally spreaded)
2.9	Type of transmission	:	Gear
2.10	Ant vibration arrangement required	:	Yes
2.11	Type of control	:	Dual i.e. both load-unload and auto start/ stop
2.12	Type of Annunciation	:	Audio-visual
2.13	Flange standard	:	ANSI B-16.5/equivalent

S. No.	ITEM		DETAIL
3.0	**MATERIAL OF CONSTRUCTION**		
3.1	Compressor chamber	:	Grey Cast Iron IS 210 Gr FG 260 coated with corrosion resistant material
3.2	Rotors	:	Forged carbon steel EN-8M coated with corrosion resistant material
3.3	Bearing	:	Oil lubricated Antifriction type suitable for at least 40,000 running hours.
3.4	Timing Gear	:	Alloy Steel AISI 862 CH Ni Cr Mo Steel
3.5	Base Plate	:	MS
3.6	Shaft	:	EN-8/8M
3.7	Inlet throttle valve & housing	:	SS-304
3.8	Shaft seals	:	Stainless Steel
3.9	Safety valves	:	Stainless Steel
3.10	Tube of oil cooler	:	SS-304/Cu Nickel
3.11	Outer casing of coolers	:	Carbon Steel / Grey Cast Iron IS: 210, FG 220
3.12	Non Return Valve		Stainless steel spring loaded type.
3.13	Gear Box	:	Grey Cast Iron IS: 210 Gr FG 260
3.14	Gears	:	Alloy Steel
4.0	**SUPPLY OF ACCESSORIES & SERVICES**		
4.1	Intake air filters with silencers	:	Yes
4.2	Intercoolers	:	Yes
4.3	After coolers with moisture separators	:	Yes
4.4	Coupling guards	:	Yes
4.5	Air receivers	:	Yes
4.6	Foundation bolts, nuts, sleeves, inserts etc.	:	Yes
4.7	All interconnecting air and cooling water piping, complete with valves, fittings as shown in relevant tender drawings and as required for reliable and smooth operation of the system	:	Yes

S. No.	ITEM		DETAIL
4.8	Eye bolts, lifting tackle, tools, etc.	:	Yes
4.9	Control panels complete with all accessories	:	Yes
4.10	Instrument gauge panels complete with all accessories	:	Yes
5.0	**DM COOLING WATER DATA**		
5.1	Quality	:	DM Water
5.2	Design inlet temperature	:	38^0C (maximum
5.3	Design pressure	:	Bidder to indicate. Shall not be less than the shut off head of DMCW pump.
5.4	Normal inlet pressure	:	Bidder to indicate. Shall be equal to the rated TDH of DMCW pump
5.5	pH value	:	8.5 to 9.5
5.6	Maximum pressure drop allowable between inlet and outlet points	:	6.0 to 8.0 MWC
6.0	DRIVE MOTOR		
6.1	Drive motor for compressor shall comply with the requirements of relevant Clause of this Chapter and Volume IV of this Specification.	:	Yes/No
7.0	**COMPRESSOR ACCESSORIES**		
7.1	**INTAKE AIR FILTER**	:	
7.1.1	Numbers required	:	One (1) with each compressor
7.1.2	Location	:	Indoor, at the suction of each air compressor
7.1.3	Type	:	Dry type
7.1.4	Silencer	:	Yes
7.1.5	Air flow rate	:	To suit compressor rating
7.1.6	Particle removing efficiency	:	99.9% up to particle size of 2 Micron
7.1.7	Maximum allowable pressure drop at stated air flow rate in new condition of filter (viscosity of air at normal ambient temperature)	:	150 mm WG
7.2	**AIR RECEIVER**		

S. No.	ITEM		DETAIL
7.2.1	Numbers required	:	One (1) for each IA compressor + (1) for each SA compressor at the Compressor Outlet. Further, dedicated receivers as required for the system shall be provided.
7.2.2	Installation	:	Outdoor
7.2.3	Type	:	Vertical cylindrical with torispherical dished ends.
7.2.4	Design pressure / Temperature	:	Minimum 1.5 times compressor discharge pressure (or 12.75 $kg/cm^2(g)$ minimum) / 80^0 C (minimum)
7.2.5	Hydraulic test Pressure	:	150 % design pressure.
7.2.6	Design code	:	ASME Sec-VIII or IS-2825/IS-7938/ Approved equal
7.2.7	Capacity of each air receiver	:	15 M^3
7.2.8	Material of construction of shell	:	MS to IS-2062
7.2.9	Material of construction of dished ends	:	MS to IS-2062
7.2.10	Material of construction of flanges	:	MS to IS-2062
7.2.11	Corrosion allowance		3.0 mm (minimum)
7.2.12	**Supply of Accessories & Services**	**:**	
7.2.12.1	Flanges with nuts, bolts and gaskets	:	Yes
7.2.12.2	Pressure gauge with snubber	:	Yes
7.2.12.3	Pressure Transmitter	:	Yes
7.2.12.4	Temperature gauge	:	Yes
7.2.12.5	Relief valve	:	Yes, set pressure shall be at least 10% above working pressure
7.2.12.6	Trap station	:	Yes
7.2.12.7	Vent valve/plug	:	Yes
7.2.12.8	Supporting stand with necessary foundation bolts, nuts, sleeves etc	:	Yes
7.2.12.9	Eye bolts, lifting tackle etc.	:	Yes
7.2.12.10	Automatic Drain Trap		Yes
7.2.12.11	Painting	:	

S. No.	ITEM		DETAIL
a.	External	:	Two coats of epoxy Primer and two finish coats of epoxy paints.
b.	Internal	:	Cleaned and one coat of black bituminous paint applied.
7.3	**INTERCOOLER, AFTERCOOLER, MOISTURE SEPARATOR, PIPING, VALVES ETC:**		
7.3.1	**After cooler :**		
a.	Installation	:	Indoor
b.	Type	:	Shell and Tube
c.	Relief Valve	:	Yes
d.	Moisture Separator	:	Yes
e.	Trap Station	:	Yes
f.	Temperature Indicator	:	Yes
g.	Temperature Switch	:	Yes
h.	Temperature Transmitter	:	Yes
7.3.2	**Intercooler :**		
a.	Installation	:	Indoor
b.	Type	:	Shell and Tube
c.	Relief Valve	:	Yes
d.	Trap Station	:	Yes
e.	Pressure Gauge	:	Yes
f.	Temperature Indicator	:	Yes
g.	Temperature Switch	:	Yes
h.	Temperature Transmitter	:	Yes
i.	Moisture Separator	:	Yes
7.3.3	**Supply of Accessories and Services**	**:**	
a.	Supporting stands with bolts, nuts and gaskets	:	Yes

S. No.	ITEM		DETAIL
b.	Eye bolts, lifting tackle etc with tools and tackle	:	Yes
c.	Flanged connections for supply and return of cooling water	:	Yes
7.3.4	**Material of Construction :**		
a.	Tube	:	Cu Nickel/Stainless steel within star profile
b.	Shell	:	IS 2062
c.	Tube Sheet	:	IS 2002 Gr 2
d.	Baffles	:	IS 2062
e.	Flanges	:	IS 2062
7.3.5	**Piping, Valves and Fittings for Compressed Air System :**		
a.	Pipes for cooling water line and service water line	:	IS-1239 (Heavy grade) up to 150 NB. IS-3589 for sizes above 150 NB with minimum pipe thickness of 6 mm.
b.	Pipes for Instrument air line & interconnecting air line	:	ASTM A 312 Gr 304 thickness as per Schedule 20S as per ANSI B16.9
7.3.6	**Fittings**		
a.	Fittings for cooling water line & service water line	:	ASTM A-234 Gr. WPB for sizing including 65 NB and above. And ASTM A105 for sizes up to 50 NB
b.	Fittings for Instrument air piping & interconnecting air piping	:	Stainless steel as per ASTM A-182 F304

AIR DRYING PLANT AND AUXILIARIES

S. No.	ITEM		DETAIL
1.0	**GENERAL INFORMATION**		
1.1	Numbers of Air drying Plant	:	Three (3) (2W + 1S) One (1) for each IA compressor
1.2	Duty	:	Continuous
1.3	Operation	:	Fully Automatic
1.4	Service	:	Instrument Air
1.5	Installation	:	Indoor
1.6	Type	:	HOC
1.7	Outlet dew point	:	(-) 40º C at atmospheric pressure
1.8	Annunciation	:	Local and remote
1.9	Location	:	Indoor skid mounted
2.0	**MATERIAL OF CONSTRUCTION**		
2.1	Adsorber vessel		IS 2062
2.2	All internals of adsorber vessels		SS 304
2.3	Cooler shells, channels and covers Cooler Tube sheet & tubes		Same as that in intercoolers/after coolers
2.4	Relief valves		SS
2.5	Desiccant		Silica gel or Activated Alumuna
2.6	Air piping		Galvanized steel to IS 1239 (H)/IS 3589 (min. 6 mm thick)
2.7	Valves in Air Line		CI or Cast steel or Forged steel body with stainless steel trim
2.8	Valves in water pipe lines		SS/Bronze/Gunmetal
3.0	**PERFORMANCE SPECIFICATION**		
3.1	Air drying capacity	:	1.10 times the instrument air compressor capacity
3.2	Inlet air pressure	:	To suit compressor rating
3.3	Air flow (Free Air delivery)	:	To suit compressor rating
3.4	Inlet air temperature	:	Refer met data in Volume II, However, shall be suitable to handle air inlet temperature of 60 ºC.

S. No.	ITEM		DETAIL
3.5	Maximum allowable air pressure drop	:	0.5 kg/cm^2
3.6	Design Requirement	:	(-) 40º C dew point at outlet (at atmospheric pressure). Dust laden, not more than 0.1 ppm, oil free
4.0	**SUPPLY OF ACCEESSORIES AND SERVICES FOR EACH ADP**		
4.1	Pre-filters and After Filters	:	2 x 100% with automatic drain trap filter arrangement & with ceramic candle type
4.2	Dew point indicator on line	:	Yes
4.3	Instruments as per specification, Tender drawing and as required for safe and trouble free operation	:	Yes
4.4	Control panel with accessories	:	Yes
4.5	All interconnecting piping complete with fittings, valves etc.	:	Yes
4.6	Insulation	:	Yes
4.7	Base frame, foundation bolts, nuts, sleeves etc.	:	Yes
4.8	Vessel internal paint	:	Anti-corrosive

CHAPTER – 24

FIRE DETECTION, ALARM & PROTECTION SYSTEM

CONTENTS

CHAPTER – 24

FIRE DETECTION, ALARM & PROTECTION SYSTEM

24.1 INTRODUCTION

This section covers the requirements envisaged for Fire Detection and Protection System including Alarm and Communication which will be used to control any outbreak of fire in the 1 x 800 MW Unit and its auxiliary plants to reduce consequential damages by containing and extinguishing the same. Bidder's scope of work covers system design, engineering, manufacturing, supply, assembly, packing, transportation, warehousing, field construction, erection, connecting piping and wiring, cabling, shop and site tests, putting them into successful commissioning of the entire fire detection and protection system including supply of all fire extinguishing equipment and systems, fire detectors, manual call points, heat sensing cables, all local, remote and repeater panels, computers and peripherals, hardware and licensed versions of software as detailed hereunder, meeting all code requirements to make the system complete and all other services as specified in relevant sections in accordance with the intent and requirements of this specification. A comprehensive Fire Detection, Protection & Alarm System shall be provided by the Bidder covering all the areas of the power plant.

Various types of protection systems and associated equipment / system components shall be completely in compliance with the regulations of Tariff Advisory Committee (TAC) of India/NFPA. **The Fire detection, Protection & Alarm system shall be designed in line with the guideline stipulated in NFPA-850 & IS-3034.** BIDDER shall also obtain necessary approvals from the local statutary body and authorised fire protection and detection system insurance agencies as applicable for the complete system. This include discussions with authorised approving agencies, arranging inspection at site, revision / modifications carried out at site as suggested by the authorities/ Owner for obtaining complete approval of the system and ensure maximum discount for insurance premium to Owner. The responsibility of getting approval from statutory body & TAC accredited professionals rests exclusively on Bidder. This include discussions with authorised approving agencies, arranging inspection at site, revision / modifications as suggested by the authorities for obtaining complete approval of the system and ensure maximum discount for insurance premium to Owner. Any other additional equipment not specifically mentioned in the technical specification but is found necessary to meet the requirements of TAC & locoal statutory body and also for safe and sound operation of the plant are to be included at no extra cost to Owner. It is Bidder's responsibility to take care of all Site routing / modifications as suggested by approving agency and Owner related to fire protection and detection system during erection and commissioning time without any price implication to Owner.

Clarified Water shall be used for fire fighting system. The fire pumps shall be installed in the clarified water pumphouse on Clarified Water Tank.

24.2 SYSTEM DESCRIPTION

One (1) RCC fire water storage tank with suction sump (provided in /adjacent to Filtered Water Sump). Effective capacity of fire water storage shall be

decided based on TAC requirements. However the effective capacity, in any case, shall not be less than 2500 M^3 with all accessories as specified.

The complete system is divided into the following systems:-

i) Fire Protection System
ii) Fire detection and alarm system
iii) Fire Station and Other facilities.

24.3 FIRE PROTECTION SYSTEM

Following types of Fire Protection system shall be provided.

i) Hydrant System.
ii) Automatic High and Medium Velocity Water Spray Systems.
iii) Automatic Fixed Foam system for Fuel Oil storage Tanks.
iv) Automatic inert Gas system.
v) Portable and Mobile Fire Extinguishers.

24.4 DESIGN CRITERIA

24.4.1 CODES AND STANDARDS

The Complete Fire detection and protection ssystem shall be designed in Conformity with Tariff Advisory Committee (TAC) / IS 3034 / NFPA, USA. Any other Standard which are not mentioned in the technical specification but are found necessary to meet the requirement of TAC and also for safe and sound operation of the plant are to be included at no extra cost to the employer.

All equipment in the entire fire protection & detection system shall have the approval from one of the followings:

i) UL of USA
ii) LPCB-UK
iii) BIS-India
iv) FM-USA
v) VDS- Germany

However, the design and installation of complete system and requirement shall be approved by statutory authorities.

24.4.2 DESIGN PHILOSOPHY FOR HYDRANT SYSTEM

The Plant is covered under "Ordinary Hazard" according to TAC. The Hydrant System of Fire Protection essentially consists of a large network of pipe with Three Ring Mains, both underground and over ground which feeds water to number of hydrants valves – indoor as well as outdoor and to number of outdoor type fixed installations and Water Monitors. Water in the pipe network shall be kept pressurised by jockey pump arrangement. These hydrant valves / Water Monitors shall be located throughout the entire powerhouse and other buildings. Hosepipes of suitable lengths fitted with standard accessories like branch pipes, nozzles etc. are kept in "Hose Boxes" along with each Hydrant for both indoor & outdoor. When the fire hoses are coupled to the hydrant valves through the instantaneous coupling, jet of water will be directed towards the fire. Where the height of the Hazard is more than 15 mtr corresponding Hydrants will be replaced by 75mm Water Monitors.

Operation of hydrant system shall be semi-automatic. A pressurised hydrant / spray main shall be maintained through the jockey pumps. When the header pressure of fire water pumps falls below a preset limit, 1st motor driven fire water pump placed in "auto mode" shall be automatically cut-in. If the header pressure is not built-up even after the running of 1st pump and falls further down, this low pressure shall be detected by pressure transmitter which in turn shall cut in automatically the second motor driven pump in hydrant system. Similarly the 3rd motor driven pump and standby Diesel Engine driven pump will come into operation based on the system required sequentially. In each case above, if any of the above pumps is not started even after the signal from pressure transmitter is through, "pump fails to start" alarm shall be annunciated in the local control panel.

The pressure in the hydrant/spray network shall be maintained by the jockey pump. When the pressure in the header is low, jockey pump shall be started automatically to maintain pressure in the hydrant & spray header. Jockey pump shall cut-out automatically when the pressure reaches the higher limit.

The Water for Spray and Hydrant System shall feed through separated headers. One (1) isolation Valve with a non return valve shall be employed in between Hydrant Pumps and Spray pumps so that the water from hydrant pumping system shall feed to spray header in case of emergency.

Hydrant system protects the following building/facilities:

i) Entire Power House within the boundary limits of power house.
ii) TG Building, Service building
iii) Mill Reject Handling System compressor house.
iv) ESP Control Building
v) Fly ash equipment building.
vi) LDO forwarding Pump House area.
vii) LDO day tank and dyke area
viii) Compressor House cum Diesel Generator Area.
ix) Generator, Station, Unit transformers and all auxiliary Transformer
x) CW Pump House.
xi) Water Pretreatment Plant.
xii) Sludge Pump House.
xiii) Clarified Water Pump House, fire water pump house.
xiv) Raw Water Intake Pump House.
xv) DM Plant with acid and alkali bulk storage tanks.
xvi) Chemical House.
xvii) Coal Handling Plant and Coal Storage Yards including all transfer points, bunker bay conveyors, sub-stations and control room, office building.
xviii) Crusher House.
xix) Coal Handling Control Building
xx) FGD system including all tanks, absorber, Control Building etc.
xxi) Gyspsum building, lime crusher house etc related to FGD package

xxii) Lime handling system and lime yards and lime conveying system including junction towers

xxiii) Gypsum handling system

xxiv) Ash Handling Plant Area including Ash Slurry Pump House, Ash Water Pump House, FA Conveying Blower Room, MCC room

xxv) All storage areas

xxvi) Effluent treatment Plant

xxvii) Open Storage Yard.

xxviii) Transformer Yard, Switchyard & Grid Control Room Building.

xxix) Service Building.

xxx) CPU Regeneration building

xxxi) Chimney area

xxxii) Diesel filling station

xxxiii) Fire water pump house

xxxiv) Cooling Tower Area

xxxv) Ash silo area

xxxvi) Switchyard area

xxxvii) SCR system including ammonia unloading, storage and forwarding systems.

i) The Fire protection system design viz. water requirement, Fire water reservoir, number of main and standby fire pumps, hydrants and accessories etc shall be designed as per TAC guidelines.

ii) Provision of "double headed hydrants" as per the configuration of "risk area" shall be acceptable. For protection of crushed coal stock piles in Coal Handling area which are of elevated position, water monitor shall be provided.

iii) Minimum terminal pressure of 3.5 Kg/cm² (g) shall be maintained at the farthest/ remotest hydrant point.

iv) Three hydrant ring mains shall be provided and entire power plant area shall be suitably divided amongst these ring mains. These ring mains shall be interconnected with isolation valves. It shall be possible to enable to take up part of any of the ring mains for the maintenance without any loss of system in the balance part.

v) All the landings of boiler staircases, turbine buildings and other multistoried buildings, transfer points in the Coal handling plant etc shall be provided with hydrant landing valves. Water monitors shall be provided for tall buildings, Coal stockpiles, ESP area apart from ground hydrant and Landing Valve.

vi) All hydrant pipe mains/pipe lines shall be routed underground as per TAC. The underground Pipe lines shall be provided with coating and wrapping as per IS: 10221/IS: 15537. Road, rail, cable trench, cable channels or pipe trench crossing shall be through RCC hume Pipe of appropriate pressure class. In main plant areas, pipes shall be laid in RCC trenches (with precast slab covers). Alternatively hydrant pipes shall be laid over ground on separate RCC pedestals or on pipe trestles along with other pipe lines, but not on fuel pipe lines.

Where ever feasible, the hydrant pipes and spray water pipes shall be routed above ground on RCC pedestals at a height of 500 mm above finished grade level.

vii) All hydrant valves shall be of stainless steel conforming to IS:5290.

viii) fire hydrants shall be spaced 45 M apart. For building etc at least one hydrant shall be provided for every 45 M of external wall measurement.

ix) Hydrants shall not be located less than 2 M from building. No building sall be deemed to be protected by a hydrant unless such hydrant is within 15 M of the building. When height of the structure, tower exceeds 15 M, the concerned hydrant shall be replaced by water monitor.

x) Friction drop shall be calculated based on Hazen Williams equation considering "C" as 100.

xi) However Velocity in fire water pipes shall be as per TAC recommendation. The velocity in the hydrant/Spray header shall not exceed 3 M/sec.

24.4.3 DESIGN PHILOSOPHY FOR SPRAY SYSTEM.

Automatic High Velocity Water Spray System

This system shall automatically detect, control and extinguish any out-break of fire and simultaneously give audible alarm. Water line shall forms a ring around the equipment to be protected with projected outlets at various selected points fitted with the specially designed nozzles. The water supply to the HVW spray system is controlled by deluge valve which shall be operated hydraulically. This valve is normally closed by water pressure in the water piping. The same water pipe forms a ring around the equipment to be protected and frangible bulb type detectors are mounted on this water line at selected places. When the surrounding temperature rises more than the rated temperature of the detector, detector quartzoid bulb collapses releasing water and consequently pressure in water line will fall sharply. This fall of pressure opens the deluge valve and water starts projecting out from the projectors. Local audible alarm shall be produced by water motor alarm gong. The operation of the Deluge Valve shall be annunciated in the Main Fire Alarm Panel situated in Main Control Room as well as in Sub Fire alarm Panel and Repeater Panels located in existing Fire Station.

The system shall also have a manual over riding facility along with regular testing facility.

<u>Automatic HVW Spray Protection shall be provided for the following equipment:</u>

- All transformers located in transformer yard of Main Plant area.
- All other transformers of rating 10 MVA and above.
- Main and unit turbine oil tanks and purifiers.
- Boiler Burner Front
- Generator seal oil tank, Cooler and Purifier.

- Turbine generator under-deck area (Oil Canal)
- Emergency DG set
- Central Lub Oil Tanks (Clean & Dirty oil tanks) and purifier units.
- Boiler Feed Pump lube oil tanks, coolers, consoles etc.

Automatic Medium Velocity Water Spray System (Mvws System)

This system essentially consists of a network of sprayers fitted with a special deflector to give required angle of discharge for the water around the area to be protected. The sprayers discharge a cone of water spray consisting of medium size droplets of water. The droplet size shall be so designed to achieve efficient cooling of the flame zone by evaporation and sufficiently large to penetrate the flame so as to reach and cool surfaces heated by the fire. The operation of the Deluge Valve shall be annunciated in the Main Fire Alarm Panel situated in Main Control Room as well as in Sub Fire alarm Panel (CHP Control room) and Repeater Panels located in existing Fire Station.

The Medium Velocity Water Spray System shall be provided for the protection of following areas:

a) All coal conveyors, all transfer points, take-up pulleys, and crusher house of the coal handling plant. In this connection, it may be noted that full length of each conveyor both top and bottom belt shall be protected with MVW Spray System.

b) The open conveyors installed shall also be provided with MVW spray system. It may be noted that full length of each conveyor both top and bottom belt shall be protected with MVW Spray System.

c) Cable vault/cable galleries/cable spreader room in Power House, CHP Control room and in other ancillary buildings as applicable and stated elsewhere.

d) LDO day tank, unloading and pressurizing pump house

DESIGN :-

a) Unless specified the HVW and MVW systems shall be as per guideline of TAC. The water for the spray system shall be tapped from the common Header throughout the plant.

b) For HVW Spray System the water pressure at any projector/ spray nozzle shall not be less than 3.5Kg/cm²(g). For MVW spray system minimum water density and minimum pressure shall be as under:-

Area	Minimum Water Density	Minimum Pressure
Cable Galleries	12.2 LPM/m²	2.8 Kg/cm²(g)
Coal Conveyors	10.2 LPM/m²	1.4 Kg/cm²(g)
L.D.O Storage Tanks	10.2 LPM/m²	1.4-3.5 Kg/cm²(g)

c) The spray system for boiler burner front shall cover all the fuel oil and coal burner elevations, its adjacent piping structure, floors etc.

e) The spray system for the fuel oil pumping station or fuel oil tank shall also cover the piping near the vicinity.

f) In cable galleries the water spray shall cover the exposed area of both the forward and return conveyors and idlers. In transfer points, crusher house, wagon tippler, pent house etc thewater spray shall cover the drive equipment, pulleys, chutes, other equipments of the floor and at various elevations.

g) Wet type fire detection system using quartzoid bulb detector shall be provided for HVW /MVW spray system employed for coal conveyors, transformers etc. In case of fire QB detector shall break due to heat and pressure in wet detector network resulting in fall in pressure which shall actuate the respective deluge valve resulting in water spray on the protected equipment.

h) All spray pipe mains/ pipelines shall be routed underground and provided with coating and wrapping as per TAC. Road, rail, cable trench, cable channels or pipe trench crossing shall be through RCC hume Pipe of appropriate pressure class. Wherever feasible, spray pipes shall be laid overground on separate RCC pedestals or on pipe trestles along with other pipe lines.

i) Each deluge valve shall be suitable for automatic actuation. Each deluge valve shall also be provided with a LCP from which valve may be operated remote manually. In addition , each deluge valve shall also be provided with an operational latch/ handlever. Each deluge valve shall be provided with gate valve on upstream and downstream with limit switches. The valve on the downstream side shall be kept locked open.

j) Each deluge valve shall be provided with a fast acting butterfly valve with limit switch as a byepass.

k) Vendor to consider the close/open annunciation of all the valves using necessary modules in the Main Fire alarm panel in TG building.

l) Cable vaults/cable spreader rooms shall be suitably zoned. Total water requirement for each zone shall be limited to one-third the capacity of spray water pump, three (3) zones (one forward and one backward and the zone under fire) shall be flooded

m) Conveyor belt shall be suitably zoned. Length of each zone shall be so selected such that water requirement of each zone shall be limited to one-third the capacity of each spray water pump and in case of fire, three (3) zones (one forward and one backward and the zone under fire) shall be flooded.

n) Water sprayer shall be placed in such a way so that the "spray cone" overlaps each other. This is applicable for all transformers, cable vaults, conveyor belts and other areas where MVW or HVW spray system has been asked for.

TECHNICAL REQUIREMENTS

a) The deluge valve (auto resetting type) assembly shall consist of accessories such as pressure gauge (two nos.), water motor gong, alarm test valves, drain valves, strainers for these valves, hydraulic releasing system, etc. Solenoid valve for remote operation shall also be provided.

b) Deluge valves shall be used for automatic HVW spray system, and MVW spray system. In automatic HVW Spray System, deluge valve in spray water line shall be kept closed normally by water pressure. Same water line will form the water circuit of fire detector. When the detector quartzoid bulb collapses in the event of fire, the water pressure in the deluge valve will fall resulting in the opening of deluge valve.

c) But the deluge valves, which will be used in the MVW spray system shall be of solenoid-operated type, will remain normally closed but in the event of fire, the solenoid will be energised to open the valve.

d) Each Deluge Valve assembly shall Consist of Y type Strainer in the Upstream and a By-pass Butterfly Valve with Limit Switch. Upstream and Downstream of Deluge Valves shall be provided with OS&Y Type isolation Valves with Limit switches. Deluge valve along with trims shall be UL/FM or equivalent approved / listed.

For further details of Specification of all valves mentioned above, Data Sheet shall be referred to.

e) A strainer ('Y' type) shall be provided at upstream of deluge valve. Strainer Body shall be constructed of mild steel as per IS: 2062 (tested quality). Strainer wires shall be of stainless steel AISI: 316, 18 BWG, 30 mesh. Blowing arrangement shall be provided with removable plug at the outlet. Screen open area shall be at least 4 times pipe cross-sectional area at inlet.

f) The design features and make of all the projectors/ spray nozzles shall be UL/FM or equivalent approved. Material of construction for projectors / spray nozzles shall be **Stainless Steel.**

g) Pressure switches shall be provided in spray and detector piping to exhibit "FIRE DETECTED" and "SPRAY ON" annunciations and interlock for tripping of respective equipment wherever applicable.

h) Wet type detector network with venting arrangement shall be provided for spray system using quartzoid bulb detectors.

i) Remote manual operation of the deluge valves shall be possible from the respective fire alarm cum control panel through the keyboard operation of Operating Work-station when the system is selected in remote manual mode. The remote manual selection for the operation of spray system on any equipment or any zone shall also be through the monitoring station of the respective panel. Apart from the automatic operation of the deluge valve, the system shall have provision for manual operation of the deluge valve by means of hand operated lever close to the deluge valve assembly. There shall also be a provision to operate deluge valve electrically from a nearby local panel.

j) Each outdoor deluge valve housing shall be provided with brick wall housing on three sides and 4" RCC roof. The fourth side of the enclosure shall be in a direction away from protected equipment. Indoor deluge valve(s) which are within 6 meters of the protected equipment shall also be separated from the latter by a brick wall enclosure.

24.4.4 FIXED FOAM PROTECTION SYSTEM

24.4.4.1 SYSTEM DESCRIPTION

- Water based automatic activated low expansion foam protection systems shall be provided for LDO day tank.
- Foam protection systems are based on the principle of blanketing the burning surface of oil stored inside the tanks by pouring foam mixed with water, enabling to cut-off the oxygen to the burning fuel thus achieving immediate Extinguishments of fire.
- In general the system shall be in line with NFPA-11 regulations.

24.4.4.2 DESIGN

The Fixed Foam System Shall consist of foam concentrate tanks, pumps, balancing line with automatic controlling valves, foam makers, discharge outlets,interconnection piping,valves, foam makers, discharge outlets, interconnection piping, valves, fittings, instrumentation, panel and control system. Semi Fixed system consisting of separate foam solution ring main around the tank with foam hydrant valves at regular intervals shall also be provided in addition to the water Hydrants.

24.4.4.3 OPERATIONAL PHILOSOPHY

The operation of fixed foam system shall be automatic with the aid of dedicated fire detection System provided in the tank/equipment. The semi Fixed system shall be operated through the foam hydrants/ monitors. Portable type foam water monitors (wheeled type with in built foam maker), hoses and nozzles for extinguishing spill fire in and around the tank.

Apart from feeding the individual tank each foam inductor will deliver the foam solution to the piping around the tank dyke, whenever foam injection system is initiated so that spill fire if any may be extinguished by means of foam hydrants through Hoses. The maximum spacing of foam Hydrants around the dyke will be similar to that of water Hydrant System. The minimum foam application rate of 3% foam solution be 6.1 lpm/sqm (Complete surface area) for fixed roof tanks. Manual operation facility will be facilitated locally from the opening of valves and injection of foam to any of the fuel oil tanks will be achieved through selectors switches, push buttons etc. The minimum effective capacity of each foam concentrate tank shall be designed considering the simultaneous protection of any of the oil tank (Largest dia) and operation of at least two Hydrants for 60 minutes. Apart from the primary protection, supplementary protection shall be provided. To achieve this at least 3 (three) nos. of Portable wheeled type foam monitors each minimum solution application rate of at least 189 L/min (50 gpm) shall be provided.

24.4.4.4 TECHNICAL REQUIREMENT

Complete system shall be designed as per NFPA-11 and TAC.

a) Water for the foam system shall be tapped off from the hydrant system.

b) The operation of foam system shall be automatic with the aid of fire detection system provided for the LDO day tank with a provision for manual operation.

c) Auto/Manual selection switch shall be provided at the local panel.

d) Foam concentrate shall be of 100% AFFF type and shall be provided in 2x100% capacity foam concentrate tanks. It shall be discharged to the foam pumps inductors through 2x100% capacity motor driven foam pumps (1W + 1S) through balancing line, with control valves, flow controllers etc.

e) Foam Pump: The design and material of construction for foam concentrate pumps shall be in accordance with NFPA-20. Special attention shall be paid to type of seal or packing used. Seals or packing used shall be compatible with foam concentrate. To ensure positive injection of concentrates, the discharge pressure rating of pumps shall be in excess of the maximum water pressure available under any condition at the point of concentration injection.

f) The minimum effective capacity of each foam concentrate tank and foam pumps shall be designed considering the following:

- Simultaneous protection of LDO day tank and operation of two hydrants for 60 minutes

  or

- Minimum capacity if specified elsewhere.

- A design margin of atleast 10% shall be considered over the calculated foam concentrate capacity, tank capacity and discharge capacity of the foam discharge pumps.

g) Foam concentrate storage tank shall be provided with discharge pipe manifolds, individual isolation valves, tank inlet, drain, overflow connection, level indicators, level switches, etc. All the foam concentrate tanks, pumps, the local panel and other shall be located indoor in a building. Foam concentrate storage tank shall be made of carbon steel as per IS: 2062 Grade 'B' and shall be provided with 2 mm thick FRP lining.

h) One number foam proportioner of adequate size shall be provided for each tanks. Besides these, one additional foam proportioner of adequate size shall be provided for foam hydrant rings around dyke area. All the proportioners are interconnected by isolation valves (manually operated), in such a way that any of proportioner may cater to the requirement of others. Further, separate isolation valves (manually operated) shall be provided for each proportioner for maintenance.

i) Automatic solenoid valve shall be provided in foam supply line to each of the LDO day tank at the upstream of foam proportioner. In the event of detection of fire, the signal (with the help of necessary electronic modules) shall start the foam pump, operate the deluge valve of water inlet valve to the designated foam proportioners of the tank, and as well as open the foam solution inlet valve to foam proportioner and thereby foam is injected to the tank under fire foam makers discharge outlets.

j) Apart from feeding the individual tank, each set of foam inductors shall deliver foam solution to foam hydrant piping ring around the tank dyke whenever foam injection system is initiated so that spill fires if any may be extinguished by means of foam hydrants, hoses & portable (wheeled type) foam generator/ monitor. Foam monitor shall conform to relevant International standard / manufacturer's standard.

k) The maximum spacing of the foam hydrants around the dyke area shall be similar to that of water hydrant system.

l) The minimum foam application rate of 3% foam solution shall be 6.1 lpm/Sq.m (complete surface area) for fixed roof type tanks.

m) The system shall incorporate features such as non-return valves to avoid mixing water with foam concentrate pipelines, strainers in water inlet and in foam concentrate lines, isolation valves of pumps/ flow control valves/ ratio proportioning devices etc.

n) Foam concentrate piping shall be of Stainless Steel (seamless) as per ASTM-A-312, TP-304, Schedule-40S. Fittings shall be of SS forged to ASTM-A-182, F-304 for sizes 15NB to 40NB and S.S. seamless to ASTM-A-403, WP-304, Schedule-40 for sizes 50NB & above. All the piping shall be laid over ground on RCC pedestals. Further, all valves, strainers, foam proportioners, balancing valves, etc. in foam concentrate line shall be of stainless steel construction.

o) Manual operation facility shall be facilitated locally from the panel and operation of foam pump, opening of valves and injection of foam to any of the LDO day tank shall be achieved through selector switches, push button etc.

24.4.5 Inert gas flooding system

24.4.5.1 System Desription

One centralized total flooding type clean inert gas extinguishing system shall be provided for the following areas as a protection for fire damage.

a) Main Control rooms under false flooring, above false ceiling, and inside the rooms' voids.

b) Electronic equipment rooms, Computer rooms, UPS rooms battery and battery charger room.

The inert gas flooding system for the above areas shall consist of battery of inert gas storage cylinders of adequate capacity. The system shall be designed as per NFPA 2001 (latest edition) considering C class fire hazard. Inert gas Storage cylinder shall be provided with a standby cylinder bank of equal capacity, which shall be located suitably near the control room. Discharge nozzles shall be provided on the gas distribution pipe network suitably located on the areas to be protected.

In the event of fire, the fire detectors shall initiate an alarm in the local panel, and main fire alarm panel. Simultaneously, the detection signal shall opens the directional valve automatically and so that the protected area is filled up by rapid injection of required quantity of inert gas through the pipe network

and discharge nozzles to create a homogenous air/inert gas atmosphere within the protected area.

The pipe network shall be connected to a gas manifold, through a manually operated valve. The manifold shall be connected to a group of inert gas cylinders.

In general the system shall be provided in line with NFPA-2001 regulations. The system shall be for total flooding application with electrical detection using optical detectors.

a) Complete design and all critical components / equipment like cylinder, cylinder valve assembly, hoses, check valve, actuation controls, restrictor/pressure reducer, directional / selector valve, pressure relief device/safety valve, pressure gauge, pressure switch, nozzle, etc. shall be approved and listed by UL / FM / VDS / LPCB or equivalent and the system shall also be approved by TAC / TAC accredited professional(s) before installation.

(b) Basic design parameters of inert gas extinguishing system like type of inert gas agent, extinguishing/design concentration, safety factor, discharge time, etc. shall be considered in strict accordance with NFPA-2001 (latest edition). Piping design/layout, nozzle arrangement/ orientation, etc. shall confirm to UL / FM / VDS / LPCB or equivalent.

24.4.5.2 Design philosophy for inert gas system

i) Complete design shall be approved and listed by UL/FM/VDS/LPCB.

ii) The complete volume of the rooms including the above false ceiling shall be consider for estimation of quantity of gas and containers.

iii) When determining the gas quantity, the leakage losses from the enclosures shall be taken in to account. Further volume of recirculating type air conditioning system and its duct work at least upto the automatic fire dampers of the ducts shall be considred as a part of the total volume so that the design concentration shall be achieved through out the hazard area. Further gas quantity shall be adjusted for ambient pressure and temperature conditions.

iv) Centralized inert gas system along with 100% standby reserve gas quantity and cylinders shall be provided for each of the areas mentioned above.

v) The discharge time period shall be such that the design concentration shall be achieved within 60 second. The flow calculations shall establish this criteria.

vi) Operating devices shall be by mechanical, electrical and pneumatic means conforming to NFPA-2001. The power supply to electrical actuators shall be backed up with reliable battery supply. Such batteries shall be charged automatically by battery chargers.

vii) Facility for manual release of gas through push buttons shall be provided. In addition local manula release through lever operation shall also be provided near the cylinder banks. Further manula abort switches shall be provided for each of the area / zones.

viii) Appropriate warning signs shall be fixed outside of those areas protected by the system and also in areas where the gas may spread indicating and hazard clearly. Apart from written warning signs, audio visual type warning signs i.e hooters and strobe lights shall be provided for pre discharge and post discharge activities.

ix) To prevent the loss/release of gas automatically or manually during maintenance, the system shall have the facility of "LOCK OUT".

24.4.5.3 Operational Philosophy

Inert gas flooding system is provided for the main control room, control equipment room for Unit and computer room & UPS room. The system shall be provided in line with NFPA 2001 regulations. The system proposed is of total flooding application with electrical detection system using optical detectors.

The detectors used in this application shall of analogue addressable type and upon receipt of signal from any detector in the protected enclosure to the MFAP, pre-discharge signal shall be sent to the gas release panel. Upon receipt of signal from second detector from the protected enclosure, discharge signal shall be sent to the gas release panel and in turn the gas release panel shall activate the solenoid valve in the master control head of the inert system cylinder. Manual mechanical actuation of the inert cylinder is also possible using the Manual mechanical actuator in the master control head.

24.4.5.4 Technical Requirement:-

Agent Supply, Design Concentration, Quantity & Discharge time

(a) System shall be designed to meet the minimum requirements of total flooding inert gas extinguishing system as per NFPA 2001. However higher concentration may be used if it is specified by the agent manufacturer/ system supplier for the area protected.

(b) The complete volume of the rooms including the above false ceiling, below false floor & room voids shall be considered for estimation of quantity of gas and containers.

(c) When determining the gas quantity, the leakage losses from the enclosure shall be taken into account by the supplier. Further volume of re-circulating type air conditioning system & its duct work (atleast upto the automatic fire dampers of the ducts) shall be considered as a part of the total volume so that the design concentration is achieved throughout the hazard area. Further gas quantity shall be adjusted for ambient pressure & temperature conditions.

Bidder to provide primary supply of gas & its cylinders, along with 100% (Hundred percent) standby / reserve gas quantity and cylinders for each room/area.

(d) However, if the system design permits provision of a common "ENGINEERED STORAGE SYSTEM" with directional valves for multiple rooms / areas of one unit, such a design is acceptable provided the total primary supply and/or reserve supply is equivalent to the requirement of largest area / room and such rooms /areas are perfectly separated from

each other by means of wall / metal cladding or floor of minimum required fire rating. Such common storage system should have been listed & approved by UL/FM/VDS/LPCB or equivalent and bidder should produce documentary evidences for design and installation of such systems else where in the past by them.

(e) In either of the case mentioned in above two clauses, both the main & reserve supply cylinders shall be permanently connected to the distribution piping through manifold and arranged for easy changeover from the panel. Suitable selector switches be provided for "Normal /Standby "supply selection.

(f) The discharge time period shall be such that the design concentration is achieved within time duration specified in NFPA-2001 (latest edition). Flow calculations shall also establish this criteria.

(g) The quality of gas shall conform to relevant design standard such as NFPA – 2001(latest edition) or as specified by listing authorities.

Storage containers

(a) The storage cylinders offered shall be of seamless type & brand new. Welded cylinders are not permitted.

(b) All the storage containers shall be provided under an enclosure. It shall not be kept open to atmosphere.

(c) The storage containers shall be securely installed as per the listed installation manual with a provision for convenient individual servicing and container weighing. Such servicing or weighing shall be possible without shutting down the system.

(d) Automatic means such as check valves shall be provided to prevent gas loss if the system is operated when any containers are removed for maintenance.

(e) The storage containers shall not be charged to a fill density or super pressurization level different from the manufacturer's listing.

(f) The design pressure for storage cylinders shall be suitable for the maximum pressure developed at 55°C and shall be designed to meet the requirements in NFPA-2001.

(g) All cylinders shall bear the marking as detailed out in NFPA -2001 and shall be duly listed by UL / FM / VDS / LPCB or equivalent in addition to approval by Chief Controller of Explosives - INDIA.

(h) The storage cylinders shall have accessories such as pressure gauges/ switches, liquid level indicators (if applicable), refilling connections, relief devices (if applicable) etc. A reliable means of indication other than weighing shall be provided to determine the pressure in cylinders.

(i) All the pressure gauges / switches, manifold connections etc shall be easily removable for servicing / maintenance without any loss of gas.

DISTRIBUTION

(a) Both main & reserve cylinders shall be permanently connected to the distribution piping through manifold and arranged for easy & auto changeover. Cylinder Manifold, directional valve manifolds, Piping, fittings & pressure relieving device shall be designed for the maximum design pressure of the system and shall conform to the requirements of NFPA - 2001 (latest edition) or as specified by listing authorities. Material of construction for manifolds shall be as per listed design manual and shall be hydro-tested as per design manual or at 1.5 times the maximum design pressure, whichever is higher.

(b) Discharge nozzles along with deflector shields shall be listed for the intended use including the flow characteristics and area of coverage and quantity & design shall be such that complete quantity of gas is uniformly distributed throughout the hazard volume within the specified discharge time without disturbing the ceilings, lighting fixtures etc.

(c) The fire detection system to be employed shall be as specified elsewhere. Operating devices shall be by mechanical, electrical and pneumatic means conforming to NFPA-2001. The power supply to electrical actuators shall be backed up with reliable battery supply. Such batteries shall be charged automatically by battery chargers. Power supply shall be taken from the Fire detection / alarm system panels of the respective unit/s. Required annunciations such as "Gas released", "Failure of automatic actuation" etc shall be exhibited in the fire alarm panel.

(d) Where pilot cylinders are employed for actuation of the cylinder banks, the number of pilot cylinders shall be as per the listed design manual.

(e) Facility for manual release of gas through push buttons shall be provided along with selection facility of "Auto/Manual" from the panel.

(f) In addition to this, local manual release through lever operation shall also be provided near the cylinder banks.

(g) All manual-operating devices shall be identified to the hazard they protect by fluorescent paint.

(h) Manual abort switches shall be provided for each of the area/zone and the same shall be provided as per NFPA -2001 or as specified by listing authorities.

(i) The gas releasing devices at cylinder outlets shall be of re-usable type after discharge at any instant.

(j) Supervision of automatic actuation devices, power supply, manual actuation circuits, and complete wiring shall be provided through control system / panel and the healthiness shall be reported or indicated in the panel automatically. Complete control system shall be listed and approved by UL/FM/VDS/LPCB.

24.4.6 Fire Water Pumps & Pump House.

i) Three (3) vertical turbine fire water pumps with drive electrical motors and all other accessories as specified. The quantity and capacity

indicated in the specification is only tentative and bidder to work out capacity and quantity based on TAC guidelines / IS 3034.

ii) Three (3) vertical turbine fire water pumps driven with compression ignition diesel engines along with all accessories required for automatic starting of diesel engine, including fuel oil system, lub oil system etc. The quantity and capacity indicated in the specification is only tentative and bidder to work out capacity and quantity based on TAC guidelines.

iii) Two (2) (1W +1S) vertical turbine jockey with drive motors and all other accessories as per TAC as specified elsewhere.

iv) Two (2) horizontal centrifugal type booster pumps (One motor driven and the other diesel engine driven) for hydrant service for maintaining required pressure on higher elevations of power house and boiler building.

v) The Selection of Spray Pump Capacity & head shall be designed on the basis of the following criteria whichever is higher.

a) Maximum capacity required for the largest risk area/equipment of HVW spray system

OR

Simultaneous operation of three zones of MVW spray system of cable galleries.

OR

Simultaneous operation of three zones of MVW spray system of Coal Conveyors.

vi) Total Dynamic head of pumps shall be 105/110/120 MWC.

vii) The Pumps shall comply with the regulations of BIS/TAC/and shall be approved by TAC acrredited agency.

viii) The fire water pump house layout shall have sufficient space for the maintenance of pumps and diesel engines.further the pump house shall be provided with a electrically operated overhead travelling type crane of capacity capable of lifting heaviest component but not less than 5 metric tones capacity.

A) FIRE WATER AND JOCKEY PUMPS

A1 Performance Requirement

a) Performance requirement for the pumps shall be guided by the `Data Sheet' enclosed in this section and TAC recommendation.

b) Pumps shall deliver not less than 150% of rated capacity at a head of not less than 65% of total head. The shut-off head shall not exceed 120% of total head of the pump.

c) Pump sets shall be capable of continuously delivering the rated output for the voltage variation of (±) 10% and frequency variation of (±) 5%

occurring separately or combined voltage and frequency variation of (±) 10% (absolute sum).

A2 **Constructional Features**

a) The design and Testing Standards of the Pumps shall conform to IS 12469 and TAC recommendation.

b) The pumps shall comply with the regulations of Tariff Advisory Committee (TAC) and National Fire Protection Association (NFPA), USA as applicable.

c) Drive Unit Power rating for the fire water pumps shall be selected such that it is equal to higher of the two conditions :

i) 110% of the duty point power requirement.

ii) Motor input power required at 150% of the duty point capacity of pump.

d) Motor of all pumps shall be rated for continuos duty and shall be generously designed. The continuous motor rating shall be atleast 10% above the load demand of driven equipment at design duty point. The rating shall be such that the motor shall not be overloaded at any operating point of driven equipment from zero to full load. The rating of the drive shall in any case be not less than the power required to drive the pump at 150% of its rated discharge.

e) **Motor driven Fire hydrant pumps shall be VFD Driven**

B) DIESEL ENGINE

B.1 Performance requirement of the diesel engine shall be guided by TAC recommendations.

B.2 The engine shall be capable of operating continuously on full load at the site conditions for a period of four (4) hours.

B.3 The engine shall be naturally aspirated, super charged or turbo-charged as recommended by the manufacturer. (Ref. Fire Protection Manual by TAC).

B.4 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be at least 20% greater than the brake horse power required to drive the pump at it's duty point at rated R.P.M. and in no case less than the brake horse power required to drive the pump at 150% of rated discharge or at any condition of operation of pump. Deaerating Factors considered by the manufacturer to arrive at the shaft power of the diesel engine at site, shall not be less than the following for normally aspirated engines only :

B.5 Design and construction of the diesel engine shall be guided by TAC recommendations.

B.6 Starting

a) The engine shall be capable of both automatic and manual start.

b) Automatic cranking shall be effected by a battery driven D.C. motor having high starting torque to overcome full engine compression. Starting power shall be supplied from two (2) sets of storage batteries(2x100%). One (1) set of battery is for automatic starting of the engine and the other provided for manual starting. A selector switch shall be provided at the automatic starting control panel to select any of the two (2) sets of battery for manual/auto starting of the engine. Also the Battery chargers shall be 2x100%.

c) The automatic starting arrangement shall include, as a safeguard, a "Repeat Start" feature so that if the pinion of the starting motor does not engage the flywheel at the first attempt, it is automatically retracted and after a short pause again will advance towards the flywheel. This repeat start cycle will continue until five (5) kicks after which there will be suitable annunciation. The battery capacity shall be adequate for ten (10) consecutive starts without recharging with a cold engine under full compression.

d) Arrangement for both trickle and booster charge of the batteries shall be provided. When the engine starts running, provision should be kept to ensure that the electric charger is automatically disconnected and the battery is charged by engine dynamo.

e) Each diesel engine shall be provided with two (2) battery charger units of air cooled design. Each charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be kept so that any of the charger units of a particular engine can be utilised for charging any one of the two (2) batteries of that engine.

B.7 Governing System

a) The engine shall be fitted with a speed control device which will control the speed under all conditions of load.

b) The governor shall offer following features :

i) Engine should be provided with an adjustable governor capable of regulating engine speed within 10% of it's rated speed under any condition of load up to the full load rating. The governor shall be set to maintain rated pump speed at maximum pump load. (Refer Fire Protection Manual by TAC).

ii) Engine shall be provided with an over speed shut-down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position. (Refer NFPA).

c) The governor shall be suitable for operation without external power supply.

B.8 Fuel System

a) The diesel engine shall run on High Speed diesel oil.

b) Each engine shall be provided with fuel oil tank having storage capacity sufficient to run the engine at full load for at least six (6) hours.

c) For each compression ignition engine driven pump set, there shall be individual fuel tank and fuel feed pipes.

d) A suitable 1 phase 230 Volt fuel pump (portable) to be provided to fill up diesel oil from Diesel Drum received from supplier of Diesel. This pump should also have facility to be operated by hand, in case electricity fails.

B.9 Lubricating Oil System

Automatic pressure lubrication shall be provided by a crankshaft driven oil pump.

B.10 Cooling Water System

The cooling water system shall conform to any one of the systems specified in Fire Protection Manual of the Regional committee of the Tariff Advisory Committee/NFPA.

B.11 Instrumentation & Control

The diesel engine shall be provided with adequate instrumentation. These shall include but not limited to the following :

a) Temperature indicator (contact type) in cooling water inlet and outlet.

b) Temperature indicator in lubricating oil outlet from the oil cooler.

c) Pressure gauges (contact type) for lubricating oil system.

d) Differential pressure gauges (contact type) across strainers/ filters.

e) Speed indicator.

f) Running hour meter.
g) Dip. stick type lubricating oil sump level indicator.

h) Gauge glass type Fuel Oil Tank level indicator.

i) Voltmeter & Ammeter in dynamo type battery charging circuit

24.4.7 DESIGN PHILOSOPHY FOR FIRE DETECTION, ALARM, PROTECTION AND CONTROL SYSTEM.

24.4.7.1 GENERAL

a) PLC based Fire Water control panel for Fire Water Pumps located in Fire Water pump house for operation of the Fire water pressurizing and pumping system. Separate parallel redundant UPS with battery shall be provided for PLC based control system.

b) Fire Protection, Detection and Alarm Panel shall be located in the Central Control Room. Each of the Panels shall be provided with a Operating work station with colour graphic Software and printer. Fire

response programme shall be integrated with the colour graphic software in order to display all the Detector Loops with their Dynamic Status. Summary of Alarm page shall also to be configured. Alarms with Beeper are to be configured in each Monitor Station with facility for acknowledgement.

c) Fire Detection and Alarm Panel in the Central Control Room shall be provided with hardwired contacts for Group Alarms for the fire Protection, detection & Alarm system and to be connected to the DDCMIS.

d) One(1) No Sub Fire alarm shall be located in Coal Handling Control room to take care of alarms etc in Coal handling area.

e) A separate parallel redundant Uninterruptible Power Supply (UPS) unit with Battery Back up shall be provided with the Fire Alarm Panel in CCR, which shall provide Power to the Operating work station & printer with Fire alarm Panel. Technical Requirements and features of the Operating work station, printer and UPS shall be provided as perNIT.

Bidder may also consider redundnat UPS feeders in main plant UPS for OWS & printer located in CCR instead of separate UPS.

e) Satellite Fire Alarm Panels wherein all connections from the Fire Detectors and Manual call Points of the respective areas shall be terminated.

f) Repeater Master Fire Alarm Panel to be located in the Fire Station. All annunciations of local Fire Detection and Alarm Panels in CCR including their respective satellite Fire Alarm panels, Fire Alarm Panel in CHP and Grouped Annunciations etc shall also be made available in the Master Fire Alarm Panel.

g) This panel is to be provided with a operating work station with colour graphic software and printer. Fire response programme shall be integrated with the colour graphic software in order to display all the Detector Loops with their Dynamic Status. Summary of Alarm page shall also to be configured. Alarms with Beeper are to be configured in the Monitor Station with facility for acknowledgement.

h) A parallel redundant Uninterruptible Power Supply (UPS) unit with Battery Back up shall be provided with the Master Fire Alarm Panel which shall provide Power to the Operating work station & printer with Fire alarmPanel. Technical Requirements and features of the Operating work station, printer and UPS are provided in the Vol V of the Specification.

i) All Fire protection, Detection and Alarm Panels in CCR, CHP, Satellite Fire Alarm Panels and Repeater Master Fire Alarm Panel in Fire Station shall be integrated through Dual Redundant Optical Fibre Data Highway connected in Ring Main Topology. The technical requirements of such FO based communication cable are elaborated in Volume V of the specification.

j) Two (2) sets (1 working & 1 standby, 100% capacity each) of 24 Volt (2x12V) Automotive type battery with charger for each diesel engine driven fire water pumps primarily for starting the engine.

k) Two (2) sets (1 working & 1 standby, 100% capacity each) of 24 Volt (2x24V) sealed type maintenance free lead-acid battery with charger for each Satellite fire alarm panel, Fire Detection and Alarm panels in CCR, CHP, Satellite Fire Alarm Panels and Repeater Master Fire Alarm Panel in Fire Station.

l) Supply, laying and connection of FRLS power, control and instrumentation cables required for complete fire protection system and Fire survival cables (950°C. for 3 hours) for CHP area.

m) Adequate no. of Back-lit maintained type emergency exit signs as per TAC.

n) Emergency Voice Communication System, adequate number of fireman's telephones and speakers. Speakers shall be provided in strategic locations throughout the Plant. Pre recorded voice messages shall be sounded through these Speakers to alert the people. Telephone set shall be provided in each Fire Alarm Panel. As minimum, Speakers shall be provided in Central Control Room, Coal and Ash Handling Plants, DM Water Plant, CW Pump House.

The Fire Protection, detection and Alarm System shall comply with NFPA - 72/72E and IS: 2189 standards. The Fire protection, detection, alarm and Control System shall consist of various type detectors, Control Cabling, Fire Alarm Panels, Central Monitoring station, repeater Panels, PLC control Panels and Local Panels(For Deluge Valves etc).

a) The fire Alarm, protection and Detection system shall be hot redundant microprocessor based, analogue addressable type.
b) Selection of temperature rating of heat detectors shall be based upon maximum ambient temperature of about 50°C for outdoor equipments (Like Transformers, boiler burner fronts, fuel oil tanks etc) and about 40°C for indoor equipments like Coal conveyors, Cable galleries, Fuel oil Pump House etc.

Fire detection and alarm system shall cover the following area & system

a) Multi sensor type Smoke detection System.

- All Switchgear/MCC/Control rooms of Main Plant Building, ESP, switchyard control room building, CHP Control room, APH Control room various auxilllary building like ash handling system, compressed air system, CW/ACW system, condensate polishing plant, water treatment plant, Pump Houses, Service,Admin building, Battery room etc.

- Below false ceiling area of all air conditioned rooms in main plant building, service building, ESP building, various control rooms, packages and auxillary buildings etc.

b) Multi criteria type smoke detectors for above false ceiling for all air conditioned areas.

c) However combination of both multisensor and photoelectric smoke detectors for above and below false ceiling of inert gas protected areas and various cable galleries protected by MVW Spray System.

d) Linear Heat sensing Cable (Digital type) detection system for coal conveyors, and cable galleries covered under MVW Spray Systems.

e) Quartzoid Bulb heat detection system for equipments protected by HVW Spray system, LDO forwarding pump House etc protected by MVW Spray System.

f) Probe type heat detectors for LDO day tank.

g) Heat detection system (microprocessor based analogue addressable based heat detector) shall be provided in the following areas in order to avoid spurious operation of the smoke detectors due to fumes, smoke & dust which are present in these areas. The heat detectors shall be suitably mounted on fire water pipes covering an open area.

- Battery and battery charger rooms.
- Oil filled type L.T. Transformers (up to and including 2500 KVA rating) However, no oil filled L.T. Transformer has been envisaged inside power house.
- Dry type L.T. Transformers located anywhere in the plant area.
- Batteries & UPS rooms.
- Pantry & Canteen area.

h) PLC based Local Fire Water control panel for Fire Water Pumps located in F.W pump house for operation of the Fire water pressurizing and pumping system. This shall be connected to DDCIMS in Mian Control room thru fiber optic cables.

i) Main Fire Detection, Protection and Alarm Panel for each Unit to be located in the Central Control Room in Power House. Each of the Panels shall be provided with a operating work station with complete Software and A4 sized B/W printer. Fire response programme shall be integrated with the colour graphic software in order to display all the Detector Loops with their Dynamic Status. Summary of Alarm page shall also to be configured. Alarms with Beeper are to be configured in each Monitor Station with facility for acknowledgement.

j) Fire Detection and Alarm Panel in the Central Control Room shall be provided with hardwired contacts for Group Alarms for the fire detection system and to be connected to the DDCMIS of the respective unit.

k) All connections from the Fire Detectors and Manual call Points of the respective areas shall be terminated to their respective Fire Alarm Panel.

l) Repeater Fire Alarm Panel to be located in the Fire Station. All annunciations of local Fire Detection and Alarm Panels in CCR including their respective satellite panels, Fire Alarm Panel in CHP and Grouped Annunciations etc shall also be made available in the Master Fire Alarm Panel as well as in repeater panel.

m) Main/Sub Fire alarm panel is to be provided with a operating work station with colour graphic software and A4 sized B/W printer. Fire response programme shall be integrated with the colour graphic software in order to display all the Detector Loops with their Dynamic Status. Summary of

Alarm page shall also to be configured. Alarms with Beeper are to be configured in the Monitor Station with facility for acknowledgement.

n) A parallel redundant Uninterruptible Power Supply (UPS) unit with suitable Battery Back up shall be provided with the Master Fire Alarm Panel which shall provide Power to the operating work station & printer of the Panel. Technical Requirements and features of the OWS, printer and UPS are provided in the Vol V of the Specification.

o) All Fire Detection and Alarm Panels in CCR, CHP, and Repeater Fire Alarm Panel in Fire Station shall be integrated through Dual Redundant Optical Fibre Data Highway connected in Ring Main Topology. The technical requirement of such FO based communication cable are elaborated in Vol. V of the specification.

p) PLC based panel at fire water pump house, electronic based panel at foam and booster pump house shall indicate the status of each pump, system pressure, operation system, failure of starting of pumps, healthiness & failure of batteries/ chargers, main supply, low level of fuel oil of diesel engines, tripping of pumps, low level / very low level of water level in the water supply system, status of batteries & chargers of panels and diesel engines etc. Alarms from these panels shall also be available to operator at fire alarm addressable panels, central monitoring station and DDCMIS.

q) Two (2) sets (1 working & 1 standby, 100% capacity) of 24 Volt (2x12V) Automotive type Ni-Cd battery with charger for each diesel engine driven fire water pumps primarily for starting the engine .

r) Two (2) sets (1 working & 1 standby, 100% capacity) of 24 Volt (12x2V) sealed type maintenance free lead-acid battery with charger for each Satellite fire alarm panel, Fire Detection and Alarm panels in CCR, CHP and Master Fire Alarm Panel in Fire Station.

s) Supply, laying and connection of FRLS power, control and instrumentation cables required for complete fire protection system and Fire survival cables (950°C. for 3 hours) for CHP area.

t) Adequate no. of Back-lit maintained type emergency exit signs as per TAC shall be provided in all staircases of the building coming under plant battery limit.

u) Emergency Voice Communication System, adequate number of fireman's telephones and speakers. Speakers shall be provided in strategic locations throughout the Plant. Pre recorded voice messages shall be sounded through these Speakers to alert the people. Telephone set shall be provided in each Fire Alarm Panel. As minimum, Speakers shall be provided in Central Control Room, Coal and Ash Handling Plants, DM Water Plant, CW Pump House.

v) The panel at coal handling plant control room shall exhibit alarms from detection and protection from coal handling plant and all other auxiliary building/areas. Further, all panels shall also be hooked-up with Fire alarm panel at Central Control room for alarm purpose.

w) The central monitoring station to be located at Central Control Room and coal handling plant control room and shall cover the fire detection and protection system of the complete (all the areas) plant. This shall give audio-visual annunciations for fire in each of the risk area / equipment/

status of the fire protection system as well as system operator open /short circuit status of detector or control cabling etc. Further, this shall activate a hooter/sounder in each of the area provided with fire/smoke detection system.

x) Alarms from all the fire alarm addressable panels shall be repeated simultaneously in repeater panel at Fire station.

y) Dual action type Manual Call Points shall be provided at strategic locations at indoor and outdoor (preferably in Coal handling plant).

z) Sounder cum flashers shall be required at the exit gates along with the hooters/sounders along with Manual Call points. With each Manual Call Point, hooter/Sounder flashers shall be considered. The distance between consecutive MCP and Hooter shall be in such fashion that a person should not travel more than 30 mtr distance from the nearest one.

aa) Response indicators shall be employed for the showing the status of the detectors placing above false ceiling.

ab) Bidder shall refer Vol. V for complete C & I requirments of Fire Detection, protection & Alarm system.

ac) All instruments, detectors, cables and control equipments etc shall ensure high avaiabilty, high reliablility, low down time and ease of maintenance.

ad) Complete Fire protection, detection & Alarm system shall be designed in such a way that any failure in cable, detector or any component used in system, wire break, short circuit etc will not impact on the system and the Fire protection, detection & Alarm system shall be available 100% all the time round the year.

24.4.7.2 **DESIGN**

1.0 Detectors (Microprocessor Based)

a) Detectors shall be intelligent analogue addressable type. Detectors shall be housed or mounted in suitable enclosures in such a way that their performance is in no way affected. Special maintenance procedures, if any, required for the satisfactory operation of the detectors shall be clearly described.

b) In case detectors having electrical contact signal output on sensing fire, it shall be noted that the contact shall be "NC" type so that under fire conditions, this contact will open to initiate fire alarm system (fail safe type).

c) Normally the detectors, which has sensed fire and operated to give fire alarm could be easily located by the numbering scheme both on the detectors and zone-panel, for fire alarm system.

d) The various fire detectors serving a particular area / zone of plant may be wired-up in group and one common signal for each area/zone shall be transmitted to the zone indicating panel. The number of detectors to be installed shall be governed by total area to be protected, type of building construction, air movement, ceiling construction and sensitivity required.

e) The detectors shall be located where the largest combustion gas concentration can be expected.

f) It shall be possible to replace any type of detector head by a different type detector without requiring change in cabling/panel wiring and condition of the zone originally covered by the detector, thereby making it possible for a smoke detector to be replaced by either heat or flame type or vice versa.

g) All detectors shall be provided with built-in response indicating Lamp/LED which shall give local visual indication, in dense smoke condition when it will operate. The failure of lamps shall not prevent the function of detector.

h) The exact location of detectors shall be coordinated with other services like air-conditioning grills, light fittings, cable trays etc. to provide aesthetically pleasing appearance. The return air paths of air conditioning shall be avoided for detector location.

i) In such areas where detectors themselves are not easily accessible, the remote response indicators outside the enclosed areas shall be provided to indicate the fire condition.

j) Make and type of detectors shall be subject to Purchaser's approval.

k) The indigenous detectors shall have the approval of ISI/ISO in addition to the approval of FM/UL/FOC. Detectors and panels shall be preferably from the same manufacturer for compatibility.

l) The detectors shall not be effected by temperature, humidity, air flows.

A. Multi Criteria Smoke Detectors

a) The multi criteria smoke detectors shall be capable of sensing the fire in the incipient or smoldering stage itself, long before the fire matures to a visible flame. For achieving this requirement, the detector shall be capable of sensing visible combustion gases (in the form of smoke) or invisible combustion gases, which are the only clues for a long time in smoldering fires.

b) The detectors shall be sensitive to very low smoke densities of the order of 0.05 gm/cum.

c) The detectors shall be of Multisensor type with a combination of photo electric and heat sensing elements. The multicriteria smoke detector provides photo electric sensing and heat sensing combined in a single sensor/base assembly. The multisensor base provides two sequentially addressable points, automatically assigned with one address selection.

d) The sensitivity of multicriteria smoke detectors shall be selected depending upon the environmental condition.

e) For further specification of multicriteria smoke detector, data sheet shall be referred to.

f) The design Coverage area for smoke detectors to be considered shall not exceed 25m² for A/C area per each detector and 35-40 m² for non A/C areas.

B. Rate-of-Rise and Fixed Temperature Heat Detector (IC Type)

a) The detector shall be solid thermal detector.

b) It shall operate on electronic-principle to provide precise fire detection.

c) The detector shall be of integrated circuit design enclosed in a robust moulded base.

d) It shall be completely moisture proof and air tight with exposed metal part specially treated to allow the device to be used in particularly corrosive atmospheres.

e) The detector should work on rate-of-rise and fixed temperature modes of operation.

f) It shall have no moving mechanical parts.

g) The detector shall be either surface mounted or with the body concealed above the ceiling and only the detecting element in view.

h) The rate-of-rise detector shall function when the rate of temperature increase exceeds a pre-determined value, around 7 to 8 Deg C per min. This detector shall be designed to compensate with the normal changes in ambient temperature, less than 6.7 Deg C per min., which are expected under non-fire conditions.

i) For further details, data sheet shall be referred to.

j) All the detectors shall comply style-7 fashion as per NFPA-72 standard.

k) Inbuilt indicating lamp shall be provided to indicate operation of the detector.

C. Linear Heat Sensing Cable

a) Linear Heat sensing cable shall be SS braided digital type (For Coal conveyors for Cable galleries/ spreader rooms. All cable shal be SS braided.

D. Frangible (Quartzoid) Bulb Type Detector

a) In frangible bulb type detectors a small amount of gas along with heat sensitive liquid (coloured) is entrapped and hermatically sealed. This detector shall generally be mounted on the pressurized water line which forms a ring around the equipment to be protected. When the surrounding temperature rises more than the rated temperature of the detector, the gas inside the detector shall expand and as a result the quartzoid bulb shall collapse releasing water and consequently pressure in the water line shall fall sharply. This fall in pressure will give signal/annunciation in the Panel.

b) The frangible bulb shall be capable of withstanding the hydraulic test pressure (19 Kg/Cm2 g) in normal practice.

c) Type and make of frangible bulb shall be of Owner's choice /approval.

d) For further details data sheet shall be referred to.

E. Infra red Spark/Ember Detector

a) The detector must respond satisfactorily even when the lens, through which the detection is sensed are covered with coal dust or oily dust substance.

b) The detectors shall be designed to work satisfactorily in the event of vibration in any axis.

c) To prevent false alarms, the detectors shall be provided with purge air facility to keep the lines clean.

d) Facility for remote response indication shall be envisaged in each detector.

F. Manual Call System of Fire Alarm (Intelligent Addressable Type)

a) The design shall be dual action type with the provision of key resetting.
b) Dual-color LED blinking for annunciation.
c) The MCP shall be made of M.S/ABS body.
d) The manual call points shall be provided at each entry & exit point of control rooms, UPS rooms, battery rooms, and other critical & mandatory locations specified else where in the specification.
e) The manual call point enclosure shall be completely dust, weather and vermin proof. The housing of the electronic circuitry shall have minimum IP 65 protection. The complete unit shall be suitable for wall/column mounting with necessary mounting accessories.
f) Clear inscription reading (in English) "FIRE ALARM - IN CASE OF FIRE PUSH" shall be provided for each manual call point unit, either on the enclosure or on a separate metal plate mounted behind the glass cover. The metal plate for inscription shall not tarnish under the atmospheric conditions
g) Type of manual call point shall be intelligent Addressable Analog type.
h) A red lamp Response Indicator shall be provided which will light up on actuation of manual call point to locate the manual call point station, which is operated.
i) The Manual Pull station shall be addressable type, the address and the location of the same shall be annunciated in the panels on operation.

G. Power Module

a) The Power Module shall be provided with AC to DC conversion circuits and the battery charger circuits. The panel which requires more than 16 Amp, A.C. power supply shall be suitable to receive 415 Volts ±10%, 3-Phase, 50 Hz ±5%, 3-wire power supply through MCB. Other panels having requirement of equal to and less than 16 Amp., A.C. power supply shall be suitable to receive, 240 Volt ±10%,, single phase, 50 Hz ±5%, phase and neutral, through MCB.

b) The panel shall have in-built stabilized power supply unit for its electronic circuitry which rectifies A.C. power supply to D.C. for system operation. Power supply to the detectors, manual call points, external hooters etc. shall be provided in the panel.

c) The automatic with manual over-ride change over inclusive of all metering, control, indication and interlock system shall be provided.

d) Parallel redundant (2 x 100% rating) Regulated power supply modules shall be used for operation of various components / cards. LED indications for system ON and blow fuses shall be provided on the Facia of Power Module.

H. Monitor Module

a) The monitor module shall be provided with all circuits which shall be able to monitor the various conditions / status of power supply section continuously. The monitor module shall be plug-in type.

I. Control Module

a) The Control Module shall be provided for hooking-up with Power Module, Monitor Module and Zone Module and for proper controlling of system of Fire Protection Zonal System. The Control Module shall be plug-in type.

J. Zone Module

a) Zone Module provided shall be of intelligible and addressable type. The zone module shall function as the interface between the various types of intelligent addressable analogue type fire detectors connected in the field and the panel circuits. Zone module shall comprise of necessary circuits for continuously monitoring the detectors, line cabling, the circuit for open, short and fire condition with audio-visual alarm. Facility for testing and isolation through push button shall be provided for zone module to simulate the open and short circuit of the cable connected between detector and the panel and fire condition with audio-visual alarm. Audio-visual alarm for each zone module in case of withdrawal or taking out of zone module from the connected system shall be provided. Zone module shall be designed in such a way that even after detection of fire from one detector located in a zone, the same zone shall be in operation for detecting fire. All the Zonal Fire Panels shall be networked through Fibre Optic Link with the Main Fire Detection and Alarm panel in CCR.

Note : 20% spare wired channel shall be provided in each module.

K) Realy Modules

i) No of contacts per relay shall be 2 SPDT or DPDT.

ii) 20% spare wired relay shall be provided in each relay module.

iii) The relay Module shall be plug-in type.

L) Loop Sounder/Hooter

i) Loop Sounder/Hooters shall be intelligent addressable and electronic type.

ii.) Loop sounder/hooters shall be provided with each Fire alarm panel, section indicating panel, Satellite Fire Alarm Panels & Repeater panel.

iii.) The system shall have provision to annunciate any one or all the loopsounder/hooters on any given condition.

iv.) The sound intensioty/volume shall be more than 85 dB at one meter distance and 5 dB above the back groud noise/sound at one meter distance.

v.) Colour of case shall be red.

vi.) Pitch, tone & volume of sound shall be adjustable.

vii.) Type of tone shall be selectable. (Minimum 4 types of tones shall be provided).

2.0 Fire Panels

A. Satellite Fire Protection, Detection & Alarm Panels

i) Satellite fire panels will be used to cater for the fire detection, deluge valve operation, associated annunciations system and power supply distribution network for the Fire Protection system. These panels shall be based on intelligent addressable Microprocessor based technology. These panels shall be strategically located in different areas of the Power Plant considering zone wise fire detection and fire fighting system.

ii) The system shall be operable from each fire detector network, automatic deluge valve right upto each local zonal fire panels, Manual Call Points provided in the area /equipment shall also be hooked up with such type of Local Fire Panels.

iii) Number of Satellite Fire Panels will be minimum as indicated in Vol V of specification and as finalized during detailed engineering. Any more no. of panels as required shall also be provided.

B) Fire Detection, Alarm & Protection Panels in Central Control Room.

i) The Fire Detection and Alarm Panel for the unit shall be based on intelligent addressable redundant microprocessor based technology and will be used to hook up with each of the Satellite Fire Alarm panels. The Panel with its operating work station, Monitor, printer and Peripheral devices shall detect, display and annunciate electrical fault (open or short circuit), individual detector wise and Group Zone wise Fire Annunciation Satellite fire panels. in addition to monitoring its own detection system. The Fire Detection and Alarm Panel shall also supervise, monitor and annunciate the condition of the circuitry of the fire detection system through Satellite fire panels.

ii) The monitor of the fire detection and alarm panels in CCR shall be located on the operator's control desk of the respective units in the Central control Room.

iii) One number of Fire Detection and Alarm Panel complete with all accessories as described above and other items to make the installation complete is to be provided for the unit.

iv) Fire Detection and Alarm Panel shall have microprocessor based annunciation system. It will supervise; monitor the detection circuit through the Satellite Fire Panels.

v) Fire Detection and Alarm Panel shall detect and display both Fault and Fire alarm from each Satellite Fire Panels. The Fire Panels shall supervise, monitor and annunciate the condition of the entire circuitry up to the detectors through Satellite Fire Panels.

vi) The Fire Detection and Alarm Panel shall be indoor, air insulated, metal clad, floor/Wall mounting type.

C) Repeater Alarm Panel in Fire Station

i) The Repeater Fire Alarm Panel used to repeat, monitor, supervise and annunciate whatever fire and fault alarms annunciations coming in the fire detection and alarm panel of central control room. This panel shall also monitor supervise the circuitry between the Fire Alarm Panels in CCR, Sub Fire alarm panel in CHP. The repeater panel shall be located in the existing Plant Fire Station.

ii) One number of Repeater Fire Panel complete with all hardware and accessories and requisite software is to be provided, in the existing Fire Station.

D) Local Fire Water Control Panel (PLC Based)

The Local Control Panels shall be provided for the following services:

i) Auto manual control, interlock, indication supervision and HW annunciation for Fire Fighting Equipment (Fire Pumps, Jockey Pumps etc.) located inside the FW Pump House. Complete operation of the Diesel engine driven pumps shall also be performed from this panel.

The following feature shall also be provided in Local Fire Panels, Main Fire Panels and Repeater Panel :

i) Actuation of any of above push buttons shall activate the corresponding Audio/Visual indications.

ii) External audio-alarms (if any) shall not come on during the testing period.

iii) No relay/contactor shall get energised during TESTING PERIOD to avoid spurious tripping / actuation / simulation of alarms in the associated equipment.

iv) The performance and characteristics of audio-visual annunciation system shall conform to BS, NFPA codes.

Local Control Panel for Fire Water System / Diesel Engine Driven Pumps and other Fire Protection Equipment located Fire Water Pump House and a local control panel for electric & diesel engine driven Booster pump.

i) Local Control Panel for the service called for shall be indoor, air insulated, metal clad, floor or wall or column mounting type. Type of mounting shall be determined by the Bidder depending upon layout convenience and size of the panel.

ii) The panel shall be fabricated out of 2 mm thick CRCA sheets. Degree of protection of the panel enclosure shall be IP-54. Lockable front door with proper gasketing shall be provided.

iii) Power module shall be provided with parallel redudant AC to DC conversion circuits and the battery charger circuits. The panel shall have in-built parallel redudant stabilizer power supply unit for its electronic circuits which rectifies AC power supply to 24 volt DC for system operation.

iv) The automatic with manual over-ride changeover inclusive of all metering, control, indication and interlock system shall be provided.

vii) All controls, interlocks, indications and annunciation system shall be provided for safe and trouble-free operation of the Plant / equipment supplied.

The Panel shall be provided with the following features as minimum:

- One (1) Auto-Start Control Section for auto start of electric driven fire pumps, jockey pumps and one (1) no. auto-start control section for diesel engine driven pumps shall be provided inclusive of following gadgets as minimum :
- Auto and Manual Selector Switch for each electrical driven fire pump, jockey pump and air compressor (if applicable).
- Manual Start / Stop Push Button for each drive.
- Indicating Lamp showing power – ON
- Indicating Lamp showing power – ON / OFF
- Engine r.p.m. Indicator
- Lubricating oil pressure indicator
- Engine Cooling Water temperature – "in and out" indicator.
- Differential Pressure Indicator across strainer.
- Voltmeter / Ammeter in Battery Charging circuit. Ammeter for each Electrical motor.
- Hardware for diesel engine driven pump's control system.
- Any other instrumentation and control required as per system demand and as per design criteria & guidelines specified in C&I part, Vol. V.
- All annunciations as listed elsewhere and as required for safe and trouble-free operation of the plant / equipment supplied.
- The operation of control panel for Booster Pumps located in the Booster Pump House shall be similar to that of FW pump Panel.

Specific Requirements for Local Fire Panels

- Local Fire panels shall be indoor, air insulated, metal clad, floor, wall or column mounted type. Type of mounting shall be determined by the Bidder depending upon layout convenience, type, rating and duty involved in each category of panels.

- Each local fire panel shall be fabricated out of 2 mm thick CRCA sheets. Degree of protection of the panel enclosure shall be IP-54. The hooter box to be mounted to the top of each panel shall also have degree of protection IP-54.

- The front door shall be provided with either toughened glass or acrylic transparent sheet over the lockable full door with proper good quality of gasketing arrangement and with proper lock or equivalent so as to maintain degree of protection of IP-54.

- The components, which are to be fixed inside the cubicle, shall be so located on separate swing compartment in such a way that component and zone modules are clearly visible through glass or acrylic transparent sheet.

- The panel shall be designed in a truly modular concept with each zone represented by a module in order to minimize the wiring inside the panel and to minimize the breakdown time of the system.

- Each intelligent addressable local fire panel shall be capable of operating the intelligent addressable detectors and provided with the following plug-in type modules.

- Panel shall be designed on solid-state circuitry with provision of zone printed circuit cards, which shall be coated, for prevention against corrosion with suitable gold plated connectors for proper contacts. Gold plating shall be in the order of 4 to 6 microns.

- System of fire alarm shall be based on two-wire circuit system. Number of zones per panel shall be provided as per actual system requirement. Each zone card shall be independent. Repetition of Fire Alarm and "Open and Short Circuit" of cables shall be provided in the panel.

- "Fire Detection Operated" signal shall be generated in the panel and shall be provided in the panel for hook-up with Owner's air-conditioning system, ventilation system, coal conveying system etc. The panel shall have provision for hook-up with external hooter, siren also.

- The panel shall have Ammeter and Voltmeter for 24 V D.C. System.

- UPS 230 Volts Volts Bus System shall be provided in the panel for solenoid operated valve required for Fire Fighting System in Coal Conveyors.

- All the Fire and Fault indications / alarms for the various zones and / or groups of zones shall be made available as electrically potential-free contact of adequate rating at the terminal strips of the Local Fire Panel for repetition of the same at Repeater Panel and Main Fire Panels.

- For each deluge valve, module shall be provided in panel in similar to Fire Detection System with the audio-visual alarm for (a) Detector circuit water pressure low, (b) Deluge valve operated (i.e. FIRE).

- The coal conveyor system shall be equipped with solenoid type Deluge Valve (SDV) to be operated automatically through fire detection system. Each SDV shall be provided with limit switch contacts to indicate actual operation of the solenoid operated valve in the panel. Since these connecting cables are to be run with other cables, the signal interference shall be avoided.

3. Microprocessor based Fire Alarm System

Bidder shall quote for a microprocessor based system to achieve the functional requirements as indicated above.

System Required

A) Panel System

i) The 100% hot standby redundant micro processor based fire detection and fire alarm system shall be designed such as to have built in redundancy to ensure availability at all times.

ii) The system shall basically comprise of the followings:

- Fire alarm panels housing the main processor units and plug in modules.
- Addressable type detectors shall be hooked up to the panel.
- Main and standby power supply units.
- Operating terminals.
- Printer.

iii) The control unit shall be of modular design, by means of plug in cards along with future expansion facility, exact tailoring of detector zones and control outputs to the actuation devices as required.

iv) The control unit shall be micro processor based and controlled by a programme contained in nonvolatile memory (EPROM).

v) Licensed version of Run and Edit mode of Software for the Fire Alarm panels, PLC System and Human Machine Interface System shall be provided.

vi) The control unit shall be suitable for accepting inputs from addressable type detector. It shall also have the facility to monitor the contact inputs.

vii) All the detection circuits shall be monitored against open circuit, short circuit and ground faults. For any malfunction in any detection line the control unit shall initiate a trouble signal for that detection line.

Further, the following criteria shall also be met.

- Fault in one detection line shall not affect the functioning of other detection lines.

- A single open circuit, short circuit or ground fault shall not inhibit the detection capability of the detection circuit. Suitable circuitry / modules shall be provided.

- The control unit shall pin point the location of fault for ease of maintenance.

- The alarm display unit, in the event of fire shall indicate the zone no. and zone description. It shall be possible to define the zones through software.

viii) The control unit shall be capable to process and evaluate incoming signals from addressable devices such as automatic heat/smoke detectors, manual call points etc. via four wire line circuits. The control unit shall be compatible with the detection line impedances.

ix) Each addressable line module shall have its own microprocessor-based circuit, working independently from the central processor unit located in the control unit.

x) In the event of an alarm or a fault condition it shall be possible to determine the exact device address at the control unit by means of numerical display. The device address shall comprise of the line number, device number and zone number.

xi) The detector shall be exchangeable without any change of programme.

xii) It is Bidder's responsibility to include required number of zone modules for the addressable detector.

xiii) Any special type of cable required for the detection system shall be provided by the Bidder.

xiv) Provision for a Remote Electronic Hooter with intelligent Control Module shall be made and the Hooter Unit shall be placed in a convenient location to draw attention to the people in the locality.

B) Detector System

i) Selection of detectors as per the requirements for that area and indicated previously. However some general criteria are elaborated additionally below for Bidder’s guidance.

ii) Selection of type and number of detectors shall be based on type of combustible and ignition source, type of environment and type of risks involve. The detector shall determine whether a fire condition exists in the room / area where the detector is located. In case of fire, the audio-visual fire alarm will be generated at Central Control Room as well as initiate signal to operate a Hooter located at convenient place in the Power House Building, along with repeat display at fire alarm panel in Fire Station.

iii) Bidder shall consider area, ceiling height and type of ceiling construction for selection of optimum detector number and their placement. Other factors like ventilation, ambient temperature, radiation etc. are also to be taken into consideration.

iv) Guidelines in various standards such as NFPA-72, IS:2189, AERB standards etc. shall be followed. Detectors shall comply style-7 of NFPA.

v) Multi criteria smoke/heat detectors shall be intelligent analogue addressable type and shall have bi directional communication capability with the control panel. The accessory if required for the programming of the detector's address shall be provided. Further it shall be possible to change the detector sensitivity, calibration and identification from the control panel.

C) Additional Features

Followings are the additional features required :

i) A Operating work station with a keyboard and a A4 sized colored Laser printer. The monitor is essentially a 24 inch LED colour monitor which shall be hooked up to the main fire alarm control panels and shall display the alarm, prewarning, faults, system diagonistics and data logging system. A print of the data logged can be taken on demand.

ii) All the panels shall be standalone floor mounted type and as per design criteria & guidelines specified in C&I part, Vol. V

24.4.7.4 OPERATIONAL PHILOSOPHY & TECHNICAL REQUIREMENT:-

Each of the Addressable Fire Alarm panel shall be able to communicate with one another as well as with repeater annunciation panel and PLC based control panel located IN Fire Water Pump House. The detectors or other devices of any other unit/area shall be addressable only from the respective Addressable Fire Alarm Panel, so that each of the Addressable Fire Alarm Panel is under the control of designated operating personnel at that location. Facility to operate booster pumps, foam system pumps and fire water pump house shall be provided from OWS based monitoring station.

At least 10% spare loop shall be provided in each of the addressable type fire alarm panel located in unit control room and in CHP control room with complete loop card and all other accessories so that OWNER can expand the system in future. Further, at least 10% of loop capacity be left free in each of the connected loop in all the panels, so that, additional devices may be connected to the system in any of the loop by OWNER in future.

Fire system (as a whole including PLC control systems) shall be provided with necessary interface hardware and software for dual fibre optic connectivity & interconnection with station wide LAN for two–way transfer of signals for the purposed of information sharing. The information shall be made available though on Ethernet link following TCP/IP standard. The system shall be OPC compliant. The exact data structure shall be as decided during detailed engg. All required plant data shall be transferred to /from through the ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalized during detailed engineering.

System Functional Requirement

The fire alarm panel shall evaluate the signals received from the detectors and shall handle the following functions:

1. System self monitoring and fault signaling.

2. Transmission of alarm and fault signals to the respective fire alarm panels and as well as in the repeater panel in fire station. Further, the panel shall activate hooter / sounds in each of the area locally provided with fire/smoke detection system. Further, the system shall enable operation of spray system from the panel through monitoring station when the system operation is selected under remote, manual mode.

3. Initiate control functions like stoppage of conveyor, closure of fire doors, shutdown of draft fans, air-conditioning and ventilation plant/ equipment, opening smoke extraction vents, switching on smoke extraction equipment, emergency lighting etc.

4. Triggering stationary extinguishing systems such as clean agent system.

5. Supervising of unauthorised removal of a detector head from its base and giving a fault alarm on the control panel.

6. Supervising and monitoring the detection cabling, to indicate fault conditions in case of open/short circuit in the wiring.

7. Supervising by a separate annunciation window, changeover from mains supply to battery supply. "Mains On" indication shall be continuously on, as long as the main supply is available.

8. Facilitating simulation of fire conditions to enable the testing of circuits (without creating actual fire) under the test mode from the fire Alarm panel

9. The control unit shall contain all the systems main switches lamps and fuses.Switches and lamps shall be easily identified even in closed casings.

10. All the circuits from the detectors to the panels and the circuits from panels to the actuating/operating devices of the respective extinguishing system shall be of closed loop type and shall be supervised for open-circuiting and shortcircuiting of cables. The cable fault shall be audio-visually annunciated on the panels. Separate hooters with different tones shall be provided for 'fault' alarms and 'fire' alarms.

11. Actuate solenoid valve in spray system in case of fire from respective fire alarm panel. **For achieving this if any additional hardware is required like relays, power supply and cables, the same shall be provided.**

Analog Addressable Fire Detection and Alarm System shall also meet the following functional requirements:

i. Each of the system shall support analog addressable detectors of all types, non-addressable type detectors / devices along with its addressable interface units / modules, Video display units etc.

ii. Each of the devices and/or detectors shall be individually, uniquely and continuously addressable by the panel to which it is connected.

iii. Detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning and tested by a single technician using the field test routine. Sensitivity of each of the detectors made available in the panel shall be adjustable from the panel.

iv. The system shall be capable of self-adjustment to compensate for the accumulation of contaminants that would change the detector sensitivity in either a more or less sensitive direction to prevent false indications or failure to alarm in the actual fire conditions. The system shall annunciate a trouble condition when any analog addressable smoke detector reaches 80% of its alarm threshold due to gradual contamination, signaling the need for service and eliminating unwanted alarm.

v. Continuous supervision/monitoring of all the circuits and its components shall be made available from the panel for open, short circuits and grounding.

vi. The system shall be able to recognize and indicate and alarm condition in a degraded mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.

vii. The system shall be programmable at site and required hardware shall be included in the scope of supply. The system software Programs shall be password protected and shall include full upload and download capability. During program upload or download the system shall retain the capability for alarm reporting. The system shall download to a OWS for program editing. The software shall eligible Owner to add the spare loop provided in the fire alarm panel or addition of additional devices/detectors in and of loop in any of the fire alarm panel.

viii. The system shall support the use of color interactive History Reporting video display terminal for the display of information in an appropriate format.

ix. The system shall include software for system database, historical event log, logic and operating system. The system shall require no manual input to initialize in the event of a complete power down condition. It shall return to an on line state performing all programmed functions upon power restoration.

x. Software logic modules and system database shall be programmable using a windows compatible program on OWS. It shall be possible to program or edit the system database off site after down loading from the panel.

xi. All detectors shall incorporate internal automatic temperature compensation to overcome the effects of either high or low ambient temperatures in the installed environment on the detector sensitivity. The detectors shall be tested at a specified frequency by raising the detector sensitivity level to the alarm threshold, to check the operation of the detector without system alarming automatically by the control panel.

xii. In an alarm or trouble condition the following shall occur on the monitoring station:
    1. Sound an audible.
    2. Write details of the actuation to a system log file on the OWS.

3. Print the details of the actuation to the system printer.
4. Activate the color graphic display system controls, providing functions such as zooming, scrolling of Alarms, troubles, etc.

xiii. System configuration shall be menu driven and capable of being operated by a person with no previous computer programming experience.

Panel Display Requirements.

System display shall consist of minimum 80 character back lighted alphanumeric LCD display readable at any angle. Thirty-two character customer defined custom messages shall describe the location of the active device. In addition to the above, the following features shall be available.

a. The system shall be capable of programming to allow troubles occurred and restored in the system to be automatically removed from the display queue, eliminating the necessity for individual acknowledging of these events. This feature shall not affect the historical logging of events as programmed.

b. As a minimum an LED display for "Alarm", "Audible Silenced", "Supervisory", "Trouble", "Security", "Power On", And "Partial System Disabled".

c. Touch activated membrane switches for "Alarm Acknowledge", "Audible Silence", "Supervisory Acknowledge", "Security Acknowledge", "Reset", "Display Hold", And "Display Next".

d. All membrane switches shall be tactile with audible feedback when pressed.

SYSTEM SOFTWARE REQUIREMENTS

i) The software shall control the operation, function and display of the graphic system and provide for automatic boot up and run from the hard disk drive of the computer.

ii) All project specifics actuating device programming shall be capable of being carried out on site via password access.

iii) The system shall monitor all alarm, supervisory; trouble and security conditions detected by the fire alarm control panel and provide separate disk based files, for each condition. These logs may be enabled, disabled, or cleared with password access. This log information is not to be lost upon power failure or fire alarm control panel reset. A utility file shall be provided to sort the log data by date or by device and display this information either on the screen or the system printer.

iv) Selective memory storage up to 800 events, shall be stored in flash memory and displayed, printed or downloaded by classification for selective event reports.

a. Software shall allow selection of events to be logged, including; inputs as alarms, troubles, supervisors, securities, status changes and device verification; out puts, as audible control and output

activation; action, as reset, set sensitivity, arm/disarm, override, password, set time and acknowledge.

b. Audible and visual indications shall be generated when memory is 80% and 90% full to allow downloading of data. The system shall be programmable circular logging, assuring that at least the last 400 events will always be stored in non-volatile memory.

v) Software has driven logic for adjusting the alarm threshold windows on detectors to compensate for accumulating contamination and keep detector response sensitivity constant. The software shall compensate for either oversensitized or desensitized units, raising a system flag when a detector approaches the allowable limits of adjustment, indicating a requirement for cleaning.

a. Values shall be stored in non-volatile memory allowing activation of all tracking functions within 90 sec of system initiation from a "cold boot". During the boot sequence, alarms from detectors programmed with the feature shall be suppressed.

When the full data history is active all devices shall be checked and any active alarms displayed.

b. The control panel shall place each detector in the system in an alarm condition, transparent to the system user, every twenty-four hours as a dynamic check of the accuracy of the alarm threshold setting. Upon reception of the alarm report, the system detector shall be restored to its pretest state.

c. The system shall be capable of monitoring the stage of detectors and displaying a message when a detector is approaching the limits of adjustment as a result of contaminates. A second message shall be displayed when the detector reaches the limits of adjustment due to these contaminate.

d. The system shall be capable of recognizing that a detector has been cleaned, initiating a series of tests to determine if the cleaning was successful and display a detector cleaned message, readjusting that detectors normal sensitivity setting reference.

vi) When an alarm or trouble is registered at the fire alarm control panel the graphics system shall display the first screen image for the first actuated device. The system shall be capable of zooming in for further information if required. At all times when in the alarm or trouble mode the fire control panel status i.e. number of current alarms and or troubles is to be displayed on the graphics screen.

Detection System for Coal Conveyors

a. The LHS cable detector for each conveyor to be provided for both forward and return conveyors and shall be mounted as per the standard practice of the manufacturer/ supplier. The mounting arrangement shall be designed such a way that the same shall not hinder the normal operation and maintenance. Suspension of LHSC through flexible chains is a preferred arrangement. Further, LHS cable shall also be provided for return side of conveyors inside the bunker house.

b. The detection zone/loop divisions of LHSC system shall match with the MVW spray system.

c. Wet type QB detection system shall also be employed in addition to LHS Cable.

d. Upon detection of fire either by QB detector or LHSC detector, the spray system shall be initiated. It shall also initiate spray system for the two adjacent zones after a time delay settable at site.

e. The LHSC detector shall be provided with suitable interface unit, which shall generate/ make the signal compatible with fire alarm panel.

f. The infra red type (IR) detectors shall be suitable for detecting moving fires in coal conveyors.

g. The IR detector shall stop the conveyor upon detection of fire and give audiovisual annunciation locally and in fire alarm panel.

h. The IR detector shall be outdoor type weather proof and shall be able to function continuously in heavily coal-dust prone atmosphere without regular maintenance.

i. The IR detector shall be designed to reject deceptive phenomenon such as electric arc, heaters, artificial light sources (HPSV/LPSV/incandescent lamps etc.) Sunlight etc. while retaining the inherent detection characteristics.

j. Each of the IR detector shall be provided with its own purging arrangement using blowers, hoses, etc and required power supply shall be derived from the fire alarm panel. Alternatively, bidder to each of the IR detector shall be provided by the bidder.

k. The performance of the proposed IR detector model for detecting moving fires shall be demonstrated to Owner as per test procedure acceptable to Owner before supply of the same at site. Such demonstration test shall be conducted in a typical coal conveyor test set up at works or in a plant.

l. Min two (2) Nos Solar Blind Infra-red detectors with inbuilt air purging unit as per specification shall be used in coal conveyor gallery and tunnel for detection of moving fire.

Detection System of Cable Galleries

a. In cable galleries, MVW spray system shall be actuated either by detection of fire by Linear Heat sensing cable detectors or by fire signal from smoke (after cross zoning) detection system. Apart from the automatic operation of spray system in the detected zone the adjacent two zones shall also be sprayed with water automatically after a set time delay simultaneously.

b. LHSC detector shall run in a zig-zag fashion (with an included angle of minimum 90 degree atleast) in each of the top tray, bottom tray and in every alternate trays. Mounting arrangement of LHSC detector shall be as per recommendation/proven practice of manufacturer.

c. The detection zone/loop divisions shall match with MVW spray zones.

24.4.8 Control and Instrumentation

For technical features and requirements of the control and instrumentation items including Field instrument, Panels and Panel mounted instruments, annunciators, PLC and other hardware and peripherals under scope of supply for the Fire water system, Bidder shall refer the relevant clauses of the Volume V – Instrumentation & Control Works

24.4.8.1 Battery and Battery Charger

24.4.8.1.1 Battery

a) Battery to be located in FW Pump house shall be suitable to meet starting requirements of Diesel Engine driven pumps. Besides these all controls, indications, annunciations etc. (including multiplication of process interlock relays and auxiliary relays) shall have power supply from 24 V (2 × 12 V-2x100%) & Battery and Battery Charger unit(2x100%)

b) Satellite Fire Panels are located strategically in the power. All controls, interlock, indication, annunciation system etc. for Fire Detection system shall have power supply from 24V (2x12V) Battery and Battery charger Unit. The Battery for each Satellite Fire Panel compatable with UL standared shall be located in the bottom portion of the same panel.

c) All controls, interlocks, indications, annunciation system etc. for each of the Fire Detection and Alarm Panels (located in Central Control room) and the Repeater Panel (located in Fire Station), shall have power supply from 24 V (2x12V) Battery and Battery Charging Units. The Battery of each of the above Panels shall be located in the bottom portion of the same Panel. The OWS with Printer in the central control room shall be powered up by the respective UPS Power of the Plant Instrumentation and Control System.

d) Diesel Engine Driven Fire Water Pump:
The Battery shall have the capacity to start the Diesel engine at least for eleven starts. Further Battery shall have capacity to meet auxiliaries & other loads of Local Control Panel, if any, for a minimum period of 10 hours. Minimum Ampere-hour capacity of the Battery shall be selected accordingly.

e) The Battery driven Power supply shall be available to local zonal fire panels, main and repeater fire alarm panel shall be designed to provide supply for a minimum period of 10 hours. Minimum ampere hour capacity of the Battery shall be selected accordingly.

f) Bidder shall compute the ampere hour capacity at suitable discharge rate based on above duty and furnish the calculation along with the Bid which shall consider the duty cycle and 25% & 15% compensation for ageing & unforeseen future growth respectively of each battery unit. The maximum and minimum ambient shall be 45°C and 8°C respectively.

The minimum voltage at the end of the load cycle shall not be less than 1.8 volts per cell.

24.4.8.1.2 Battery Charger

For design and construction of Battery Charger refer Volume : V

24.4.8.1.2.1 Layout of Battery & Battery Charger

a) The battery and charger of the respective panels shall be an integral part of each of the local fire protection panel / main fire panel / local fire panel / repeater panel.

b) Bidder shall indicate his own layout of 24 volt Battery and Charger to suit the space available.

24.4.8.1.2.2 Fittings & Accessories

Each battery shall be furnished with necessary accessories required.

24.4.8.2 Contact Rating and Contact Multiplication for Pressure Switch/Limit Switch of Valves

a) Contact rating of 10 Amps. at 240V A.C. or 0.5 Amp. at 220V DC is required to operate different circuits. If the same rating is not available from process switch contacts of the fire protection system, suitable auxiliary contactor/relay shall be included in the offer and provided in the respective panels to get the suitable number of contacts which can meet the current rating stipulated above.

b) Further if the number of the process switch contacts of Fire Protection System are not adequate to meet the requirement for "System of Operation", annunciation and monitoring system, the same shall be included in the offer and provided in the respective Panels to get the suitable number of contacts which can also meet the current stipulated above.

24.4.8.3 Interlock Between "Fire Protection System" and Coal Handling Plant and Ventilation and Air Conditioning System

a) In case of fire in any Zone of conveying system in coal Handling Plant, fire detector of that particular zone will operate at a preset value and an alarm will be annunciated in the Fire Alarm Panel located in Coal Handling Building. Simultaneously, the conveyor motor of the particular conveying system will be tripped automatically through IR Detector.

b) In order to achieve this, "Detector Operated Digital Signal" will be generated in the Fire Panel by the Bidder (i.e. successful Bidder) with the help of auxiliary contactor/relay for interlock purpose to trip the conveyor motor. This signal shall be provided in the form of potential free (not changeover type) 1NO + 1NC contact combination for trip of each such conveyer motor.
The list of such inputs required shall be developed by the successful Bidder.

c) In case of fire in a zone/area where ventilation fans and/or Air-conditioning Ducts are installed similar "Detector Operated Digital Signal" shall be generated in the nearby Fire Panel. This digital signal shall also be generated in the form of potential free (not change-over type)

1NO + 1NC contact combination with the help of auxiliary contactor/relay for automatic trip or closing of each such ventilation fan-motor, fire damper of ventilation fan/duct, damper motor of Air-conditioning duct, blower motor of corresponding Air handling unit & compressor motor of chiller unit.

d) The list of such inputs required shall be developed by the successful Bidder.

e) The auxiliary contactor/relay required as mentioned in clause nos. a) and b) above shall have 24V D.C. power supply system provided in the respective Fire Protection Zonal Panels.

f) Number of contacts for the auxiliary contactor/relay shall be 4NO + 4NC. The contact rating of each such auxiliary contactor/relay shall be of 10 Amps. at 240V A.C. or 0.5 Amp. at 220V D.C.

g) Since the false ceiling of above area shall act as return duct of Air conditioning and since roof extractor is used without any ducting arrangement for ventilation system, detectors for air conditioning duct and ventilation duct are not envisaged. If Ducts will be decided during detail engineering, the same shall be required.

24.4.8.4 Annunciation System

a) A Board Sequence of Annunciation System shall be as per the following Table:

Status	Visual Display	Audio Signal
NORMAL	OFF	OFF
FAULT	ON WITH BLINKING	ON
ACCEPT	ON (STEADY)	OFF
NORMAL BEFORE ACCEPT	ON WITH BLINKING	ON
FAULT CLEAR BUT NOT RESET (after ACCEPT)	ON (STEADY)	OFF
RESET WHEN FAULT IS CLEARED	OFF	OFF
RESET WHEN FAULT IS NOT CLEARED	ON (STEADY)	OFF

b) The detector zone connections shall be supervised to indicate fault condition in case of removal of one or more fire detectors from the detector base.

c) All cabling between detector and the panel shall be supervised so as to indicate fault condition in case of open/short in detector cabling with a direct fault condition. The tone of this audio-alarm shall be distinct and different from that of zone wise fire alarm.

d) The printed circuit cards provided for individual fire-zone shall be coated for prevention against corrosion. Gold plated connectors shall be provided for proper contacts.

e) Separate set of "Accept", "Test" & "Reset" push buttons shall be provided for "Fault Alarm" and "Fire Alarm" systems.

f) Each panel shall be provided with a hooter/buzzer, which shall have dual toners for differentiating the fire alarm with the fault alarm.

g) Facility shall be provided for connection of external electrical hooter/gong, which shall be energised in case of fire alarm condition within any of the zones provided on the panel. The input for the hooter/gong shall be 24 Volt D.C.

h) Fire Detection and Alarm Panels and Master Fire Alarm Panel shall also have "Fault Alarm" & "Fire Alarm" system. For this purpose potential free contacts shall be provided in the respective Satellite Fire panels for hook-up between Fire Detection and Alarm Panels/ Master Fire Alarm Panels and each Satellite Fire Panel.

i) Each zone module shall have a facility for diagnostic check of all the related circuitry for their operation healthiness. The same shall be accomplished through the following push buttons :

a) Fire, b) Open, c) Short, d) Insulation level.

Fire proof sealing/Fire Stop/Fire Protection Coating System

The fire-proof sealing/fire stop system/fire protection coating system is required to prevent spreading of fire from one place to another (or one zone to another) through the openings in wall/floor, cables laid in trays / racks and openings below Electrical Switchgear / MCC / Distribution Boards / Cabinets / Panels etc.

Fire-proof Sealing System

The material/components used for fire-proof sealing system shall be provided to meet the following requirements:

a) Life expectancy should not be less than 30 years from the date of installation.

b) Free from shrinkage or cracking or asbestos in composition and should achieve smoke and gas tightness during fire and should be modifiable.

c) Not to generate toxic gas and harmless to the personnel handling the system.

d) Prohibition of production of acid or alkali during gas generation.

e) Will not produce suffocating/corrosive gas.

f) Repellant to pest/ rodent/ termite.

g) Expansion co-efficient - very low, which is to be comparable with masonry concrete.

h) Not soluble/reactive to acid, water, alkali.

i) Thermal conductivity - low.

j) The material in contact with the cables in the fire-proof sealing system shall be compatible with the material used for outer sheath of cables.

k) It should not have any adverse effect on the cables and should not alter the current carrying capacity of the cables.

l) Retrofit in design to accommodate not less than 15% more addition of cables depending upon the size of cables, physically and chemically stable.

m) Capable of withstanding vibrations, drop-loads, foot traffics, mechanical loads, etc.

n) Non-hygroscopic, non-inflammable and shall not get affected over a period of time due to humidity, moisture and ozone etc. and should not contain volatile solvents which may cause a fire hazard during application.

o) The fire rating shall not be less than three (3) hours and the system shall be stable after application of water jet in the exposed side in order to extinguish fire.

Fire Protection Coating to be Applied on Installed Cables

a) The cables shall be coated with fire protection material of 2 mm dry thickness at the strategic locations as follows so as to limit the spread of fire:

   i) At fire stops in walls and floors on either side upto 500 mm length.

   ii) At fire stops below Electrical Switchgears / MCCs / Panels / Cabinets etc. on one side coating of 500 mm length i.e. on the cable vault side/cable trench side.

   iii) Length of 500 mm on all sides of the junction/crossing of cabling work in open cable routes/cable trench.

   iv) In fire risk areas and where specified at suitable intervals as decided upon site conditions in open cable routes.

   v) Where necessary and specified at site at intervals along cable routes in cable trenches.

   vi) The coating shall be applied evenly on the cables only.

b) The fire protection coating shall have the following properties / composition:

   i) Asbestos free, non-volatile, not eatable by vermin, harmless and non-irritant to skin of human.

ii) Not affecting the current carrying capacity of the cables and the properties of the installed cables.

iii) It shall delay fire damage to cables and prevent flame spreading meeting the requirement of IEC-332-1 & IEEE- 383.

iv) Coating material shall show no signs of cracking and peeling when the coated cable is bent to the radius of minimum 12 times the diameter of the maximum sized cable at 180°C.

v) The limiting oxygen index of the material shall not be less than 35% as per ASTMD-2863.

vi) Life expectancy equivalent to the cable installations.

The various openings in the cable vault, vertical / horizontal raceways of cables penetrating walls / floors and the bottom of Electrical Switchgears / MCCs / Distribution Boards / Cabinets / Panels shall be provided with fire stop systems. Cables passing through the openings at various locations are laid on various tiers of the cable trays/racks in the bunch formation. In case, for the purpose of installation of seal system, steel frames are required to be fabricated and fixed in the openings, the fabrication of frame and fixing of the same shall have to be done by the Bidder. The necessary steel section for fabrication of frames shall be supplied by the Bidder without any extra cost. Any, civil works required to be done in the openings shall be carried out by the Bidder. Bidder shall also include one set of tools and accessories required for addition or removal of cables after the seal is made. This shall include special tools, compound injection guns, spray guns, etc.

Power and Control Cables

Fire survival Power and Control Cables shall be of following types :

a) Power Cables

750V grade heavy duty mineral insulated copper sheathed copper conductor cable with outer covering of LSF material equivalent to BICC Fire Safe, conforming to BS:6207. The cables shall be rated for 950°C. for three hours and shall meet with requirements of CWZ class as per BS:6387. Minimum cross-section shall be 2.5 Sq.mm.

b) Control Cables (for fire detection)

Survival cables shall be similar to the above except that voltage grade shall be 500V in place of 750V. In addition the cables shall have high degree of immunity from electromagnetic interference. Minimum cross section shall be 1.5 Sq.mm.

FRLS Power and Control Cables

a) Power Cables

1.1 kV grade 85°C. rating heavy duty power cable with stranded Aluminium/Copper conductors, HRPVC insulation, extruded PVC inner sheath, round wire armour and extruded FRLS PVC overall sheath. Minimum cross-section shall be 2.5 Sq.mm. Cu. and 16 Sq.mm. Al.

b) Control Cables

1.1 kV grade, 70°C. rating control cables with stranded copper conductor, PVC insulation, extruded PVC inner sheath round wire armour, overall extruded FRLS PVC sheathed. Minimum cross-section shall be 1.5 Sq.mm. Cu.

Instrumentation Cables

a) Bidder to refer Vol. V, Chapter 9 for details of instrumentation cables. For any binary or Analog signals, instrumentation cables shall be used as per design criteria & guidelines specified in Vol. V, Chapter 9.

b) In Fire Protection & Detection system, Loop wiring & Panel networking shall be designed meeting the NFPA Style 7 requirements.

24.4.9 **CIVIL SUPPLY**

a) Design and construction of Fire Water pump house including foundation of fire water system equipments (viz, pumps & motors, diesel engine, compressor etc.)

b) Excavation, preparation of bed and backfilling with compaction for laying underground pipelines and underground cables (where approved by purchaser).

c) Construction of RCC valve chamber as required.

d) Construction of shed for deluge valve, Booster Pump House as per specification. The shed shall be of masonary enclosed structure with minimum four inch (4") RCC Roof.

e) Construction of pylon support including foundation for spray water ring and water circuit for detection of H.T. Transformer, Oil tanks etc.

f) Design & construction of foundation of fire water steel storage tanks mentioned above.

g) Adequate no. of staircases as per National Building Code (NBC) and TAC.

24.4.10 ELETRICAL, CONTROL & INSTRUMENTATION

Complete Electrical, Control & Instrumentation system for safe and reliable operation of the system shall be included as per design criteria & guidelines specified in Volume IV & Volume V.

a. Fire stops/fire ceiling of two (2) hours rating at 750°C in wall/floors.

b. Fire stops below switchgear / MCC / Switchboards, junction boxes / panels / cabinets etc. which are floor-mounted type.

c. Fire retardant coating of thirty (30) minutes rating at 750°C to be applied for installed cables.

d. Fire barrier / baffle wall in transformer yard, fire barriers for compartmentalizing the cable spreader rooms, fire proof door.

e. Materials for fire barrier walls/baffle wall in Transformer Yard.

g. Materials for fire barrier for compartmentalizing the cable spreader rooms.

h. Materials for fire proof doors.

24.4.11 Fire Extinguishers

Fire Extinguishers shall be installed in all the buildings within the Plant boundry as per TAC requirement. The Bidder shall supply the required quantities of Fire extinguishers and install the same at all location within the power plant boundary limits. Distribution of these extinguishers in various locations shall be as per TAC guidelines.

Class-A

Fire in ordinary combustibles such as wood, coal dust, vegetable, fibre, paper and the like.

Class-B

Fires in flammable liquids, paints, grease, solvents and the like.

Clas-E : Fires in Electrical and Control & Instrumentation Equipments

To encounter the above classes of fires, extinguishers of Gas/Expelled water type, Carbon dioxide type, Dry chemical powder type and Mechanical Foam type shall be provided by the Bidder inside the Power House Building and all other main/auxiliary buildings where the above mentioned classes of fires are envisaged.

The selection of number of extinguishers for each type shall basically follow the guidelines laid down in Cl. No. 4.0 of the latest edition of the Fire Protection Manual Published by TAC.

24.4.11.1 DESIGN, CONSTRUCTION AND SPECIFIC REQUIREMENTS

24.4.11.1.1 Design and manufacture of the extinguishers shall conform to the latest editions of Indian and other equivalent International Standards and shall be suitable for respective design pressure, temperature and service conditions.

24.4.11.1.2 All the extinguishers along with accessories shall be guaranteed for satisfactory and trouble-free operation.

24.4.11.1.3 Portable extinguishers shall be complete with brackets/fittings suitable for mounting on wall and a carrying handle of ample strength.

24.4.11.1.4 Mobile extinguishers shall be provided with a wheeled trolley for movement. Trolley mounted extinguishers shall be provided with 6 or 9 meter long high pressure discharge hose with horn/ telescopic applicator.

24.4.11.1.5 Spanner and other accessories as required shall be supplied with each fire extinguisher.

24.4.11.1.6 Each extinguisher shall be designed, constructed, tested and painted in accordance with respective Indian/International Standard and marked with BIS Certification.

24.4.11.1.7 First charge of chemicals in each extinguisher shall be provided. All chemical charges shall be refilled after testing at site.

24.4.11.1.8 As required by Tariff Advisory Committee (TAC), 20% spare charge of the total no. of extinguishers installed, with a minimum of six recharges, shall be supplied for each type of extinguishers.

24.4.11.1.9 Fire extinguishers shall be fitted with pressure gauges as applicable to indicate whether the extinguisher is charged or in need of a recharge.

24.4.11.1.10 For design and construction standard, capacity and accessories of various portable/mobile extinguishers, datasheet appended shall be referred to.

24.4.11.1.11 The discharge horn of the Carbon-Dioxide Extinguishers shall be made of a material non-conducting to electricity.

24.4.11.1.12 All extinguishers shall be mounted at strategic locations in bunches and/or individually to TAC approval. These extinguisher cylinders shall have the approval of Chief Inspector of Explosive (CIE), Nagpur.

24.4.12 Passive Fire Protection System:-

Passive Fire Protection System for all outdoor transformers, and indoor transformers having rating more than 10 MVA, Cable Vault, Cable Spreader Room & Enclosed Cable Risers (Cable Shafts) shall be provided

DATA SHEET FOR FIRE WATER PUMPS

DATASHEETS

A. FIRE WATER HYDRANT & SPRAY PUMPS

S. No.	Description	Electrical Motor Driven Pump	Diesel Engine Driven Pumps
1.0	**GENERAL INFORMATION**		
1.1	Service Liquid	Water	Water
1.2	Duty	Intermittent	Intermittent
1.3	Location	In-door	In-door
1.4	Type	Vertical Centrifugal Type	Vertical Centrifugal Type
1.5	Quantity of Hydrant Pumps	2*	2*
1.6	Quantity of Spray Pumps	1	1
1.7	Rated capacity (m^3/hr)/ Nos.	410m^3/hr	410m^3/hr
1.8	Rated speed (RPM)	1500 (max)	1500 (max)
1.9	Total dynamic head MWC	105/110/120 MWC	105/110/120 MWC
2.0	**MATERIAL OF CONSTRUCTION**		
2.1	Base Plate	MS, IS:2062 Gr B	
2.2	Discharge elbow / Casing / Bowl / Suction Bell	CI, IS 210 Gr Fg 260	
2.3	Column Pipe	MS, IS:2062 Gr B	
2.2	Impeller	SS CF8M	
2.3	Shaft	SS410	
2.4	Shaft Coupling	SS 410	
2.5	Line Bearing	Cutless nitrile rubber in SS shell	
2.6	Shaft Sleeve	SS 316	
2.7	Impeller Wearing rings	CF8	
2.8	Stuffing Box	CI, IS210 Gr Fg 260	
3.0	Design standard	HIS/IS-6595 Part-2/Equivalent Standard	
4.0	Type	---------Vertical Turbine--------	
5.0	Impeller type	----------Closed----------	
6.0	Type of gland lubrication and sealing	----------By Bidder----------	
7.0	Shaft sealing arrangement	---------- Gland ----------	
8.0	Axial thrust balancing device to be designed for pump shut-off operation	---------- Yes ----------	
9. 0	Type of pump-motor connection	----------Direct ----------	
10. 0	Type of coupling	---------- Flexible Coupling ----------	
11. 0	Mode of pump starting	-- Discharge valve fully open ---	
12.0	Supply of accessories & services		
	a) Base plate	---------- Yes ----------	
	b) Foundation bolts, nuts, sleeves etc.	---------- Yes ----------	
	c) Suction & Discharge companion flanges with bolts, nuts & gaskets		

S. No.	Description	Electrical Motor Driven Pump	Diesel Engine Driven Pumps
	d) Priming connection with 3 way SS isolating valve	---------- Yes ----------	
	e) Suction & Discharge pressure indicator	---------- Yes ----------	
	f) Vent with 3 way SS isolating valve	---------- Yes ----------	
	g) Pump-motor coupling and guard	---------- Yes ----------	
	h) Drain connection with valve	---------- Yes ----------	
	i) Eye-bolts, lifting tackle etc.	---------- Yes ----------	
Note: * Quantity to be decided by bidder based on TAC			

B. FIRE WATER BOOSTER PUMPS

S. No.	Description	Electrical Motor Driven Pump	Diesel Engine Driven Pumps
1.0	**GENERAL INFORMATION**		
1.1	Service	Water	Water
1.2	Duty	Intermittent	Intermittent
1.3	Location	In-door	In-door
1.4	Type	Horizontal Centrifugal Type	Horizontal Centrifugal Type
1.5	Quantity	1	1
1.6	Rated capacity (m^3/hr)/ Nos.	137m^3/hr	137m^3/hr
1.7	Rated speed (RPM)	1500	1500
1.8	Total dynamic head MWC	50	50
1.9	Sealing	Mechanical Seal	Mechanical Seal
2.0	**MATERIAL OF CONSTRUCTION**		
2.1	Casing	CAST STEEL	
2.2	Diffuser	Fabricated CS as per IS 2062	Fabricated CS as per IS 2062
2.3	Impeller	SS CF 8M	Ss CF 8M
	Wearing rings	AISI-410	AISI-410
2.4	Shaft	AISI-410	AISI-410
2.5	Shaft sleeve	AISI-316	AISI-316
2.6	Base plate	MS to IS: 2062	MS to IS: 2062
2.7	Shaft Sealing	Mechanical Seal	Mechanical Seal
2.8	Shaft Coupler	Forged/Cast Steel	Forged/Cast Steel
2.9	Wetted Fasteners	SS 316	SS 316

C. FIRE WATER JOCKEY PUMPS

S. No.	Description	Electrical Motor Driven Pump
1.0	**GENERAL INFORMATION**	
1.1	Service	Water

1.2	Duty	Intermittent
1.3	Location	In-door
1.4	Type	Horizontal Centrifugal Type
1.5	Quantity	1
1.6	Rated capacity (m^3/hr)/ Nos.	40 m^3/hr
1.7	Rated speed (RPM)	1500
1.8	Total dynamic head (MWC)	105/110/120 MWC
1.9	Sealing	Mechanical Seal
2.0	**MATERIAL OF CONSTRUCTION**	
2.1	Casing	2.5% Ni CI: IS 210 Gr.FG.260
2.2	Casing Liner	2.5% Ni CI: IS 210 Gr.FG.260
2.3	Diffuser	Fabricated CS as per IS 2062
2.2	Impeller	AISI-410
	Wearing rings	AISI-410
2.3	Shaft	AISI-410
2.4	Shaft sleeve	AISI-410 (Hardened)
2.5	Base plate	MS to IS: 2062
2.6	Shaft Sealing	Mechanical Seal
2.7	Shaft Coupler	Forged/Cast Steel
2.8	Wetted Fasteners	SS 316

D. DIESEL ENGINE

1.0	GENERAL INFORMATION	
1.1	Service	Fire Water Pumps (Hydrant, Spray and Booster)
1.2	Type	Compression ignition, mechanical (airless) Direct injection, multi cylinder and four stroke cycle and cold starting type.
1.3	Duty	Intermittent.
2.0	ENGINE PARAMETERS	
2.1	Nominal output of engine at site operating under ambient conditions	Bidder to indicate during detailed engineering
2.2	Speed of the engine	Not more than 2300 rpm
2.3	Brake horse power rating at rated speed	As per TAC / Factory Mutual
2.4	Speed of the engine	As per TAC / Factory Mutual
2.5	Oil Lubrication System	As per TAC / Factory Mutual
2.6	Fuel Oil System	As per TAC / Factory Mutual
2.7	Governing system	As per TAC / Factory Mutual
2.8	Starting System	As per TAC / Factory Mutual
2.9	Cooling System	As per TAC / Factory Mutual
2.10	Manufacturer	As Per approved Vendor List
2.11	IS Standard Applicable	IS:3046
2.12	No. of cylinders	4 Inline
2.13	No of stroke	4 stroke
2.14	Cooling	Heat Exchanger
2.15	Battery Type and Volts	Ni- Cd(12 V)-2x100%
2.16	Battery Charger	2x100%
2.17	Fuel Tank Capacity	Min 4 Hrs(As Per TAC)
2.18	Spare Parts	As per TAC Clause 7.4.5.11

E. PIPING AND FITTINGS AND SPECIALTIES

1.00.00	**Type**	**Buried pipes**	**Over ground pipes normally full of water**	**Over ground Pipes normally empty but periodically charge with water & foam system applications**	**Over ground compressed air pipes**
		(i)	(ii)	(iii)	(iv)
2.00.00	Material	M. S. ERW pipes as per IS-1239, Part – 1 heavy grade (for pipes of sizes 150 mm NB or below) and IS-3589 Gr.410 ERW (for sizes 200 mm NB and above) or equivalent and galvanized as per IS 4736 for pipes normally empty and periodically charged with water and foam system application.			
3.00.00	Piping Thickness	AS per IS Standards			
4.00.00	Pipe Protection	Refer Volume II			
5.00.00	Size	As per final design and engineering by Bidder and approved by Owner. However Bidder shall consider velocity of fluid in the pipeline & other criteria as indicated elsewhere for selection of pipe size			
6.00.00	Construction	---------- ERW ----------			
7.00.00	Joints	Butt-welded for size 65 mm NB & higher as per ANSI B 16.9 and socket welded for sizes up to 50 m NB as per ANSI B16.11		Screwed flange as required for dismantling purposes for sizes 65 mm NB & above as per ANSI B 16.5 and screwed socket for sizes 50 mm NB & below. Welding on GI Pipes/fittings would be permitted provided the same is carried out by means of special electrodes suitable for the above application and the same shall be approved by the Owner. After welding, welded portions shall be applied with three coats of zinc silicate treatment/rich paint over one coat of suitable primer. Further the Bidder shall provide proper zinc paint at the point of welding.	

6.00.00	Fittings Ratings/Wall thickness Material	Minimum thickness to match with that of pipe for pipe size 65 mm NB and above. For pipe size above 150 mm NB, minimum thickness shall be 6 mm. For pipe size 50 mm NB & below rating shall be 3000 lbs or wall thickness matching with that of corresponding pipe. The material shall conform to ASTM A234 Gr. WPB or ASTM A 105 or equivalent.
Notes :	1. All fittings and flanges for galvanized pipes shall be galvanized. 2. Unless otherwise specified, all elbows/bends shall be long radius type. 3. The fittings shall be galvanized as per IS:4736 for galvanized pipe application. In case of branching connections from GI mains for spray piping network socket may be welded for more than two pipe reduction instead of standard tees. 4. Fabricated fittings shall not be acceptable up to pipe size of 300 NB. For sizes 350 NB & above, fittings may be fabricated as per BS:2633/BS:534.	

F. VALVES AND SPECIALTIES

S. No.	Description	Specification Requirement
1.0	**C.I. Gate Valves**	
1.1	Type	Rising spindle type (For Above ground Piping and Non Rising Spindle type for Underground piping)
1.2	Code / Standard	IS-14846 for sizes 65 mm NB to 300 mm NB. IS-2906 for sizes 350mm NB and above.
1.3	Material of construction	
A	Body	CI IS: 210 Gr FG 260
B	Bonnet	CI IS: 210 Gr FG 260
C	Stem	Gun metal IS: 315 CTB2 or IS: 320 HT2
D	Wedge disc	CI IS: 210 Gr. FG 260
E	Body seating ring	Renewable, gun metal to IS: 315 LTB2 or IS: 318 LTB2
F	Back sheet	Renewable, gun metal to IS: 315 LTB2
G	Stem packing	Renewable, expanded PTFE
H	Hand wheel	CI IS: 210 Gr. 260
I	Bonnet bolts & nuts	CS IS: 1367
J	Bonnet gasket	Neoprene or Teflon
1.4	Testing	As per IS: 14846
1.5	Approval	ISI marked / TAC approved
2.0	**Gun Metal Globe Valves**	
2.1	Type	Rising spindle
2.2	Code / Standard	IS: 778 / BS 13789
2.3	Material of construction	
i	Body	GM, IS: 318 Gr. 2, Casting
ii	Bonnet	GM, IS: 318 Gr. 2
iii	Disc	GM, IS: 318 Gr. 2, Guided
iv	Stem	HT brass, IS: 320, OS & Y, Forged
v	Seat ring	GM, IS: 318, Gr. 2, Renewable
vi	Gasket (Bonnet)	CAF, IS: 2712

	Packing	Renewable with valve open, graphite asbestos to IS: 4687
vii	Hand wheel / lever	CI IS 210 Gr. 200
2.4	Testing	As per IS: 778
2.5	Approval	ISI marked / TAC approved
3.0	**C-I Check Valves**	
3.1	Type	Swinging disc type
3.2	Code / Standard	As per latest BS 1868 / IS code
3.3	Material of construction	
i	Body	CI IS: 210 Gr. FG 260
ii	Cover	CI IS: 210 Gr. FG 260
iii	Disc	CI IS: 210 Gr. FG 260
iv	Hinge bracket	CI IS: 210 Gr. FG 260
v	Body seat ring	Leaded tin bronze IS: 310 LTB-2
vi	Flap seat ring	Leaded tin bronze IS: 310 LTB-2
vii	Hinge pin	H.T. brass IS: 320 HT-2
viii	Gasket	CAF IS 2712
ix	Bolt, nut & studs	CS IS 1367
3.4	Testing	As per latest BS / IS code
3.5	Approval	ISI marked and TAC approved
4.0	**Butterfly Valves**	
4.1	Type	Wafer up to 300 NB, lug type up to 500 NB & shot flanged for 600 NB and above. Valve above 150 NB will be gear operated
4.5	Code / Standard	IS: 13095
4.6	Material of construction	
i	Body	SA 216 Gr. WCB, casting
ii	Shaft	SS 40, stub shaft
iii	Disc	SA 216 Gr. WCB, casting
iv	Disc retaining ring	SS 316
v	Body seat "O" ring	Nitrile rubber
vi	Bush	PTFE
vii	Hand wheel / lever	CS
viii	Studs	SA 193 Gr. B7
ix	Nuts	SA 194 Gr. 2H
4.7	Testing	AWWA-C 504
4.8	Test pressure	Body – 24 Kg/cm^2 Seat – 16 Kg/cm^2
4.9	Approval	ISI marked / TAC approved
Note:	Gate, globe and check valve of size 50 mm NB & below shall be of forged CS body as per API 602(Gate valve), BS 1868(Check valve) and BS 1873(Globe valve). These valves shall have socket welded ends. Valves will be provided with locking arrangements.	
5.0	**Hydrant**	
5.1	Type	Single / Double headed, female oblique type
5.2	Code / Standard	IS: 5290
5.3	End connection Inlet Outlet	Flanged and drilled to ANSI 150# B 16.5 Female instantaneous coupling with spring lock type coupling with blank cap & chain.
5.4	Size	63 mm

5.5	Flow	900 LPM at 7 Kg/cm^2 for type-A 1800 LPM at 7 Kg/cm^2 for type-B Or as per TAC
5.6	Testing	As per IS: 5290
5.8	Working pressure	9 Kg/cm^2
5.9	Material of Construction	
i	Body	SS to IS: 3444
ii	Female outlet	SS to IS: 3444
iii	Stop valve	SS to IS: 3444
iv	Blank cap	SS to IS: 3444
v	Bonnet	SS to IS: 3444
vi	Gland	As per IS: 5290
vii	Gland packing	Non-asbestos
viii	Gland nut	As per IS: 5290
ix	Check nut	SS to IS: 3444
x	Seat	SS to IS: 3444
xi	Spindle	Brass to IS – 319
xii	Hand wheel	CI IS 210 Gr. 200
xiii	Spring	SS to IS: 6603
xiv	Washer & rubber seat	Rubber to IS: 937
5.10	Approval	ISI marked / TAC approval
6.0	**Water Monitor**	
6.1	Type	Horizontal and vertical swivel type
6.2	Code /Standard	IS: 8442
6.3	Rotation Horizontal Vertical	360^0 +90° above horizontal, -45° below horizontal
6.4	Material of construction	
i	Water barrel	IS: 1239 (Part-I)
ii	Wire braided hose	PVC
iii	Nozzle	SS to IS: 3444
iv	Handle	MS to IS 2062
v	Base flange	MS IS 2062. Drilled to ANSI 150# B 16.5
vi	Reducer & 90^0 Elbow	Seamless ANSI B 16.9 / IS: 1239 (Part-II) / IS 4310
vii	Swivel joints (horizontal & vertical)	SS to IS: 6603
viii	(Horizontal / vertical rotation lock)	SS to IS: 6603
ix	Grease nipple	Brass
x	Drain cock	Bronze IS 318 LTB-2
6.12	Approval	ISI marked & TAC approved
7.0	**Branch Pipe & Nozzle**	
7.1	Size	63 NB with 20 NB nozzle
7.2	Nozzle Type	Hexagonal, detachable
7.3	Code /standard	IS: 903-1995
7.4	Material of construction	
i	Branch pipe / nozzle	SS to IS: 3444
ii	Spanner	Steel of grade C-40 to IS: 1570 (Part 5) chromium or zinc plated.
7.5	Testing	As per IS: 903
7.6	Approval	ISI marked / TAC approved

8.0	**Hose coupling**	
8.1	Type	Instantaneous male and female
8.2	Size	63 NB
8.3	Code /standard	IS: 903
8.4	Material of construction	
i	Female half coupling	SS to IS: 3444
ii	Male half coupling	SS to IS: 3444
iii	Seal washer	Rubber
iv	Outer disc	Brass IS: 3189
v	Self locking nut	Steel
vi	Locking latch	Brass IS: 319
vii	Spring	Phosphor bronze
viii	Guide disc	Brass IS: 319
ix	Knob	GM IS: 318 LTB-2
8.5	Testing	As per IS: 903
8.6	Approval	ISI marked/TAC approved
9.0	**Fire Hose**	
9.1	Type	RRL
9.2	Size	63 mm
9.3	Code / Standard	IS: 636 Type B
9.4	Length	15 m for external & internal hydrant
9.5	End fittings	Instantaneous spring lock type coupling at both ends
9.6	Testing	As per IS: 636
9.7	Hose weight (gm/m)	IS: 636
9.8	Bursting pressure	IS: 636
9.9	Proof pressure	IS: 636
9.10	Kink test pressure	IS: 636
9.11	Change in length test pressure	IS: 636
9.12	Change in diameter test pressure	IS: 636
9.13	Approval	IS: 636
10.0	**Hose Cabinet**	
10.1	Type	FRP (3 mm Thickness)
10.2	Size	Approx. 750x600x250
10.3	Mounting	Wall/column mounted for internal hydrant pedestal mounted for external hydrant.
10.4	Special requirement	(i) Each Cabinet will accommodate 2 nos. of 15 m long hoses and 1 no. branch pipe & nozzle. (ii) Cabinet to have double door having toughened glass panel (3mm) with rubber lining and marked Fire on it in 80 mm size letter. (iii) Approved lock with duplicate keys kept wired in a break glass key cabinet in the hose box itself. (iv) A spanner and a set of spare rubber rings packed in fresh chalk to be kept inside the hose box.

		(v) Clamp for holding branch pipe to be provided.
10.5	Accessories	- Fastening nuts, bolts and hardware - Hammer for breaking the glass to take out the keys.
11.0	**Deluge Valve**	
11.1	Type	Quick release, diaphragm type
11.2	Size	80 NB, 100 NB & 150 NB
11.3	Design data	Normal working pressure: 7 kg/cm^2 Design pressure: 10.5 kg/cm^2 Test Pressures: Body: 24 kg/cm^2 Seat: 16 kg/cm^2
11.4	End connection	Flanged, Flat Faced to ANSI B 16.5 # 150
11.5	Type of operation	Hydraulic (wet pilot)
11.6	Trim description	(1) Wet pilot trim (2) Electrical release trim (3) Test & Alarm trim (4) Drain valve (5) Priming connection (6) Drip check valve (7) Emergency release valve
11.7	Accessories	(1) Pressure gauges (2) Pressure switches (3) Solenoid valves(UL Listed only) (4) Water motor and gong (5) Globe valves (including instrument globe valves) (6) Ball valves (7) Check valve (8) Drain valve / Drip valve (9) Positive drain actuators (10) Emergency release (11) Y-strainer (12) GI piping
11.8	Material of construction	
i	For Diaphragm type	
ii	Housing	CI IS 210 Gr. 260
iii	Cover	CI IS 210 Gr. 260
iv	Clapper	Cast bronze IS 318 LTB-2
v	Clamp ring	Cast bronze IS 318 LTB-2
vi	Seat	Cast bronze IS 318 LTB-2
vii	Diaphragm	Neoprene
viii	Seat rubber	Neoprene
ix	Listing	UL listed for complete valve and trims assembly.
11.10	Approval	TAC approval
12.0	**Spray Nozzles (high velocity Water Spray System**	
12.1	Type	Open type, solid cone
12.2	Working pressure	3-5 bar
12.3	Material	SS
12.4	K FACTOR / Orifice size (mm)	During detail engineering

12.5	Spray angle	During detail engineering
12.6	Approval	TAC approved
12.7	End connector	Screwed, ¾" BSP
12.8	Marking	K-factor to be marked on hexagonal face.
13.0	**Spray Nozzles (Medium velocity Water Spray System**	
13.1	Type	Open type
13.2	Working pressure	2.8 – 6 bar
13.3	Material Body, deflector & deflector pin	 SS
13.4	K factor / orifice size	During detail engineering
13.5	Spray angle	During detail engineering
13.6	Approval	TAC approved
13.7	End connector	½" BSP, Screwed
13.8	Marking	K-factor to be marked on hexagonal face.
14.0	**Quartzoid Bulb Detector**	
14.1	Material	SS
14.2	Sensitive element	Heat sensitive bulb
14.3	Set temperature	79^0C
14.4	Response time	During detail engineering
14.5	End connector	½" BSP, Screwed
14.6	Approval	TAC approved
15.0	**Y-Strainers**	
15.1	Manufacture	As per approved vendor list
15.2	Sizes	80 NB to 300 NB
15.3	End connector	Flanged and drilled to ANSI 150 # B 16.5
15.4	Screen open area to pipe room sectional area ratio	4:1
15.5	Material of construction Body Screen	 MS to IS: 2062 AISI: 316, 18 BWG
15.6	Screen mesh	30 mesh
15.7	Testing pressure	Two times working pressure or 1.5 times design pressure whichever is higher.
16. Extinguishers		
1	Applicable Standard for all Extinguishers	IS:15683
2	Type of Extinguishers	Co2, Foam, DCP type, both Mobile and portable type.
17. SHED FOR DELUGE VALVE, BOOSTER PUMP		
1.	Service	To accommodate deluge valves coming under spray system
2.	Location	Outdoor. Bidder to select the Suitable locations based on piping layout
3.	Number	Bidder to indicate
4.	Material of Construction	Brick Masonary with minimum 4" RCC Roof
18. STRAINERS		
1.	Type	Y type
2.	Material of construction	
a)	Body	MS fabricated IS:2062 tested quality
b)	Internal	SS (AISI 316), 30 mesh suitably reinforced

G. FIRE ALARM AND DETECTION SYSTEM

1. Main/Sub Fire Alarm Panel		
1	Make	
2	Type	Intelligent Analog addressable type
3	No. of addressable Devices per loop	As per Manufacturer Standard
4	**Features of Main Fire Alarm Panel- :**	
i	Five Programmable Function Switches	yes
ii	Point Status Control Keys	yes
iii	Event Time and History Back up.	yes
iv	LCD Navigation Control	yes
v	Numeric KeyPad	yes
vi	Inbuilt Regulated DC Power Supply	yes
vii	Inbuilt Battery Charger	yes
viii	Redundancy in CPU(Hot)	yes
ix	Redundancy in Power Supply	yes
x	Accessories required	
xi	Graphics software	Yes
xii	OWS + Printer(Laser type)	Yes

A.	MULTI CRITERIA SMOKE DETECTORS	
1.	Manufacturer :	As per approved make.
2.	Type :	Combination of Photo electric sensing and heat sensing, intelligent Analogue Addressable.
3.	Code/Specification :	NFPA-72E/BS-5839/IS.
4.	Sensitivity :	Preset at factory/Adjustable at site (as per UL-268).
5.	Temperature range :	0.0 Deg.C to + 38 Deg.C
6.	Humidity range :	10% to 90% RH.
7.	Air velocity :	0 to 300 ± 25 feet/minute.
8.	Plug in type detector to be provided :	Yes
9.	No. of terminals on detector on mounting base :	Bidder to indicate.
10.	Area covered by single detector :	Bidder to indicate.
11.	Operating voltage :	24 volt D.C.
12.	Inbuilt indicating lamp : to indicate operation of the detector provided	Yes [Separate response indicators mounted on false ceiling to be provided for smoke detectors mounted above false ceiling].
13.	Material of detector body :	Metallic/Plastic.
14.	Detector is approved by	Yes.

	UL/FOC/FM/TAC :	
15.	Detector Base :	Mounting box (if applicable) Double Compression gland.
16.	Coverage area	Considering maximum spacing as per IS:2189.
B	**PhotoElectric Smoke Detectors**	
1	Make	DDE
2	Type	Intelligent Analog.
3	Model No	DDE
4	Remote LED Indicator Alarm Current	1mA, no impact to alarm current.
5	Temperature Range within which detector operates	0-38 degree C
6	Humidity Range	10-95% RH
7	Smoke sensor ambient rating	Air Velocity-0-4000ft/min
C.	**HEAT DETECTORS**	
1.	Manufacturer :	As per approved make.
2.	Type :	Fixed temperature cum rate of rise type, intelligent Addressable Analog.
3.	Sensitivity :	Preset at factory/Adjustable at site.
4.	Operating temperature range :	54°C. to 60°C.
5.	Humidity range :	5% to 90% RH.
6.	Detector automatically resets after actuation:	Yes.
7.	Area covered by single detector :	Bidder to indicate.
8.	Operating voltage :	24V DC.
9.	Type of contacts :	Silver.
10.	Principle of operation :	As per Specification.
11.	Detector approved by FOC/FM/UL/TAC :	Yes.
12.	Detector Base :	Mounting box (if applicable) Double Compression gland.
13.	Coverage area :	As per NFPA-72.
14.	Special cable :	To be provided.
D.	**QUARTZOID BULB DETECTORS**	
1.	Manufacturer :	As per approved make.
2.	Type :	Frangible bulb type.
3.	Operating temperature :	79°C.
4.	Material of Construction	

a)	Frame :	Bronze (ASTM B 145) Class-5A Leaded gun metal, Chrome plated.	
b)	Bulb :	Glass filled with heat sensitivity liquid (coloured).	
c)	Deflector :	Brass.	
d)	Cap :	Copper.	
e)	Seal :	Teflon/Rubber.	
5.	Working pressure :	3.5 Kg/Sq. cm (g) minimum.	
6.	Detector approved by : TAC/FOC/UL/FAS/NFPA	Yes.	
E.	**LINEAR HEAT SENSING CABLE**		
1.	Manufacturer :	As per approved make	
2.	Type :	SS Braided Digital type	
3.	Operating voltage	24 Volt D.C.	
4.	Ambient temperature	-20 to 79 degreeC	
5.	Operating temperature	Programmable type, with combination of fixed temperature and Rate of Rise in temperature	
6.	Cable Jacket :	Steel Type(for conveyor)	
	i) Nominal Cable Diameter :	3.2mm	4mm
	ii) Maximum weight :	33kg/km	23 kg/km
	iii) Minimum Bending Radius :	75mm	63mm
8.	Typical Performance :		
	i) Sampling Resolution :	1.0 meter	
	ii) Measurement Time :	10 sec for 4 kms	
	iii) Measurement Range :	-20o C to 150oC	
11	All accessories such as fittings, fastenings, sleeves, straps, staples, clips (mounting) rings, test terminals, Junction Box etc. as may be required for interconnection of linear heat detector cables as well as interconnection to Control and Power Cable :	Yes	
12.	Linear Heat Detector approval	FM / UL / TAC / NFPA / VDS / LPCB	
	Fire Detection	Unit should be able to detect abnormal/hot spot within 1 mtrs.	
F	**INFRARED DETECTORS**		
1	Manufacturer :	As per approved make.	
2	Type	Air Purging type with inbuilt blower	

3	Operating Voltage	24V DC
4	Temperature Range :	- 40°C to 60°C
5	Nominal Response Time :	75 milli sec. (Max.)
6	Sensitivity :	1.0 to 5.0 Microwatt shall be Field Adjustable.
7	Dimensions :	As per manufacturer's standard.
8	Enclosure :	Dust and Water proof.
9	Mounting :	To be mounted in protective sheet metal housing above conveyor.
10	Quiesent Current :	10 mA/As per manufacturer standard.
11	Alarm Current :	20 mA/As per manufacturer standard.
12	Acceptance Angle :	120°/As per manufacturer standard
13	Spectral Response :	0.8 to 2.0 Micron/As per manufacturer standard.
14	Spectral Range	3000-14000Nm
15	Half Power Cone Vision :	90°/As per manufacturer standard.
16	All accessories such as air purging facilities for cleaning lens, protective housing mounting hinge & latch, J. Box Glands etc. as required. :	Yes
17	Detector shall be solar blind :	Yes
G.	**Manual Pull Stations**	
1	Make	Approved amke
2	Type	Manual Pull type
3	Temperature Range	0-40 degree C
4	Humidity Range	0-93% RH
H.	**Fixed/ROR type Heat Detectors**	
1	Make	Approved make
2	Type	Fixed/ROR type
3	Maximum Operating Temperature	68 degree C
4	Operating Range in case Rate of Rise	8.3-11.1 deg C per minute.

DATASHEET - PORTABLE FIRE EXTINGUISHERS

S.NO.	DESCRIPTION	CARBON-DIOXIDE TYPE	MECHANICAL FOAM TYPE	DRY CHEMICAL POWDER TYPE	GAS/EXPELLED WATER TYPE
1.0	APPLICATION	Equipment Control Rooms, Control equipment room [housing DDCMIS, UPS etc.], MCC/ Battery charger room/ Switchgear Rooms. Dry Type L. T. Trans-former etc.	The areas where class B fires are liable to occur.	Boiler & Auxiliaries area, Turbine and Aux. area, CW/Ash water and Ash slurry pump house, fuel oil pressurizing pump houses, Intake Pumhpouse and other areas of the plant, Raw water Intake Pumphouse. Chlorination building near Raw water intake pumphouse, service building, and administration building.	Stores & other Building in the proposed. Plant.
2.	MINIMUM QUANTITY REQUIRED	22.5 Kg - 20 nos. 9 Kg – 30 nos. 4.5 Kg – 110 Nos.	45/50 litre - 15 nos. 9 litre - 50 nos.	75 Kg - 4nos. 10 Kg - 15 nos. 5 Kg - 65 nos.	9 litres - 85 nos.
		However, bidder shall establish the requirement of Portable Fire Extinguishers based on the fire hazard in the entire plant. The final requirement shall be subjected to approval by the TAC and by the Purchaser.			

S.NO.	DESCRIPTION	CARBON-DIOXIDE TYPE	MECHANICAL FOAM TYPE	DRY CHEMICAL POWDER TYPE	GAS/EXPELLED WATER TYPE
3.	DESIGN, FABRICATION AND TESTING CODE	IS-2878/ Equivalent standard	IS-10204/ Equivalent stan-dard (for 9 litres). For 45/50 litres capacity, extinquisher shall be made of mild steel coated with lead tin alloy. It shall be tested to 30 Kg/Sq.cm for 5 minutes & fitted with 3 mtr. long Nylon braided PVC hose with foam making branch pipe. The appliance shall be supplied with litres of AFFF concentrate and 1Kg. CO2 cylinder. The jet range shall be 8 litres, discharge time 75 seconds and discharge 95% (minimum).	IS-2171/IS-10658/ Equivalent standard	IS-940/ equivalent for gas pressure type, IS-6234/ equivalent for constant air pressure type.
4.	ACCESSORIES TO BE SUPPLIED	Control valve, one (1) metre rubber hose, discharge horn, mounting bracket with screws	As required	Nozzle, mounting bracket, carrying handle, screws etc. and all other accessories as perapplicable design standard.	Nozzle, mounting bracket, screws etc. as required as per relevant standard

CHAPTER 25

AIR CONDITIONING AND VENTILATION SYSTEM

CONTENTS

CHAPTER – 25

AIR CONDITIONING AND VENTILATION SYSTEM

25.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract notwithstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

25.2 Codes and Standards

The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

25.3 Design Criteria for Air conditioning system

25.3.1 Design ambient conditions

Season	Dry Bulb Temp (Deg C)	Wet Bulb Temp (Deg C)
Summer	44	26
Monsoon	33	27
Winter	23	8

For other details of ambient conditions, refer published documents for meteorological data for Plant site. (Refer Volume II)

25.3.2 All equipments of air conditioning system shall be designed for continuous duty.

25.3.3 All air conditioned areas like control room, control equipment rooms, service building, administrative building shall be maintained as per conditions indicated below:

Dry bulb temperature : 24± 1.0°C

Relative humidity : 50± 5%

25.3.4 The fresh air quantity for air conditioned areas like control room/ control equipment rooms/ UPS etc shall be 0.45 M^3/ min/ person or 1 air change per hour whichever is greater. However for areas like service building,

administrative building etc, quantity of fresh air shall be minimum 1.5 air changes per hour.

25.3.5 Lighting load shall be minimum 2 Watts per Ft^2 or actual whichever is higher.

25.3.6 The occupancy for general area shall be minimum one person per 3 M^2 and for conference room the same shall be one per 1.5 M^2. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 M^2 (Minimum).

25.3.7 In air conditioning system, the return air shall be through ducts and use of plenum space for return air shall be avoided, further, for service building where various floors are air conditioned and no intermediate or intervening floor are left non air conditioned, the space above false ceiling shall be used as return air plenum.

25.3.8 The supply & return air ducts shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) at locations where ducts pass through walls & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of A/C plant for further wiring up to fire alarm panels.

25.3.9 Clarified water make up (if required) for complete air conditioning and ventilation system shall be provided by the bidder.

25.3.10 Design Chilled water flow shall not be less than 0.7 M^3/hr per TR of air-conditioning load and design Condenser cooling water flow shall not be less than 1.0 M^3/hr per TR air-conditioning load.

25.3.11 Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/Sec. Water piping shall be sized for a maximum velocity of 2.0 M/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 M/sec. Air distribution system shall be sized to have constant frictional drop along its length and velocity through ducts shall not exceed 7.6 M/s.

25.3.12 Requirement of underdeck Insulation (for A/C area)

25.3.13 Underdeck insulation of 50 mm nominal thickness of glass wool (32 kg/cum) or rock wool (48 kg/cum) shall be provided if

i) Non A/ C area is located just above the A/C area. In this case, underdeck insulation shall be provided underneath the ceiling of A/C area.

ii) Non A/ C area is located just below the A/C area. In this case, underdeck insulation shall be provided underneath the ceiling of Non A/C area.

25.3.14 For air handling unit (AHU) serving main plant control area, where microprocessor based equipments are located, the dehumidified air shall be filtered at three different stages i.e., pre (coarse) filter followed by fine filter followed by HEPA filter before discharge it to air conditioned space. For all other areas, AHU's shall be provided with two stage of filteration i.e., pre filter & fine filter. All fresh air supply shall also be filtered using pre & fine filter.

25.3.15 A minimum design margin of 10 % shall be considered in design of AC Plant capacity for each area, 20% design margin shall be considered for the cooling tower capacity over the selected A/C capacity provided. Head of the pumps shall take into account minimum 10% margin on friction head. For pumps continuous motor rating (at 50^0 C ambient) shall be at least 10% above the maximum load demand of the pump in the entire operating range.

25.3.16 For areas like ESP control rooms, water system control room, where A/C load is of the order 25-60 TR, direct expansion (D-X) type condensing unit shall be provided depending on the availability of space/layout etc. For areas where A/C load is of the order of 8-25 TR, ductable split/ packaged A/C shall be provided. Smaller areas which are away from the D-X type condensing unit/ central chilling units which may require air conditioning < 8 TR rating shall be served with Hi–Wall split/Cassette air conditioner units (5 star rating) as per requirement. For static excitation control room (if applicable) precision air conditioners of required capacity shall be provided.

25.3.17 Valves at discharge of pumps, outlet of chillers and inlet of cooling towers or any other valve in the system shall be motor operated type for remote operation of the air conditioning system.

25.3.18 Air conditioning system for service building & administration building shall be designed with ECBC code to make it "Green Building". Mandatory requirements of ECBC to be followed for A/C equipments of service building & administration building:

a) Coefficient of performance (COP) of the chiller (water cooled & rotary screw & scroll chiller)

S. No.	Chiller Capacity	Min. COP
1	Upto 150 TR	4.7
2	≥ 150 TR < 300 TR	5.4
3	≥ 300 TR	5.75

b) Coefficient of performance (COP) of air cooled chiller

S. No.	Chiller Capacity	Min. COP
1	Upto 150 TR	2.9
2	≥ 150 TR	3.05

c) Pumping System: chilled water and condenser water pumping system shall be variable flow type. i.e., pumps shall be VFD driven.

d) AHU: AHU shall be variable flow type. i.e shall be VFD driven.

e) Refrigerant: Refrigerant shall be CFC/HCFC free.

f) Controls & sensors: sensors like occupancy sensors, CO2 sensors, daylight sensors etc shall be provided for optimum use of A/C system.

g) Insulation for supply and return air ducts: Supply and return ducts shall be insulated.

h) All types of insulation used for HVAC application shall be CFC/ HCFC free.

25.3.19 During normal operation period, all the working equipment shall run on AC power supply. However, in case of complete black out condition, DG sets being provided are required to cater the load of some of the air conditioning equipment so that control rooms and CER remain air conditioned. The equipment to run on the DG set are:

- 1 no. Chilling machine
- 1 no. Chilled water pump
- 1 no. Condenser water pump
- 1 no. Cooling tower fan
- AHU's for CR & CER
- 1 no. Fresh air fan.

25.3.20 **Redundancy of Equipments**

a) For main plant areas (control room, control equipment room, UPS room and SWAS room)

- Vapor compression type Chilling Units 2 x 100%
- Condensing Unit - 2 x 100%
- Condenser water pumps - 2 x 100%
- Chilled water pumps - 2 x 100%
- FRP cooling towers - 2 x 100%
- Air handling units (DX type) - 2 x 100% (Per AHU room)
- Air handling units - 2 x 100% Multiple AHUs of similar (Chilled water type) capacities per AHU room. AHU shall be variable voltage frequency driven (VVVFD).

b) ESP Control Building

- Water Cooled/Air Cooled Condensing units/ Precision Air Conditioners - 2 x 100%
- Condenser water pumps - 2 x 100% (if applicable)
- FRP cooling towers (with VVFD Fan)- 2 x 100% (if applicable)
- Secondary Chilled Water Pumps (with VVFD)- 2 x 100%
- Air handling units- 2 x 100% AHU shall be variable voltage frequency driven (VVVFD).

c) Service Building

- Screw/ Centrifugal Type Water Chilling units 2 x 100%
- Condenser water pumps (with VVFD) - 2 x 100%
- Primary Chilled water pumps - 2 x 100%
- FRP cooling towers (with VVFD Fan)- 2 x 100%
- Air handling units – No Standby - AHU shall be variable voltage frequency driven (VVVFD)
- Secondary Chilled Water Pumps (with VVFD)- 2 x 100%

d) FGD Control room

- Screw/ Centrifugal Type Water Chilling units 2 x 100%
- Condenser water pumps (with VVFD) - 2 x 100%
- Chilled water pumps - 2 x 100%
- FRP cooling towers (with VVFD Fan) - 2 x 100%
- Air handling units - 2 x 100% (with VVVFD)

e) Water Treatment Control Building

- Water Cooled / Air Cooled Condensing units/ Precision Air Conditioners - 2 x 100%
- Condenser water pumps - 2 x 100% (if applicable)
- FRP cooling towers (with VVFD Fans)- 2 x 100% (if applicable)
- Air handling units- 2 x 100% AHU shall be variable voltage frequency driven (VVVFD).

f) 100% standby shall be provided for areas served by precision/ cassette/ Hi wall split type AC for all other offsite control rooms

g) Fresh air fans shall be 2 x 100% for each AHU room.

25.3.21 The AHU Rooms shall be located in the TG building appropriately as per layout developed. AHU rooms shall be provided on each floor for service building & administration building. AC Plant Room shall be located in TG building and ground floor of service building & administration building.

25.4 **Design Criteria for Ventilation system:**

25.4.1 The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

S. No.	Area	Air Changes
i.	Evaporative type ventilation system	8
ii.	General areas	20
iii.	Various pump houses: CW Pump House Filtered Water Fire Water Ash Water Ash Slurry Blower room (AHP) Gypsum building Lime preparation building Compressor building (SA/IA) DM Plant building	20
iv.	All Switch gear / MCC rooms and cable vaults.	30
v.	Battery and battery charger rooms and other hazardous areas where gaseous fumes are generated	30
vi.	Chlorination plant building	30

S. No.	Area	Air Changes
vii.	Chemical houses	30
viii.	DG set room	45

25.4.2 However in areas producing lot of heat, the temperature shall be the criteria, as follows:

- Inside temperature shall be minimum 3^0 C below the design ambient temperature during summer for evaporative cooled areas.
- Inside Temperature shall be maximum 3^0 C below the design ambient temperature during summer for mechanically ventilated areas.
- The criterion which gives higher number of air changes/higher quantity of air in either of the conditions as mentioned above shall be the basis for selecting the required air flow for that area.

25.4.3 All ventilation system shall operate on 100% fresh air. All mechanically ventilated areas shall be positively ventilated by means of supply air fans fitted with filters and/or gravity operated back draft dampers and exhaust fans. MCC/Switchgear rooms and cable gallery shall be provided with gravity operated back draft dampers in association with supply air fans in order to maintain positive pressure. Battery rooms & other fumes/ odour generating areas shall be negatively ventilated by means of exhaust air fans/ roof exhausters. Supply air fan catering for electrical areas (MCC & switchgear rooms) shall be provided with pre filters and fine filters and for other areas shall be provided with pre-filter only.

25.4.4 All the equipment of Ventilation system shall be designed for continuous duty.

25.4.5 The supply air ducts of evaporative type ventilation system shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) entry in switchgear room, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and shall also possible from the control panel remote manually.

25.4.6 Circulating water capacity for Air washer units shall be minimum 1 M^3/hr per 1000 M^3/hr of air flow. Velocity through piping shall be limited to 2 M/s and for gravity flow the same shall be limited to 1.5 M/s. Air distribution system shall be sized to have a constant frictional drop along its length and air velocity through ducts shall not exceed 12.5 M/s.

25.4.7 The air washer unit shall be designed for a maximum velocity of 2.7 M/s and at least 90% saturation efficiency.

25.4.8 For pumps, continuous motor rating (at 50^0 C ambient) shall be at least 10% above the maximum load demand of the pump in the entire operating range. For fans, compressors and blowers continuous motor rating (at 50^0 C ambient) shall be at least 10% above the maximum load demand at the design duty point.

25.4.9 Supply air fans, exhaust air fans & ventilation of each area shall be provided with local starter panels.

25.4.10 **REDUNDANCY OF EQUIPMENT**

- Air Washer Units and Unitary Air Filtration Systems shall be multiple units without any standby.
- Pumps for each Air Washer Unit shall be 2 x 100%
- Pumps for each Unitary air filtration system shall be 2 x 100%.
- Fans for each air washer unit shall be 2x50% capacity while for unitary air filtration unit shall be 1x100% capacity.
- Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

25.5 **Systems to be furnished**

25.5.1 **Air Conditioning System**

The areas to be air conditioned shall be as follows:

a) Control rooms/ Central Control rooms, Control Equipment rooms, UPS & Battery Charger Room, SWAS Room etc.
b) ESP Control Room
c) Water System Control room
d) Switchyard Control Room.
e) Service Building: Various office areas, entrance lobbies, visitor & VIP lounge, reception area etc.
f) Administration Building: Various office areas, entrance lobbies, visitor & VIP lounge, reception area, Canteen etc.
g) Fire Water Pump house Control room.
h) Fire Water Booster Pump house Control room.
i) CPU Regeneration Control room.
j) Ash Water Pump house control Room.
k) Ash Slurry Pump house control room.
l) Auxiliary Boiler control Room.
m) Clarified Water Pump house control Room.
n) Fuel oil Pump house Control Room.
o) CT Switchgear Control Room.
p) Static Excitation Control room (if applicable).
q) Coal Handling Control rooms.
r) FGD Control Room
s) All Laboratories (chemical, C&I, Electrical etc.)
t) Various remote I/O rooms with PT Plant, Raw Water service water, DM & CW Chemical Plant, CPU Service Vessels, CW Chlorination & CW Treatment, ETP etc.

25.5.2 **Ventilation System**

25.5.2.1 The areas to be ventilated by Evaporative Cooling system are as follows:

a) All floors and area of turbine hall (TG building) other than the areas which are air conditioned.

b) Switchgear rooms and cable gallery areas of turbine building.

c) Any other evaporative area where equipment heat load is high and requires ventilation of evaporative cooling spaces.

25.5.2.2 The areas to be ventilated by unitary air filtration unit (UAF) are:

Non A/C areas of ESP building.

25.5.2.3 The areas to be ventilated by Mechanical ventilation process (using roof extractors/ supply air fans and/or exhaust fans) shall consist of but not limited to the following:

a) All the pump houses like fuel oil pressurizing pump house, CW pump house, filtered water pump house, fire water pump house, Raw Water pump house, Fire Water Booster Pump house, ash water pump house, Ash disposal pump house, ash conveying blower room, lime preparation building, gypsum building etc.

b) Battery rooms, lube oil purification room, non A/C areas of SWAS room.

c) Switchgear Rooms/ MCC/ Battery rooms in various auxiliary buildings.

d) Air Compressor house.

e) Ash Blower room

f) Complete water treatment plant building facilities like PT, DM, Chlorination, CW treatment etc.

g) Air conditioning plant equipment areas.

h) A/C Plant room, MCC room, Battery room etc in service & administration building

i) Battery rooms of various remote I/O rooms.

j) Elevator machine rooms

k) Transfer towers/tunnels for CHP

l) Crusher House of coal and lime/Bunker Bay

m) All toilets & pantries (to be provided with propeller exhaust fan)

n) Non AC areas of service & administrative building.

o) Any other areas which are not covered either by air conditioning system or by evaporative cooling system.

25.6 System description Ventilation System

25.6.1 Evaporative Cooling System for Turbine Building

25.6.1.1 Each air washer unit (evaporative system) shall consist of the various sections such as Air Washer chamber/ casing, tank, distribution plates, set of metallic/ fabric filters at suction, suction louvers, bird screens, water headers, spray nozzle, piping, valves etc, drift eliminators, pumps fans, necessary controls & instrumentation and all other required accessories.

25.6.1.2 The air washer chamber casing shall be fabricated from 10 SWG black MS sheet with adequate stiffeners etc and various sections shall be bolted through gaskets to avoid leakage of water. The inside & outside of casing shall be protected by spray galvanization. The nuts and bolts used for joining the section shall be galvanized. The connection pieces shall have at least two (2) coats of rust inhibiting paints.

25.6.1.3 The air washer tank shall be fabricated from MS plate of minimum 6 mm thk and inside & outside surface of the tank shall be spray galvanized (minimum 60 microns DFT). Minimum depth of the tank shall be 600 mm. Tank construction shall be such that suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve make up connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.

25.6.1.4 The distribution plate shall be fabricated out of 180 G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

25.6.1.5 Air washer shall be two bank construction (one uni flow and other cross flow). All header and stand pipe shall be galvanized.

25.6.1.6 The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 kg/cm^2.

25.6.1.7 The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS: 4892 for 500 hours. Type test report of compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray & drain pipe.

25.6.1.8 An airtight inspection door of 600 mm x 700 mm size and a water marine light be provided for each air washer tank.

25.6.1.9 Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement.

25.6.1.10 The specification for centrifugal fans shall generally be as indicated below. However the fan shall be of DIDW type for TG building and SISW for ESP building.

25.6.1.11 Saturation efficiency of air washers shall be minimum 90%.

25.6.2 **Unitary Air filtration**

25.6.2.1 Each unitary air filtration shall consist of casing, Tanks, Fans, distribution plates, moisture eliminator and water repellent type nylon filter with frame and support. Header and standpipe with support, spray and flooding type nozzle, Screen type, suction strainer, pumps, necessary controls & instrumentation and all other required accessories.

25.6.2.2 All equipments, components used in unitary air filtration system shall be in line with the specification requirements stipulated in air washer units above except the fans may be of SISW type.

25.6.2.3 Saturation Efficiency of unitary air filtration units shall be minimum 60%.

25.6.3 **Centrifugal Fan**

25.6.3.1 The casing shall be of welded construction fabricated with heavy guage galvanized sheet steel or MS sheet with spray galvanization (minimum 60 micron DFT). The minimum thickness of casing shall be 3mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required.

25.6.3.2 The impeller shall have die formed backward curved blades tie welded to the rim and back plate to have a non overloading characteristic of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft sleeves shall be secured to the shaft by key and/ or nuts.

25.6.3.3 The bearing shall be self aligning, heavy duty ball, roller or sleeve bearing. They shall be easily accessible and lubricated properly from outside.

25.6.3.4 Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be galvanized wire mesh of 25 mm square.

25.6.3.5 Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have minimum of 70% efficiency.

25.6.3.6 The first critical speed of the rotating assembly shall be at least 25% above the opening speed.

25.6.3.7 The fans shall be direct driven.

25.6.3.8 Transfer towers/tunnels of Coal handling plant shall mainly consists Supply air fans of DIDW type with pre and fine filters, Supply air ducting and grills, Exhaust air ducting and grills and Exhaust air fans of SISW type.

25.6.3.9 The ventilation system for the various areas shall be designed duly considering the factors such as temperature, relative humidity and maximum allowable concentration of gases present in the rooms, corresponding to international guidelines.

25.6.4 **Axial Fans**

25.6.4.1 These fans shall have fixed / variable pitch cast Aluminium blades of aerofoil design.

25.6.4.2 The fan casing shall be heavy gauge sheet steel construction.

25.6.4.3 Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc shall be provided.

25.6.4.4 The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 MMWC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be at least 25% above the operating speed.

25.6.4.5 All other accessories like supporting structure etc as required shall be provided.

25.6.4.6 Fans of capacity 1000 cum/hr & lower shall be propeller exhaust type.

25.6.4.7 **All battery room & hazardous area shall be provided with fire proof supply/exhaust fans. These fans shall be epoxy painted.**

25.6.5 **Roof Ventilators**

25.6.5.1 The roof ventilators shall be "COWL" type.

25.6.5.2 Impeller shall be axial flow type, cast aluminium in one piece and dynamically balanced. Casing shall be heavy gauge sheet steel construction of 3 mm thick for impeller upto 750 mm diameter and 5 mm for fans with impeller of diameter 750 mm and above. In casing, access door with locking arrangement shall be provided.

25.6.5.3 The cowl shall be designed for weather protection of the fan also inside the roof on which the extractor is installed. Galvanized bird screen of 15 mm square be provided with the cowl. All accessories, steel supports as required will be provided.

25.6.5.4 The speed of the fan be limited as per limitation given above for axial fans.

25.6.5.5 All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel support vibration isolators, bird screen, etc as required shall be provided.

25.6.5.6 The vibration level of fans shall be as per ISO: 14694.

25.6.6 **Specific Requirements**

i. The battery room shall be maintained at negative pressure to prevent leakage of fumes to outside from the battery rooms. The exhaust from the battery room shall be exhausted by means of duct with the outlet 1m above the roof level by means of tube axial fans. Also the ducting, grilles, fans, motors etc. provided for battery rooms to be painted with acid & fume resistant paint.

ii. In chlorination room, ducted exhausts shall be provided and exhaust air grilles will be located near the floor level. The fan, motors ducting and grilles shall be given acid and fume resistant paint.

v. For hazardous areas, fans with anti-spark characteristics to be provided.

vi. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.

vii. Evaporative cooling ventilation fans shall be interlocked with fire protection system, to get the same tripped in the event of fire.

viii. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Air washer /UAF water circuit to reduce the blockage in nozzles.

25.7 **Equipment Description**

25.7.1 **Vapour Compression Type Machines**

Each chilling unit shall comprise of compressor with drive motor, Condenser, Water Chiller/evaporator, and other accessories such as supporting structure, vibration isolators, insulation, piping, valves, instrumentation, microprocessor / PLC based Control panel, etc. Chilling unit shall have stepless capacity control. The screw/centrifugal compressor based chilling unit to be supplied shall be ARI /Eurovent/Equivalent standard certified.

25.7.2 **Chilling Unit/Condensing Unit**

Type	**Water cooled type (Chillers for main plant shall be with multiple compressors)**
Vibration isolators	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	Compressor shall be open/ semi hermetic/ multiple hermetics in case of Screw or centrifugal type operating on R407 refrigerant complete with accessories and automatic control facilities
Type of drive	Motor driven, through direct/ V Belt along with star delta/ double delta starter
Accessories	High / Low pressure cut outs, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil

	Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Condenser	
Type	Water cooled, shell and tube type.
Fluid	
	Shell side – Refrigerant
	Tube side - Water
Capacity	To match with respective compressor and to provide atleast 2^0 C sub-cooling. To store full charge of refrigerant.
Design fouling Factor	Not less than 0.0002 (in MKS units)
Shell material	Mild steel (IS:2062)/ SA 106 Gr B
Tube material	Replaceable seamless copper (ASME B-111)
Fin material	Copper
Accessories	Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc.
Refrigerant	For chilling Unit- R 407 or any other environment friendly refrigerant.
Steel structure	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Inlet Temperature	33^0 C
Leaving Temperature Differential	Maximum 5^0 C
Chiller	
Type	Shell and tube type
Superheating of	At least 2^0 C
Design Fouling Factor	Minimum 0.0001 (MKS units)
Fluid	Shell side - Refrigerant
	Tube side - Water
Capacity	To match with respective plant capacity.
Shell material	Mild steel (IS:2062)/ SA 106 Gr B
Tube material	Plain Tube internally/ externally finned copper as per manufacturer's standard
Fin material	Integral
Accessories	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, thermostatic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame etc.
Steel Structure	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

25.7.3 Condensing Unit (Water cooled D-X Type)

Type	Water cooled type
Vibration isolators	Steel spring/Neoprene rubber cushy foot/ neoprene cushy rubber pad type with isolation efficiency not less than 85%.
Compressor Type	Compressor shall be screw, serviceable, either open type or hermetic type or semi hermetic type with load, unload and automatic capacity control (minimum 3 steps)
Type of drive	Motor driven, direct or through V belt.
Refrigerant	R 407
Accessories	High/Low pressure cut out, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Capacity	Minimum capacity shall be suitable for the identified/ selected at evaporating temperature and shall be indicated.

Note: up to 50 TR capacity chilling/ condensing unit can be of air/water cooled type. However beyond this capacity unit shall be water cooled type only.

25.7.4 Air Handling Unit (AHU)

a) Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs.

b) The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24g) galvanized steel sheet (thickness of galvanization as per manufacturer's standard) , with 25mm thick polyurethane foam insulation of minimum 38 Kg/Cum density in between. Suitable reinforcements shall be provided to give structural strength to prevent any deformation/buckling.

c) Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass

section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.

d) Cooling coil shall be of seamless copper tubes with Aluminium fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.

e) All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.

f) Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less then 96%.

g) Sloping condensate drain pan shall be made of minimum 1.2 mm thk stainless steel sheet. It shall be isolated from bottom floor panel through 25 mm thick heavy duty treated for fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.

25.7.5 Centrifugal Fan for AHU

a)	Fan Type	Blower type
b)	Fan impeller	Backward curved blade & centrifugal type.
c)	Casing material	GI/ Mild steel with minimum thickness of 3 mm.
	Impeller material	Carbon Steel
d)	Shaft	EN 8
e)	Fan bearings	Self-aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
f)	Critical speed	First critical speed of rotating assembly shall be at least 25% above the operating speed.
g)	Drive	Motor driven. With removable belt guard.

25.7.6 Mixing Box

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.

25.7.7 Pan Humidifier

Pan humidifier shall be made of 22 gauge SS 304 tank, duly insulated with 25 mm thick resin bonded fibre glass insulation (min 24 kg/cum density) with 0.5 mm GSS cladding. The humidifier shall be complete with stainless steel immersion heaters, safety thermostat, float valve with stainless steel ball, sight glass, overflow and drain connections, steam outlet nozzle and float

switch. Step controller shall be provided for switching on/ off heater banks as per system requirement.

25.7.8 **HI- Wall Split/Cassette/Precision air Conditioners**

25.7.8.1 Hi Wall split/ Cassette air conditioners shall in general consist of the following:

1. Casing.
2. Hermetically sealed rotary/ scroll compressor.
3. Condenser.
4. Evaporator and condenser cooling fan.
5. Cooling coil.
6. Filters.
7. Piping, valves, refrigerant strainer etc.
8. Control, instruments, control panel/ starter panels.
9. Vibration isolation pads as required.
10. Refrigerant as per manufacturer's standard.

25.7.8.2 Indoor unit of ceiling mounted Cassette type unit (Multi Flow Type):

The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

Unit shall have four way supply air grills and return air grill in center.

Each unit shall have high lift drain pump and very low operating sound.

25.7.8.3 **Precision Packaged Air Conditioners**

Precision air conditioning system shall be designed for high sensible heat ratio. The system shall contain scroll compressor, evaporator blower & coil, heater, humidifier, air cooled condenser, externally equalized electronic expansion valve etc. All items except condenser shall be contained within the cabinet of the unit, which shall be placed inside room. Air cooled condenser shall be located outdoor.

i. Compressor shall be high efficiency (EER should be not less than 3.5) scroll design and shall have inbuilt overloads. It shall be mounted on anti vibration mountings.

ii. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.

iii. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.

iv. Evaporator coil: The unit shall be fitted with large surface area cooling coil with split coil mechanism/ or any other equivalent method for dehumidification. The distance between fins shall not be less than 1.8 mm and face velocity shall not exceed 2.5 m/s.

v. Filters- Filter chamber shall be integral part of the system & withdraw able from the unit. Filter shall be capable of filtering air to 95% down to 5 micron efficiency.

vi. Refrigerant piping shall be heavy gauge copper or IS: 1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.

vii. Refrigeration Circuit: The circuit shall be direct expansion type. It shall include a manual reset HP and auto reset LP switch, filter drier, charging port, electronic expansion valve, sight glass etc.

viii. The indoor unit shall have forward/ backward curved centrifugal type double inlet width statically and dynamically balanced fans. Fan shall be electronically commutated type fan.

ix. Electrical heating: The heating circuit shall include dual safety protection through loss of air and temperature controls.

x. Air Cooled Condensers: The equipments shall be designed for 47^0 C outside ambient condition. Low ambient refrigeration controls (LARC) shall also be available. The condenser frame shall be constructed from heavy duty galvanized steel and in corporate copper tube & aluminium fins.

xi. **Cabinet Construction:**

The frame & panel shall be constructed of heavy gauge Zinc annealed corrosion resistant sheet steel. The fan section shall be insulated with fire retarded insulation. The cabinet shall be powder coated and have a textured finish.

xii. **Humidifier**

Humidification shall be provided by boiling water in a polypropylene steam generator. The steam shall be distributed evenly into bypass air stream of precision air conditioning unit. Humidifier shall be fitted with an auto flushed cycle activated on demand from the control system. Further, humidifier shall be fully serviceable with replaceable electrodes. Waste water shall be flushed from the humidifier by initiation of water supply solenoid valve.

xiii. The Units shall be designed for 68 DBA at 1 meter from the unit outlet quiet operation with all moving parts mounted on anti-vibration mounting and carefully balanced to ensure minimum vibration.

xiv. The refrigerant shall be R-407 or any other environment friendly refrigerant.

xv. All necessary operating and safety controls shall be provided including the following:

Controls:

The controls shall be of microprocessor based programmable with PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:

a) Modes of operation (cooling, heating, humidification & de-humidification).

b) Simultaneous graphical displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.

c) Date, time and unit identification display.

d) System component Auto / Manual status display on the controller screen.

e) Backup battery charge status display on the controller screen.

f) Visual system alarm indication (along with mutable audio alarm as well).

g) Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).

h) 48 Hours temperature and relative humidity graph display menu.

i) Programmable services interval indication display / alarm.

There should be a feature to enable operator to program the start-up and shut off of the system components (blower fan start/stop delay, first compressor start/stop delay, second compressor start/stop delay, etc.). Access to the controller settings shall be protected with passwords to prevent against unauthorized access.

Safety Protections:

The unit shall also incorporate the following protections:

a) High pressure trip- Manual reset for each compressor
b) Low pressure trip- Manual reset for each compressor.
c) Single phasing preventers.
d) Reverse phasing
e) Phase imbalancing
f) Phase failure
g) Overload tripping (MPCB) of all components

Safety Interlocks:

Operation of heaters & humidifiers shall be possible only when blower fan is in operation.

Fire detection signal from fire detector system shall be able to switch off the package unit operation in event of fire in conditioned space.

xvi. A suitable number of vibration isolation pads shall be provided for the packaged units.

25.7.9 Centrifugal Pumps

a)	Type	Horizontal Centrifugal, Axially split type casing pump
b)	Impeller	Closed type
c)	**Material of Construction**	
	i) Casing	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	SS CF 8M
	iii) Wearing rings	Bronze
	iv) Shaft	SS 410
	v) Shaft sleeve	SS 316
	vi) Lantern ring	Brass / Bronze
	vii) Packing	Asbestos free
	viii) Base Plate	Carbon steel as per IS:2062
	ix) Speed	Maximum 1500 rpm

For other requirements of pumps refer Volume III, Chapter 34.

25.7.10 Air Filters

a) Pre Filter

1)	**Filter medium :**		
	i)	Washable non-woven synthetic fibre or high density Polyetylene (HDPE) media having 18G GSS/ 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
2)	**Type**		
		Flange/ Cassette	
3)	**Other requirements (as applicable) :**		
	a)	Suitable aluminium spacers be provided for uniform air flow;	
	b)	Casing shall be provided with neoprene sponge rubber sealing.	
	c)	Capable of being cleaned by water flushing.	
	d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.	
	e)	Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.	
4)	**Efficiency :**		
		Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76/ EN-779.	
5)	Minimum thickness	50 mm	
6)	Face Velocity	Not more than 2.5 m/sec.	

7)	Pressure drop	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location	
	a) Fabric type	1) At the suction of each AHUs
		2) At the suction of each Fresh air fan
		3) At suction of each supply air fan
		4) at suction of air washer & UAF (Water repellent nylon type)

b) **Fine Filters (Microvee type)**

1)	Type	Flange/ Cassette
2)	Construction	Washable non-woven synthetic fibre or high density Polyetylene (HDPE) media having 18G GSS/ 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
3)	Frame	Aluminium alloy of (minimum 16 gauge conforming to IS:737)
4)	Other requirements	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing. c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
5)	Efficiency	Average arrestance of > 90% when tested in accordance with BS:6540/ASHRAE–52-76/ EN-779.
6)	Minimum thickness	150 mm or 300 mm.
7)	Face Velocity	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
8)	Pressure drop	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.
	Location	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air fan. iii) At the discharge of each supply air fan having static pressure of 30 mm WC or more.

c) **Absolute Filter / Hepa Filter**

1)	Media	100% sub-microscopic glass fibres.
2)	Frame	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3)	Other requirements	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
4)	Efficiency	99.97 % down to 0.3 micron when tested in

		accordance with BS: 3928 (Sodium flame test)/FED–209B.
5)	Minimum thickness	300 mm
6)	Face Velocity	Not more than 1.2 m/sec.
7)	Pressure drop	Initial pressure drop - Not to exceed 25 mm WC at rated flow; Final pressure drop - Up to 75 mm WC.
8)	Location	At the discharge of each individual AHU having static pressure of 125 mm WC.

25.7.11 **Cooling Towers**

Type	Induced draft, cross or counter flow.
Capacity	110% of rated capacity of each cooling water pump.
Material of construction of Casing & Sump tank	FRP
Fan	Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill	Non combustible PVC or Equivalent of light grey colour.
Louvers	FRP /PVC
Nozzles	Brass with chrome plating
Eliminators	In removable sections to reduce the drift loss to 0.2% of water flow.
Supporting structure	Mild steel with spray galvanisation or epoxy painting.
Strainer at water outlet	Plate strainer made of SS wire mesh of 16 gauge.
Bird screen on top of tower	25 mm square made of SS wire mesh of 16 gauge.
Ladder	Hot dip galvanised steel ladder for each tower.
Distribution Pipe (if any)	Galvanised MS pipe.
Accessories	a) Drain connection with isolation valve b) Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. c) Overflow connection d) Equalizing connection to connect sump of all the towers wherever applicable. e) Access door in louvers / fan deck.

25.7.12 Non- Chemical Type Scale Preventor

The unit shall be a non-chemical on-line type scale preventer not requiring any chemicals. Non-chemical water treatment system shall prevent the formation of hard scale in cooling circuits of air conditioning equipment. It shall work with a combination of Adsorption, and Turbulence. The inner core shall be able to convert the hardness salts into colloidal particles. The unit shall not require any electricity or any other source of energy. The unit shall not have any recurring, operating and maintenance cost. The size of the unit

shall be determined based on the water quality and water flow rate. The unit shall be installed in the condenser water circuit. The outer casing shall be of stainless steel. The method of checking the performance of system through computer simulation shall be provided.

25.7.13 **Low Pressure Air Distribution System**

I) Through Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The Galvanised sheets shall confirm to 275 GSM IS-277 or Aluminium alloy (grade 19000/ SIC or 3100/ NS 3 of IS 737).

The thickness of rectangular ducts shall be as follows:

	Larger dimensions of Duct, mm	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
a.	Upto 750	0.63 (24 G)	0.8
b.	751 to 1500	0.80 (22 G)	1.00
c.	1501 to 2250	1.00 (20 G)	1.50
d.	2251 & above	1.25 (18 G)	1.80

The thickness of round ducts shall be as follows:

	Diameter of Round Duct, mm	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
a.	150 to 500	0.63	0.8
b.	501 to 750	0.80	1.00
c.	751 to 1000	0.80	1.00
d.	1001 t0 1250	1.00	1.50
e.	1251 & above	1.25	1.80

25.7.13.1 **Duct Fabrication & Supports**

a. Duct fabrication shall be as per the latest relevant BIS/SMACNA standard.

b. Ducts for AC system may be site fabricated or factory fabricated and installed at site. However in case of partly used factory fabricated ducts, vendor shall take back the unused ducts.

c. The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns as provided by the owner with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach

screws and all other supporting material required shall be provided by the bidder.

d. Where the sheet metal duct connects to the intake or discharge of fan units, a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer canvas or neoprene coated fibre glass.

e. All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

f. Wherever duct passes through wall, all the openings between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

g. Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.

h. Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control of system. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.

i. All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonary construction to which angles are fastened.

j. Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

k. All air terminals shall be of mill finish extruded aluminium profile construction.

l. The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation,

supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

m. Each branch line shall have dampers to isolate the branch for maintenance purpose.

25.7.13.2 **Factory Fabricated Ducts**

a. All ducting shall be fabricated of LFQ (Lock forming quality) grade prime GI.

b. Unless otherwise specified here, the construction, erection, testing & performance of the ducting system shall conform to SMACNA – 1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – second Edition – 1995" SMACNA)

c. All ductworks including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply :

   i. Coil lines to ensure location of longitudinal seams at corners/ folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
   ii. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
   iii. All edges to be machine treated using lock formers, flanges and roll bending for turning up edges.
   iv. Sealant dispensing equipment should be used for applying built in sealant in Pittsburg lock where sealing of longitudinal joints are specified. Sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for ducts over 2" w.g static pressure.

d. All traverse connectors shall be 4-bolt slip on flange system with built in sealant, if any. To avoid any leakage additional sealant shall be used.

25.7.13.3 **Diffusers, Grills & Dampers**

Supply air diffusers/ grills with factory fitted volume control dampers to be provided for all air conditioned areas.

Return air diffusers of air conditioned areas shall be without volume control dampers.

The diffusers/ grills shall be extruded Aluminium of minimum 2mm thk with powder coating. The colour of powder coating shall be as per the interior decor.

Supply air grills shall be double deflection type and return air grills shall be single deflection type.

The nozzle type diffusers shall be fabricated from minimum 1.5 mm Aluminum sheet. The base shall be fixed type. The nozzle shall be of volute design with the spout diameter being half the base diameter and designed for low noise and long throw. The nozzle shall be able to rotate to any angle within the base. The whole assembly shall be powder coated as per interior decor.

All volume control (VC) dampers shall be operated by a key from the front of the grills/ diffusers and shall be of GI sheet.

The thickness of VC dampers shall be minimum 20 guage and thickness of louvers shall be minimum 22 gauge.

Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of baffles wherever required shall be provided.

Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.

All plenum chambers of connections to fans, dampers, etc shall be constructed in 18 gauge GS sheet and supported in MS angle frames.

All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.

25.7.14 **Thermal & Acoustic Insulation**

Application

a. All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive be applied @ 1.5 kg/ sqm on the surface (CPRX compound of Shalimar Tar products or equivalent).

b. Insulation material (either expanded polyestrene foam or glass wool/ glass fibre or equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen.

c. Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.

d. Insulation finish of types specified under shall be provided thereafter.

25.7.14.1 Type of Insulation & Finish

S. No.	Surfaces	Insulation Material	Insulation Form	Thick, (mm)	Finish, (mm)
1	Supply & Return air duct of AC system	Resin bonded glass wool or closed cell elastomeric Nitrile rubber	Roll/ Slab Sheet	50	F-3
2	Refrigerant (Suction & Liquid Lines)	Closed cell elastomeric Nitrile rubber	Tube	19	As per manufacturer's std.
3	AHU Drain pipe	Closed cell elastomeric Nitrile rubber	Tube	19	As per manufacturer's std.
4	AHU Condensate pan (insulation if required)	Mineral wool or resin bonded glass wool.	Slab	25	As per manufacturer's std.
5	Chilled water piping, valves & specialties	Resin bonded mineral wool or resin bonded glass wool.	Pipe section	75	F-1
6	Chiller (Insulation if required)	As per manufacturer's std.			
7	Chilled Water Pumps	Resin bonded mineral wool or resin bonded glass wool.	Slab	50	F-1
8	Expansion tank with associated piping	Resin bonded mineral wool or resin bonded glass wool.	Slab/ pipe section	50	F-1
9	Acoustic Insulation of duct	Resin bonded glass wool	Slab	25	As per spec
10	Exposed air duct	Resin bonded glass wool	Roll	50	F-4

25.7.14.2 Specification for insulation shall be as follows:

Insulation Material	Code	Thermal Conductivity (w/m/Deg C)	Density, kg/ m^3
Resin bonded glass wool	IS:8183	0.049 at 50 Deg C	i) 24 (for thermal insulation) ii) 48 (for acoustic insulation)
Mineral wool pipe section Min Gr 2	IS 9842	0.043 at 50 Deg C	144

Insulation Material	Code	Thermal Conductivity (w/m/Deg C)	Density, kg/ m^3
Closed cell Elastomeric Nitrile rubber		0.036 at 20 Deg C	60-70

Note : Insulation for HVAC application shall be CFC/ HCFC free.

25.7.14.3 The specification for various finishes shall be as follows:

a) **Finish F-1**

Step – 1 Wrapping of Poly- Bonded Hessain (PBH- to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.

Step – 2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.

Step – 3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick. The second layer being brought to a smooth finish. A water proofing compound shall be added to cement before its application.

b) **Finish F-2**

Step – 1 Insulation shall be covered with 500 g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.

Step – 2 Same as Step-2 of Finish F-1 above.

Step – 3 Same as Step-3 of Finish F-1 above.

c) **Finish F-3**

Step – 1 Same as Step-1 of Finish F-2 above.

Step – 2 The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self locking screws at a pitch of minimum 100 mm.

d) **Finish F-4**

Step – 1 Same as Step-1 of Finish F-1 above.

Step – 2 Same as Step-2 of Finish F-1 above.

Step – 3 Same as Step-3 of Finish F-1 above.

Step – 4 Application of 3 mm thk coat of water proofing compound "SHALIKOTE 30" or equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thk water proofing compound "SHALIKOTE 30" or equivalent over thr RP tissue.

Step – 5 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface.

For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm & above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is maintained.

25.7.14.4 ACOUSTIC INSULATION

a) All ducts up to a distance of 5 m from AHU shall be acoustically lined from inside with 25 mm thk resin bonded glass wool of 48 kg/ cum density with 30 gauge perforated Aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre to centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.
b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated Aluminium sheet. Application of acoustic insulation shall be in line with requirements specified above.

25.7.15 Piping and Fittings

Material of Construction for Piping & Fittings

a)	Piping for Chilled and Condenser water	Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 lines NB with thickness as indicated
b)	Refrigerant piping	Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).
c)	Drain piping	Same as (a) above & galvanized as per IS:4736
d)	Fittings	1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above. 2) For sizes 50 NB and below, the material shall conform to ASTM A-105. 3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5 4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe

		diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534. 5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5

25.7.10 **Valves**

i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.

ii. Valves for regulating duty shall be of Globe type suitable for controlling throughout its lift.

iii. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

iv. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

v. Manual gear operator be provided for valves of size 200 NB and above.

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arrangement.

viii. The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.

ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

x. Balancing / Controller Valves:

The valves of sizes 32 mm to 65 mm dia shall be of gun metal / cast iron construction with screwed ends angular design digital hand wheel with locking facility. Whereas valves of sizes 75 mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends

25.7.11 **Instruments, Protective Devices and Interlock**

On-off thermostat with adjustable setting shall be provided with temperature control. Interlocks shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with condenser water flow switch, chilled water flow switch / circulation pump. Safety devices such as high/low pressure cut out, hermetic motor winding thermostat etc. shall be provided. HP cutout shall be manual

reset type while LP cutout shall be auto reset type. The control system shall be PLC based with redundant processor, power supply and communication modules, with CRT operator interface and peripherals serial link shall be provided for transfer of important signals to the DCS in the central control room.

Strip heaters shall be provided with an adjustable thermostat to control the temperature and a safety thermostat and safety interlock shall be incorporated to cut-off the electrical supply to the heater whenever there is failure of airflow.

Fire dampers (solenoid operated) shall be installed at places where supply air duct crosses fire barrier wall, floor slab, return air space (near the wall separating AHU rooms / PAC rooms and A/C area). The fire damper shall be of the same fire resistance as the structure but in no case less than 120 minutes and should be energized to close and the air conditioning equipment shall be tripped off in the event of fire.

25.7.12 Gravity Damper

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

25.7.13 Fresh Air Unit for Air Conditioning system

The fresh air unit shall consist of:

- Wall cowl with bird screen, tube axial fan with motor.
- Pre-filter made up of HDPE and efficiency 90% down to 10 microns and maximum face velocity of 2.25 m/sec. The pre filter used for evaporative coolers and ventilation system shall be of same specification.
- Fine filter made up of HDPE and efficiency 99.5% down to 5 microns and maximum face velocity 2.25 m/sec.
- Volume control damper, ducting, fixing frame and necessary supports.
- Filter frame shall be of aluminium and shall be flanged.

25.8 Plant Control for Air conditioning system

a) **General**

Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Bidder. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

b) **Control Scheme of Air Conditioning System**

i. The Air Conditioning System control system shall be PLC based. The PLC configuration and detailed specification of the same shall be as per Control & Instrumentation requirements specified elsewhere in the specification.

ii. Each system shall be provided with required I/O modules and two numbers of Operator Work (OWS) Stations. All the functional requirements specified below and general control logic specified under this section shall be implemented in the respective PLCs.

iii. The basic function of the system shall be to closely control and monitor temperature and humidity conditions inside the air-conditioned spaces, to optimize/minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and inside room temperature and humidity of CR, CER, ESP Control Room, UPS and battery charger room shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For service building & administrative building inside room temperature and humidity shall be maintained by varying the chilled water flow of chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For sequential operation/ duty cycling, programmed start up/ stop of individual AHU's, pumps and cooling towers as per operating requirements and inside room temperature and humidity.

iv. PLC provided for the Control of AC system shall suitably interface with integral microprocessor based controls of Chiller units.

v. The PLC based control system of Air Conditioning system shall also interface with Wide Area Network of the Station to be supplied by the Bidder.

c) **Water Chilling Plant Control**

i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.

ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.

iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vi. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

vii. Provision shall also be made for the manual restarting of the compressor.

viii. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

ix. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.

x. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xi. Closure of fire dampers shall raise an annunciation in the panel.

xii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.

xiii. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.

d) **Air Handling Unit**

i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and by varying the flow by means of VFD driven AHU's which shall get signal from the control system for main plant A/C system. For service building & Administrative building inside room temperature & humidity shall be controlled by varying the chilled water flow of chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor.

ii. Humidity sensor & gyserstat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with fire Detection System.

vii. Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii. Miscellaneous control requirements

ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

e) D-X Air Conditioning System

- The control and interlocks described above for water chilling plants are applicable for this system also.
- Further the compressor starting/ running shall be interlocked with the flow switches in condenser water circuit as well as with AHU motors.
- The standby condenser water pumps, fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/ Manual selector switches and working/ standby selector switches for the pumps, fresh air fans and AHU shall be provided in the panel.

f) Cassette/ Hi- wall Split Air Conditioners

The control and interlocks for these type of units shall be as per manufacturer's standard practice.

g) General

- Separate emergency local stop push button shall be provided for each pump, compressor, fans etc of A/C system.
- Status shall be provided of each pump, compressor, fans etc of A/C system and ventilation system on HMI system at control room.
- All the annunciations related to failure of equipments, tripping of equipments, source of failure/ reason due to which the equipment is stopped/ tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC, AWY etc.
- The fans (both supply & exhaust fans) associated with mechanical ventilation system shall be operated locally.
- Relative humidity and temperature measurement of all control rooms and CER's, ESP control room and all major air conditioned areas shall be available in DDCMIS. Relative humidity and temperature measurement for main plant control room and CRE's to be available in multiple numbers.

- Vibration and noise level of screw chillers, condensing units, pumps with motor shall be measured during PG test. Permissible limit of vibration for pumps shall be 75 micron peak to peak. For fans/ screw chillers/ condensing units, the same shall be in line with VDI-2056 Group-T machines (maximum vibration level 7.1 m/s r.m.s.

- The maximum noise level shall be 85 dBA at 1.5 m elevation and at a horizontal distance of 1 m from the equipment.

25.9 **Plant control for Evaporative cooling and Ventilation system**

a) General

i. Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Owner. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

b) Air Washer Units (AWU) & Unitary Air Filtration Units (UAF)

i. Air washer units shall be started/ stopped by initiation from OWS provided in control room of air conditioning. Starting/ stopping of pumps shall be automatic upon such initiation.

ii. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/ tripped.

c) Miscellaneous control requirements

i. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ii. The status of each pump, fans, etc of ventilation system is available on OWS in control room locally.

iii. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.

iv. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

v. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

CHAPTER – 26

POWER CYCLE PIPING, VALVES, FITTINGS & THERMAL INSULATION

CONTENTS

26.0 POWER CYCLE PIPING, VALVES, FITTINGS & THERMAL INSULATION

This chapter covers all the power cycle piping, valves and specialties which connect the different equipment like the boiler, turbine, condenser, pumps, heaters etc. to make the power cycle complete and thermal insulation to be provided for the power plant.

26.1 PERFORMANCE REQUIREMENT

The piping system acts as the pressure boundary for the fluid in circulation, water and steam in this case, which is subject to high pressure, temperature, change of phase and various types of transient and steady state operation. All the piping systems supplied shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years and shall withstand to the maximum sustained load.

26.2 Line Sizing

26.2.1 Inside diameters of piping shall first be calculated for the flow requirement of various systems based on velocity limits listed below::

Steam

(i)	Superheated Steam (MS, CRH, HRH)	:	76.0 m/s
(ii)	Saturated Steam	:	30 m/s
(iii)	Wet Steam/ Exhaust Steam	:	30 m/s
(iv)	Auxiliary Steam	:	50 m/s
(v)	Main Steam Hot & cold reheat piping	:	100 M/s
(Vi)	HP/LP Bypass Upstream	:	105 m/s
(vii)	HP/LP Bypass Downstream	:	125 m/s
(viii)	Extraction Steam (superheated)	:	60 m/s
(vii)	Extraction Steam (saturated)	:	30 m/s

Water

(i)	Pump suction	:	1.0 m/s
(ii)	Pump delivery	:	2.5 m/s;
(iv)	Feed Water discharge	:	4 - 6 m/s
(v)	Feed Water Suction	:	2 - 3 m/s
(vI)	Condensate Discharge	:	3 – 5 m/s
(vii)	Condensate Suction	:	1.5 m/s

Oil

(i)	LDO	:	2 m/s

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

(i)	Carbon steel pipe	100
(ii)	CI Pipe/Ductile Iron	100
(iii)	Rubber lined steel pipe	120
(iv)	Stainless steel pipe	100
(v)	FRP/GRP	140

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

26.3 CODES & STANDARDS

The design, manufacture and performance of the LP Piping System specified hereinafter, shall comply with the requirements of the following codes and standards and shall include all the latest amendments

- ASME-B31.1: Code for Power Piping
- ASME-B16.5 : Pipe Flanges & Flanged Fittings
- ASME-B16.9 : Factory-Made Wrought Steel Butt-Welding Fittings
- ASME-B16.10 : Face to Face and End to End Dimension of valves.
- ASME-B16.11 : Forged Steel Fittings, Socket-Welding and threaded
- ANSI B-16.25 : Butt Welding Ends.
- ASME-B16.34 : Valves – Flanged, Threaded and Welding End
- ASME-B36.19 : Stainless Steel Pipe
- IBR : Indian Boiler Regulations (Latest Revision)
- IS-1239 : Carbon steel tubes, tubular and other wrought steel fittings.
- IS-3589 : Seamless or Electrically welded steel pipes for water, gas and sewage.
- IS-11428 : Specification for Wrought Carbon Steel butt welding pipe fittings.
- IS- 4736 : Hot-dip Zinc coatings on Carbon steel tubes
- IS- 2062 : Steel for general structural Purposes - Specification.
- IS- 4682 : Code of practice for lining of vessels and equipments for chemical processes: Part 1 Rubber lining.
- ASTM A312 : Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- ASTM A403 : Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- API-594 : Check valves: Flanged, Lug, Wafer and Butt-welding.
- API-598 : Valve Inspection and Testing
- API-600 : Bolted bonnet steel gate valves for Petroleum and natural gas industries.
- API-602 : Compact Steel Gate Valve – Flanged, Threaded, Welding and Extended Body Valves.
- BS- 1873 : Steel Globe and globe stop and check valves (flanged and butt-welding ends) for Petroleum, Petrochemical and allied industries.
- BS- 1868 : Steel check valves (flanged and butt-welding ends) for Petroleum, Petrochemical and allied industries.
- IS 12709 : GRP pipes, joints and fittings for use for potable water supply
- IS 14402 : GRP pipes, joints, and fittings for use for sewerage, industrial waste and water.
- ANSI/AWWA C950-07: AWWA Standard for Fiber Glass pipes.
- AWWA M45 : AWWA manual of water Supply & Fiberglass Pipes Design.

Design, fabrication, assembly and testing of pipes, fittings shall generally conform to the requirements of ANSI B-31.1. But the portions, which come under the purview of Indian Boiler Regulations (IBR), shall completely comply to the requirements of IBR, as a minimum.

Any other internationally accepted codes and standards are also acceptable. However, the compliance of ANSI codes and IBR will be considered as minimum for acceptance of the piping and all appurtenances.

26.4 Scope of Supply

Scope shall include all piping, valves & specialties as indicated in Annexure-I as a minimum. However all piping as required for the completeness of the system shall be supplied.

26.4.1 In general, the equipment and materials to be supplied under this specification shall include, as a minimum:

a. Supply of all power cycle piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc as required.

b. Matching pipes, matching pieces like reducers/enlargers etc, counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.

c. The pipe spools shall be supplied along with necessary test certificates of the pipes, after necessary machining to the required bore, for assembly of flow nozzle element. The assembled flow nozzle shall be installed in the piping system. Additional length of pipes equal to length of all fully assembled flow nozzle & orifice plates pipe piece shall be supplied and the same shall also be erected prior to cleaning of the pipes by flushing or steam blowing or chemical cleaning or both. After completion of cleaning of piping, the assembled flow nozzles shall be erected replacing the temporary pipe spools.

d. All motorised valves, manually operated isolating and regulating valves, non- return valves, steam traps, relief/safety valves, strainers, pressure reducing orifices, expansion joints and other flexible connections, complete with the counter flanges and matching connecting pieces as required within the entire power cycle piping system.

e. Anchors, hangers and supports, vibration dampeners, restraints, shock absorbers etc as required.

f. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor including access ladders, supporting structures etc.

g. All secondary structural steel members required for pipe supports from building steel structures and from embedded steel including pipe supports in trenches.

h. Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated either in Blow down tank/flash tanks or permanent drain trenches of the Power Station. All steam and saturated water open drains shall be drained through a water seal in drain funnels/tundish with a water connection in funnels/tundish for maintaining water seal level in them. All oily effluent drains shall be separately routed and connected to separate pit.

i. For the isolation and check valves located on the main steam, hot reheat, cold reheat, L.P. bypass and extraction lines, suitable line drains shall be provided just upstream and downstream of each of these valves. No drain is needed at the downstream of L.P. bypass isolation valve. Each of these drains shall be independently led to the condenser with branching off to atmosphere.

j. Line drains from Main Steam, Hot Reheat, Cold Reheat, L.P. bypass & high pressure (above 40 kg/cm2) extraction lines shall be provided with double isolation valves in series for each branch - each located at the two extreme ties of the line drain route. The valve near the condenser shall be motorised one. The balance line drains shall be provided with only one isolation valve for each branch.

k. Bolts, nuts, washers, temporary and permanent gaskets, fasteners as required for interconnecting piping, valves & fittings.

l. Complete insulation material for piping, valves, specialties & auxiliary equipment specified in this specification and as called for in the specification for thermal insulation.

m. Painting of all piping, valves & specialties at site. Coating and wrapping for buried pipes.

26.4.2 Bidder shall furnish his own technical details of piping, valves, specialties and accessories along with his offer.

Following general requirements shall however be considered:

(a) Instrument Connections

(b) Pipe stubs and blanking plates required for chemical cleaning and hydro testing.

(c) Flanges, spool pieces, gaskets, ring joints, jointing materials, aluminium and stainless steel forged marking plate and temporary piping for steam blowing.

(d) Drain/drip pockets on steam piping as per stipulation of ASME TDP – Volume I and general requirement.

(e) Expansion marker for high temperature steam lines.

(f) Fine threaded Radiography holes with stubs and suitable matching plugs which shall be finally seal welded for piping, more than 25 mm nominal thickness.

(g) For conducting performance test of Turbo-Generator and Boiler, the required pressure, temperature, flow measurement points shall be provided.

(h) Provision for creep measurement on the piping operating in creep region.

26.4.3 Electrodes and filler wires required for stainless steel and alloy steel welding during shop fabrication at works and erection/installation at site.

26.4.4 All temporary pipes and accessories, supporting arrangement for cleaning, flushing and steam blowing of the main steam, cold reheat and hot reheat piping including HP/LP by pass piping and auxiliary steam piping.

26.5 SCOPE OF SERVICES

26.5.1 The Contractor shall design the piping system and perform necessary stress analysis of all piping and dynamic analysis as necessary for the piping systems shown in Annexure-I of this chapter as a minimum.

26.5.2 For stress analysis purpose, individual piping systems shall be considered up to the anchor points (location to be decided during detail engineering). All anchors coming within the piping are to be designed, supplied and erected by the Contractor.

26.5.3 Stress analysis and hanger selection for all piping specified, including piping attachment for hangers/supports, all auxiliary supporting structures are included in the scope of the Contractor.

26.5.4 The Contractor shall submit the design calculations for pipe sizing, thickness with specified diameters of pipes and stress analysis data to Owner/Engineer for review/ reference/records. Pressure drop calculation for main steam, cold reheat and hot reheat piping shall be submitted by the Contractor to show the adequacy of pipe sizes to meet steam parameter at turbine inlet.

26.5.5 Preparation of detailed fabrication drawings (isometric) of shop fabricated piping which are of size 50 NB and above should be based on the "Released for Construction" drawings pertaining to power cycle piping layout prepared by the Contractor.

26.5.6 "As built" drawings of the power cycle piping layout shall also be prepared by the Contractor based on any layout modifications made at site over "Released for Construction Drawings".

26.5.7 The Contractor shall design and detail all piping supports including restraints, guides, stops, snubbers, dampers etc based on the final stress analysis and hanger load data. The Contractor's design of all supports shall be submitted to the Owner/Engineer for review.

26.5.8 The Contractor shall furnish separate sketches for each support, restraint, anchor, snubber, dampers, spring hangers etc. These sketches shall include the location with reference to column co-ordinates, identification number, bill of material, design loads, operating load, spring stiffness, amount of spring pre-compression etc and method of attachment to the pipe and steel structure.

26.5.9 In order to ensure that all piping, supporting elements, anchors and restraints have been installed and adjusted in accordance with the drawings and other written instructions of the Contractor, the hangers associated with the main steam, hot reheat, cold reheat, HP & LP by-pass, feed water, auxiliary steam piping etc. shall be inspected as follows :

- After hydro test, with the piping in the cold position, with all travel stops removed, with the pipe completely insulated and in all respects ready for start-up.
- Piping in the hot position, with the unit operating at maximum load.

- Piping in the hot position after 6 months of operation.
- Piping in the cold position during first complete shutdown after at least 6 months of operation.
- The contractor shall depute his personnel for this purpose to site if the plant is officially handed over to the owner before such inspection after 6 months of operation.

26.5.10 At the time of each inspection, the Contractor shall determine the necessity for revision, adjustment or replacement of pipe supporting elements, restraints and anchors. Any changes proposed shall be incorporated by the Contractor after Owner's/Engineer's concurrence.

26.5.11 All shop tests satisfying the requirements of Indian Boiler Regulations (IBR), ANSI standards, the standards enumerated herein and/or as specified.

26.5.12 Furnishing drawings, data, design calculations, stress analysis results.

26.5.13 Furnishing certified copies of test results for all tests and examinations specified in the specification and for the mandatory tests and analysis required by the ASTM material specification, for the materials used for piping and the pressure parts of the valves.

26.5.14 Obtaining approval from Chief Inspector of Boilers as per Indian Boiler Act, including the following:

- For all pipelines coming under the purview of Indian Boiler Regulations (IBR), necessary approval of the design and layout drawings shall be obtained from the Chief Inspector of Boilers and furnished to the Owner/Engineer. Necessary certificates of design, manufacture and tests in specified Form of IBR, for each fabricated pipe with proper identification shall be submitted.
- For fittings and specialties, viz. valves, flanges, traps and other specialties etc of all pipelines coming under the purview of IBR, Certificate of design, manufacture and tests in specified Form of IBR with appropriate identification shall be furnished to the Owner/ Engineer.
- Erection & testing of the pipe lines coming under the purview of IBR shall meet all the requirements of IBR and certificate of manufacture & tests in specified Form of IBR, for each of the erected pipe lines shall be submitted to the Owner/Engineer prior to the application of insulation and/or flushing the line before commissioning.

26.5.15 Steam blowing or chemical cleaning of piping systems, as specified.

26.5.16 Omission of specific reference to any item or material or work which is necessary for completion of the piping systems shall not relieve the bidder of the responsibility of furnishing all material and services for a complete installation satisfying the operational and other requirements stated in the specifications.

Drawing indicating the layout of pipe work shall be prepared in line with the flow diagrams and shall be provided as part of the Contract. These drawings shall indicate the position of all supports, guides, restraints and anchors; all drain and vent connections and the position of all pipes. All piping systems shall be arranged to allow adequate falls in the direction of flow, except where otherwise

approved by the Engineer. At the points of drainage, drain pockets of ample size and approved construction shall be fitted as per details indicated in the enclosed drawings.

26.6 POWER CYCLE PIPING

26.6.1 EQUIPMENT SIZING CRITERIA

(a) All the piping systems and equipment supplied shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years and shall withstand the operating parameters fluctuations and cycling normally expected during this period.

(b) The design engineering erection testing etc. of the complete piping systems shall be to the requirements of power piping code ASME B 31.1. in addition to this, requirements as laid down in Indian Boiler Regulations (latest edition) shall also be met completely.

26.6.1.1 PIPE SIZING

(a) Inside diameters of piping shall first be calculated for the flow requirement of various systems. The velocity limits for calculating the inside diameters are indicated in clause 26.1.1.

(b) Inside diameters thus calculated for various piping systems shall be checked for the allowable pressure drop as per HBD's.

(c) Pipes shall be sized for the worst (maximum flow temperature & pressure values) operating conditions for each system considering the maximum occasional pressure & temperature variations. In case of BFP suction sizing "transient analysis" shall be carried out for optimum sizing of the system in order to establish the pipe inside diameter for minimum pressure drop in system to match with pump NPSH requirement under worst operating conditions. The design pressure of MS piping system from superheater outlet header upto and including boiler stop valve shall not be less than the design pressure of superheater outlet header,

(d) The design pressure for BFP discharge piping upto and including downstream valve at feed regulating station (FRS) shall be selected such that the minimum calculated thickness for various pipes at design temperature is sufficient for the following conditions, considering allowable stresses as per ASME B 31.1.

- Discharge pressure corresponding to turbine driven BFP trip speed at shut off head flow condition, if TDBFFP characteristics is governing for calculation of boiler feed discharge piping design pressure.

- Discharge pressure corresponding to motor driven BFP trip speed (frequency 51.5 Hz) at shut off head flow condition, if MDBFFP characteristics is governing for calculation of boiler feed discharge piping design pressure

However bidder may consider 20% higher stress as per the provision of ASME B 31.1 (for the piping upto downstream valve at feed regulating station only) for which the requirement of special provision as per stipulation of clause no. 520 of IBR shall be met as a must by the bidder.

The valve rating in such case shall be arrived at based on design pressure calculated as per above.

(e) The design pressure of boiler feed discharge piping at downstream of FRs shall be 105% of pressure corresponding to the emergency point of BFP operation. However pressure relief valve across the HP heaters shall be provided so that piping & valves beyond feed regulating station are not subjected to shut off head condition.

(f) With feed regulating station (FRS) located at upstream of HP heaters and no isolating valve provided at inlet of economizer, the design pressure of boiler feed discharge piping at downstream of FRS shall be worked out corresponding to design pressure of the boiler. This shall be for HP heaters provided with spring loaded relief valve(s) or having provision of media operated three way valves at inlet/ outlet of HP heater(s) as per approval of IBR so as to prevent BFP shut off pressure from being communicated to downstream piping system and HP heaters.

(g) The design pressure and temperature, down-stream of any pressure reducing valve upto and including the first block valve shall be the same as that at up-stream of pressure reducing valve. If a pressure relief valve is provided in the downstream of PRV, the downstream piping shall be designed to a lower pressure as per set pressure of the relief valve. The piping at downstream of de-super-heater shall be designed for spray failure condition. The length of piping system considered for spray failure condition shall not be less than the length required for proper spray mixing as recommended by de-super heater supplier.

26.6.1.2 Inside diameters calculated for various piping systems shall be checked for the allowable pressure drop. Pressure drop in the main steam line shall not be more than 90% of the allowable pressure differential between superheater outlet header and HP turbine inlet valves at BMCR. Similarly combined pressure drop in cold & reheat piping will not exceed 90% of the pressure differential between HP turbine exhaust and IP turbine inlet valves minus pressure drop in reheater. The pressure drop in the complete reheat line from HPT exhaust to IPT inlet shall not be more than 10% of the pressure at HPT. Wherever possible 5/6 dia radius bends will be used to minimize the pressure drop. Pressure drop in CRH NRV shall be considered as furnished by supplier for calculating the pressure drop in the reheat circuit.

26.6.2 MATERIAL SELECTION

The material used for power cycle piping shall be equal to or better than the following unless specified otherwise:

i) Up to & including 400^0C Carbon steel to ASME SA-106 Gr. B/C or SA 210 Gr. C or equivalent.

ii) Up to & including 550^0C Alloy steel to ASME SA-335: P-11, P-12, P-22, P91 or equivalent

iii) Up to & including 605^0C Alloy steel ASME SA-335/213: P-91, P 92 or equivalent.

Above 605^{0}C Austenitic stainless steel, P-92, Super 304H, TP347H or equivalent.

26.6.3 PIPE WALL THICKNESS

Thickness calculation shall be made on the basis of procedure and formula given in ANSI/ ASME B 31.1. Thickness thus calculated shall be checked based on the procedure and formula given in IBR. Then, based on the higher value of the two calculations (after adding manufacturing tolerance), the next heavier commercial wall thickness shall be selected from the thickness schedules (e.g., Sch 40, Sch 80 etc) as contained in ASME B 36.10 for OD controlled pipes and from manufacturers schedules for ID controlled pipes.

However, in such cases where the calculated thickness for OD controlled pipes falls beyond the thickness corresponding to the listed schedule nos. as given in ANSI B 36.10 for the pipe size, both ID & OD controlled pipes to manufacturers schedules are acceptable.

OD controlled pipes shall be to dimensional standards ANSI B 36.10 for carbon steel & alloy steel pipes and ANSI B 36.19 for stainless steel pipes.

To account for losses due to erosion, corrosion etc during the plant service life, an allowance of 1.6 mm/ 0.75 mm shall be considered in the minimum wall thickness calculation of pipes as per ASME B 31.1/ IBR respectively.

Further, the design pressure and temperature, downstream of any pressure reducing valve upto and including the first block valve shall be the same as that at upstream of pressure reducing valve. The piping at downstream of de superheater shall be designed for spray failure condition. The length of piping considered for spray failure condition shall not be less than the length required for proper spray mixing as recommended by desuperheater supplier.

However in no case, the selected pipe thickness shall be less than Sch 80 for alloy steel & carbon steel pipes of sizes 50 NB & below. The selected thickness for SS pipes shall not be less than Sch 40S of ANSI B 36.19.

Further, for the piping systems likely to be subjected to two phase flow, i.e down stream of control valves on heater drain lines etc. and for length of piping which is required for the proper mixing of spray water at downstream of de-superheater the selected thickness shall not be less than :

a.) Sch 40 pipe sizes above 50 NB but below 300 NB.
b.) Sch STD for pipe sizes 300 NB & above.

26.6.4 LAYOUT

(a) All high points in piping system shall be provided with vents. All low points shall be provided with drains. Provision of drains on steam piping shall be as per ASME code TDP-1. Drain lines shall be adequately sized so as to clear condensate in the line and prevent water hammer and damage to turbine due to water induction. All piping shall be sloped towards the system low point such that slope is maintained in both hot and cold condition.

(b) All drain and vent lines in piping system with design pressure 40 Kg/cm^2 (g) and above or with vacuum service shall be double valved.

(c) The piping routing shall be such that clear headroom of not less than 2.5M above the walkways /working area is available. The contractor shall ensure correct orientation of and easy access to valves and instruments etc. and sufficient clearance for removal and maintenance of the same. The piping shall not encroach on withdrawal space of various equipment and walking space.

(d) Wherever there is possibility of ingress of rain water through floor /ceiling opening at points where any pipe passes through floor /ceiling suitable weather protection hood shall be provided.

26.6.5 STRESS ANALYSIS

(a) Flexibility and stress analysis for various piping system shall be carried out by the contractor as per the requirement of ASMR B31.1 analysis results shall satisfy the following.

(i) Calculated stresses in the piping shall be within the allowable limits stipulated in ASMR B 31.1 as well as in IBR for piping under the purview of IBR.

(ii) Calculated forces and moments on equipment nozzles/TP are not more than the allowable loading provided by respective equipment manufacturer(s) / contractors. Flexibility analysis also calculates the deflections in all directions (translational and rotational) to enable design and selection of hanger/support system.

Besides the flexibility analysis, steam hammer analysis/ dynamic analysis shall also to be performed wherever required to study the effects of fast closure of steam admission valves and safety valve blowing. Requirements of additional restraints/ snubbers to take care of these effects shall be established, and such restraints/ snubbers shall be provided. The effects of seismic and wind loads and adequate support to take care of the same shall be provided.

(b) Cold pulling is not permitted. The contractor shall so design the piping system that there will be no requirement of cold pulls for meeting allowable reaction/stress values.

26.6.6 HANGERS AND SUPPORTS

26.6.6.1 All hangers and supports shall be so erected that they are preferably vertical when the piping is in hot condition (rated parameters). However, in piping system connected to the turbine/turbine valve nozzles it may be required to erect the hangers/supports vertical in the cold condition or as per the recommendation of TG supplier to ensure that there is no transfer of undesired pipe weight/ load on the turbine valves/nozzles.

26.6.6.2 All the hangers/supports shall be of reputed make, approved/tested quality and shall have proven performance record for similar application. They shall be designed to provide the required supporting efforts and allow pipeline movement with thermal changes without causing overstress. The design shall also prevent complete release of the piping load in the event of spring failure or misalignment and all parts of supporting equipment shall be fabricated and assembled so that they will not be disengaged due to movement of the supported piping.

Necessary guides, anchors, braces and structural steel to be attached to building/boiler structure as well as any braces and/or dampeners required to eliminate piping vibration and seismic loading shall be provided.

26.6.6.3 The design of the pipe supports and hangers and their locations shall be guided by the following general principles:

(a) Criteria of loading.

(b) Design loads for anchors, restraints, hanger supporting structures.

(c) Supports shall be adequate for extra loading due to hydrostatic tests and when piping system is full of water during chemical cleaning.

(d) Supports for relief valve stacks shall be adequate for both the pipe weight and the thrust developed when the valve is open.

Besides vibration elimination, hangers shall ensure that the amplitude of oscillations in the pipe work owing to shock and vibration due to variation of fluid flow from zero to full capacity remains within approved limits.

All pipes hangers and supports shall be designed to carry the weight of the piping, fitting, thermal insulation, self-weight of the hanger assembly and medium transported or test medium whichever is heavier. In addition, all rigid rod hangers and variable spring shall be designed to carry the operation load in hot condition.

Design and Manufacture of hangers and supports shall conform to ANSI B 31.1, MSS-SP-58, MSS-SP-89.

26.6.7 THERMAL INSULATION

(a) Thermal insulation shall be provided mainly for the following reasons.

(1) Conservation of heat and maintenance of temperature as per design cycle.
(2) Personal protection.

(b) Design for personal protection

For the piping and the equipment with surface operating temperature of 60°C and above the personal protection insulated shall be applied such that the temperature of protective cladding shall be below 60^0 C

(c) The contractor shall prepare an insulation thickness schedule covering both the cases of heat conservation and personnel protection based on the following design data.

Design ambient temperature	40^0 C for inside and 45^0 C for out side the main plant building.
Maximum cladding temperature	60^0 C
Wind speed	0.5m/sec. for inside and

	0.25m/sec. outside the main plant building.
Emissivity of cladding	0.2
Pipe/equipment wall temp.	Maximum operating temperature.
Thickness calculation	As per ASTM C-680 or equivalent

The minimum acceptable insulation thickness:

75 mm for Boiler & TG
70 mm for ESP surfaces
25 mm for other surfaces

The insulation thickness to be provided shall be calculated as per ASTM C-680 or BS- EN-ISO 12241 subject to minimum thickness values as mentioned above.

The material and application of insulation material, protective cladding, wire mesh etc. shall conform to the latest edition of the following standards/ codes: IS Code Table:

(i)	IS 280	Mild steel wires for general engineering purposes
(ii)	IS 3144	Methods of test for mineral wool insulation materials
(iii)	IS 3677	Unbounded rock and slag wool for thermal insulation
(iv)	IS 5696	Loose mineral wool
(v)	IS 8183	Lightly bonded mineral wool for thermal insulation
(vi)	IS 9428	Pre-formed calcium silicate insulation
(vii)	IS 9742	Sprayed mineral wool thermal insulation
(viii)	IS 9842	Preformed fibrous pipe insulation
(ix)	IS 4164	Code of practice for thermal insulation on cold surfaces
(x)	IS 15402	Ceramic fibre blanket insulation
(xi)	IS 737	Wrought aluminum and aluminum alloy sheet and strip for general engineering purposes
(xii)	ASTM C 892	Standard specification for high-temperature fiber blanket thermal insulation
(xiii)	ASTM B 209	Standard specification for aluminum and aluminum- alloy sheet and plate.

26.6.8 FLASH TANKS

(a) The flash tanks shall be adequately sized to take care of the total drains in the complete power cycle piping system. There shall be sufficient margin to accommodate the possible carination in drains quantities as well as flash steam. Flash tanks shall be designed as per the requirement of ASME boiler and Pressure vessels (B&PV) codes, & ANSI standard. The contractor shall submit the design calculation for Owner's review.

(b) However the minimum design pressure and temperature for the flash tanks shall be 3.5 Kg/cm2 (g) and 210^0C respectively. Flash tanks shall also be designed for full vacuum condition.

(c) Corrosion allowance of 3.0 mm shall be added to the design thickness of the shell and head of the vessels. The minimum thickness of the vessels including corrosion allowance shall not be less than 8 mm.

(d) The flash tanks and manifolds shall be designed to take care of the impact forces due to incoming drains.

(e) In case the spray is in manifold, the material for the flash tank manifold shall conform to ASTM A335 Gr. P22 or better and its thickness shall not be less than SCH 100 of ANSI B36.10 irrespective of temperature of the fluid handled

(f) The temperature in the flash tanks shall be maintained by using condensate /feed water spray, as the case may be and in whichever case applicable. The spray shall be automatically controlled. However for flash tanks open to atmosphere continuous spray through an orifice shall also be acceptable.

26.6.9 SPECIFIC REQUIREMENTS – PIPES & FITTING

Manufacturing tolerances on pipe diameter (both ID & OD controlled pipes) and thickness shall be as per ASTM-A530/ A999M, as applicable.

Bend thinning allowance shall be provided for all bends as per the recommendations of ASME B 31.1. The finished bends wall thickness at any point of the bend shall not be less than the calculated minimum straight wall pipe thickness.

Steel pipes & fittings shall in general be provided with butt welding ends as per ANSI B 16.25. Pipe fittings of size 50 NB & below shall be socket welded as per ANSI B 16.11. However in certain cases the preparations of welding end for the pipe may be required to be done to match equipment terminals, valves etc.

All stubs welded to the pipe including welded thermo wells and instrument source shall be installed on the pipe prior to stress relieving.

Instrument tubing up to and including the root valves and all drains & vents shall be generally of the same pipe material as that of the main pipe in which they are located unless & until specified otherwise elsewhere.

Maximum carbon content for ASTM A 106 Gr. B or A- 105 shall be limited to 0.30% and for ASTM A 106 Gr. C, it shall be limited to 0.35%.

Wherever mitered bends are used the thickness of pipe from which they are fabricated shall conform to the requirements of regulations 361 (C) of IBR. The angle between axes of adjoining pipe sections shall not exceed 22.5^0 C.

Non destructive examinations for butt weld of NPS over 50 mm and for welded branch connections of branch size over 100 mm NPS shall be specified elsewhere. For smaller sizes the mandatory minimum requirements shall be as per Table 136.4 of ANSI B 31.1 for non IBR piping as per regulation 360 of IBR or table 136.4 of ANSI B 31.1, whichever is more stringent, for piping under the purview of IBR.

All drains and vent lines in piping system with design pressure 40 kg/cm^2 and above shall have two valves in series.

Where welded pipe and fittings are used the longitudinal weld seams of adjoining sections shall be staggered by 90^0.

Piping system fabrication shall be in accordance with the requirement of ANSI B 31.1. However for system under purview of IBR, the requirements of IBR shall also be complied with

26.6.10 SPECIFIC REQUIREMENTS – VALVES & SPECIALTIES

For all globe and check valves, the direction of flow shall be clearly stamped on the body of the valve.

All globe valves shall be capable of being closed against the design pressure.

Where globe valves have been specified for regulation purpose, the disc shall be tapered plug type and suitable for controlling throughout its lift.

All gate and globe valves shall have bonnet back seating arrangement.

Check valves shall have full floating and accurately guided discs.

All gate, globe & check valves shall be designed for reconditioning seating surfaces and replacement of stem and disc without removing the valve body from the line.

Hand wheels for all the valves shall close the valve in clockwise direction when viewing from the top. All hand wheels shall be clearly marked indicating the direction of opening/ closing.

Manual gear operators shall be provided to open/ close the valve against the maximum differential pressure across the valve such that the effort required to operate the valve does not exceed 25 Kgf.

Valves 65 NB & above with rising stem shall be provided with position indicator/ visual indication either through plastic stem covers or through metallic stem covers. All gate and globe valves of size 50 NB and below in vacuum service shall have extra deep gland packing without requiring water gland sealing. All gate & globe valves of size 65 NB & above in vacuum services shall have adequately deep gland packing and shall be equipped with lantern rings to admit pressurized water for gland sealing.

Where floors and extension spindle arrangement is required for valves, the height of floor stand shall be about one meter from the floor/ platform. The floor stand shall be sturdy condition and tied with column, nut plate and hand wheel made of cast iron conforming to ASTM-A-126 Grade B. Suitable thrust bearing shall be provided/ between the hand wheel and floor stand. The connection of the extension spindle to the valve stem shall be through a flexible coupling and shall be designed to permit valve thermal movements. Necessary nuts, bolts etc. For mounting the floor stand platform shall be provided.

All valves shall be full port and shall meet the requirements of ASME B 16.34. The class of the valves shall be compatible to the service requirements. All materials that are bent, forged or formed shall be subject to heat treatment

after the forming operations as required by the original material specification. For alloy steel materials the preferred heat treatment process is full annealing.

Valves of size 65 NB and above shall have butt welded ends as per ANSI B16.25 and valves 50 NB and below shall have socket weld ends as per ANSI B16.11. Rubber lined valves shall have flanged ends as per ANSI B16.5.

Minimum differential hardness between seat and other disc material shall be 50 HB in case of 13% chrome hardened with heat treatment of steel.

26.6.11 INTEGRAL BYPASS VALVES

The requirement of integral bypass valves shown in flow diagrams is the minimum required. The final requirement shall be worked out as per the process requirement during detailed engineering.

If integral bypass valve selected is of size 50 NB & below, then the gate or globe type of forged construction with socket weld end as per ANSI B 16.11 shall be provided. For integral bypass valves of size 65 mm and above only cast steel gate valves with butt weld ends as per ANSI B 16.25 shall be provided.

Bypass pipe shall be of seamless construction and thickness corresponding to minimum of schedule 80 and shall be of same material class as the main pipe.

Integral bypass shall be motor operated if main valve is motor operated.

26.6.12 SPECIFIC REQUIREMENTS: FABRICATION

26.6.12.1 Piping system fabrication shall be in accordance with the requirement of ANSI B 31.1 however for system under purview of IBR, the requirements of IBR, shall also be complied with. All dissimilar material piping connection shall be subjected to the acceptance and approval of the Owner. Complete document shall be submitted by the contractor in addition to the fulfillment of IBR requirement.

26.6.12.2 Where welded pipes and fittings are used the longitudinal weld seams of adjoining sections shall be staggered by 90 deg.

26.6.12.3 Access holes for radiography at shop for piping requiring 100 % radiography shall be provided only if the area to be radio graphed is not accessible from pipe ends. Access holes for field radiography shall be provided.

26.6.12.4 Except where otherwise specified, all piping shall have butt-welded connections with a minimum of flanged joints, if necessary. All high pressure steam valves and accessories shall have welded connections. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

26.6.12.5 Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. All welded branches shall be reinforced where needed as per the applicable codes/regulations.

26.6.12.6 Unless otherwise specified, for all welded lines with pressure above 7 kg/ cm^2 (g) and/or temperature above 200^0 C, branch connections for branch sizes upto 25% of welded mains shall be made with special forged steel welded fittings.

26.6.12.7 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

26.6.12.8 All workmanship shall be carried out using methods and procedures of best recognized pipe fabrication practice and must be done in a good and workman like manner in accordance with ANSI standards, ASME Codes, PFI standards and IBR as applicable.

26.6.12.9 All high-pressure steam valves and accessories shall have welded connections.

26.6.12.10 Miter bends and elbows will not be accepted unless otherwise specified. Only forged tees, 90^0 elbows and 45^0 elbows are acceptable. In case the Bidder wants to deviate from this requirement on the ground of non-availability of such forged items, he may submit his alternative offer for Owner's consideration with sufficient documents to justify the same. In such a case, the concerned fittings shall be manufactured with necessary reinforcing pads, bend thinning allowance etc to satisfy code requirements.

26.6.12.11 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations.

26.6.12.12 A cross section through any bend portion of the pipe shall be true in diameter. All pipe bends shall have a radius of not less than 3 times the nominal pipe size unless otherwise mentioned. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per ANSI B 31.1. The ends of pipe and welded fittings shall be bevelled according to details shown in the relevant piping codes.

26.6.12.13 For bends in pipes, straight piece of pipes shall be bent to required bend radius. However, forged bends (Bend radius = 1.5 x pipe diameter) wherever required provided at no extra cost.

26.6.12.14 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

26.6.12.15 Pipes of size 50 NB and above shall be shop fabricated and of size 40 NB and below shall be field run.

26.6.12.16 All welding shall be made in such a manner that complete fusion and penetration are obtained without any excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

26.6.12.17 Pipe and attachments shall be properly aligned prior to welding. If tack welds are used, the tacks shall be either fused into the first layer of weld or else chipped out.

26.6.12.18 All welding for steam and feed pipe work shall be electrical welding using the shielded arc process and electrodes in accordance with the relevant code. For pipes up to and including 100 NB, provided the pipe does not exceed 12.7 mm in thickness, gas welded butt joints will be accepted without backing rings.

26.6.12.19 Welded joints in pipe work shall be pre-heated to a temperature as required by the agreed standard or code or to the approval of the Engineer. The temperature shall be maintained during the welding operation and a record of metal temperature shall be obtained by means of a recording thermometer throughout the welding operation.

26.6.12.20 All welds shall be built-up by the application of multiple layers or passes. The thickness of metal applied for each layer or pass shall not exceed 3 mm. Each layer shall be cleaned and lightly peeled before the next layer is applied. Before being assigned to welding work, each operator shall have passed a qualification test as prescribed in the applicable Code/ Regulations. Each approved welder shall have an identification number which shall be indicated on all welds.

26.6.12.21 Welded joints shall be stress relieved as per ANSI B31.1/IBR. Stress relieving temperature shall be measured by thermocouple pyrometers or other suitable equipment. Readings of temperature against time shall be recorded.

26.6.13 BENDS AND ELBOWS

(a) Elbows shall be generally of long radius type.

(b) Bends for piping 65mm NB and above shall be made hot and for piping 50mm NB and smaller may be made cold.

(c) Bends shall be made in accordance with PFI-ES-24. Bends shall be supplied with the minimum tangents exect where the piping layout necessitates shorter lengths in which case the tangents shall be suitably reduced after the bending operation to suit the requirements of the piping layout.

(d) Heat treatment of bends shall be done as per material specification.

(e) Where examinations of bends indicates that wall thinning has resulted in thickness less than the minimum specified, repair by weld deposition shall be allowed only where the length of the affected area is 150mm or less as measured along the outside arc of the bend. Repairs in excess of this amount shall not be allowed. All repairs shall be carried out only after approval of the Owner.

(f) Circumferential butt weld shall not be used in the area of the bend. Longitudinal welds, where bends are formed from welded pipe shall be located on the bend's neutral axis.

(g) Bend thinning allowance on straight pipe prior to bending shall be applied as per ANSI B 31.1. For bends of 5D or higher radius, the difference between maximum and minimum diameters shall not exceed 8 percent of average measured outside diameter of the pipe before bending.

(h) All bends in 50 NB and larger piping shall be made hot. Bends in 40 NB and smaller piping may be made cold only when commercially available bending shoes are used. Finished bends shall be smooth in contour and free from buckles and distortion.

(i) Pipe bends may be fabricated by the incremental induction heating process. Circumferential butt welds or longitudinal welds (where seamless piping has been specified) shall not be used in the arc of the pipe bends, without Engineer's permission. After bending, such welds, where permitted, shall be re-examined and re-inspected.

(j) All piping bends shall be subjected to heat treatment as required by the original material specification unless otherwise approved by the Engineer.

(k) All pipe bends in 50 NB and larger piping shall be examined ultrasonically after fabrication for wall thickness conformance. Measurements shall be taken in accordance with PFI Standard ES-20 using the "Pulse Echo" method. Data reports containing information as recommended in PFI Standard ES-20 shall be forwarded to the Engineer for record purposes.

(l) Where examination of pipe bends indicates that wall thinning has resulted in less than code required minimum wall thickness repair by weld deposit shall be allowed only where the affected area is 150 mm or less as measured along the outside arc and with Engineer's approval. Repairs in excess of this amount shall not be permitted.

26.6.14 End Preparation, Cutting etc.

26.6.14.1 For steel pipes, end preparation for butt-welding shall be done by machining/flame cutting.

26.6.14.2 Socket weld end preparation shall be saw/machine cut

26.6.14.3 For tees, laterals and other irregularities details, cutting template shall be used for accurate cutting and cutting shall follow the outline of the template.

26.6.14.4 Alignment Considerations

- The pipes joined by welding shall be aligned correctly within the existing tolerances on diameter, wall thickness and out of roundness, which shall be preserved during welding.

- All flange facings shall be true and perpendicular to the axis of the pipe with bolt-holes being off centre.

26.6.14.5 Branch connections shall conform to the requirements of ASME B 31.1. All branch connection welds shall be full penetration welds, except as permitted by ASME B 31.1/IBR. The branch connections shall generally conform to the following:

- Socket welding and threaded connections on pipelines shall be made by forged outlet fittings. The holes in pipe headers made for these connections shall be drilled to the same size as the fitting inside diameter. All burrs shall be removed and threaded fitting shall be repeated after welding.

- For branch connection, additional reinforcements shall be provided wherever necessary by the applicable codes including supply of necessary material by the contractor at his own cost.

- The design and fabrication details for the instrument stub connection are included in Tenderer's scope. Materials for instrument connection shall be the same as that of the pipe to which it is attached. Fittings ratings shall be in accordance with those specified for the main process pipe.

26.6.14.6 All materials that are bent, forged or informed shall be subjected to heat treatment after the forming operations as required by the original material specification. For alloy steel materials the preferred heat treatment process is full annealing.

26.6.15 SPECIFIC REQUIREMENTS: WELDING

In addition to the requirements spelt out elsewhere, the followings shall be taken into consideration:

26.6.15.1 Welding Process

(a) Welding under this specification shall be done by one of the following processes:

- Manual oxy-acetylene welding process
- Manual shielded metal arc process (SMAW)
- Manual inert gas tungsten arc process (TIG)

(b) Automatic or semi-automatic welding shall be done only with the specific approval of the Owner/Consultant.

(c) Socket weld joint shall be done with low hydrogen type covered electrodes with manual shielded metal arc process.

(d) Welding at any joint should be completed uninterrupted. If this procedure cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

(e) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

(f) As a rule no backing ring shall be used for circumferential butt welds.

26.6.15.2 Alignment and Spacing

(a) Components to be welded shall be aligned and spaced. Root opening shall be as under:

(i)	For wall thickness 2.5 mm or under and for all thickness in oxy-acetylene welding	1.0 mm - 2.0 mm
(ii)	For wall thickness over 2.4 mm	2.0 mm - 3.0 mm

Special care shall be taken for fitting and alignment in case of inert gas tungsten arc welding. Flame heating for adjustment of ends is not permitted without the approval of the Owner/Consultant.

(b) A wire spacer of proper diameter may be used for the weld root opening but must be removed after tack welding and before application in root pass.

(c) Tack welding for the alignment of pipe joints shall be executed carefully and shall be free from defects since tack welds form a part of final welding. Defective welds shall be removed prior to the welding of joints. Electrode size for tack welding shall be selected depending upon the root opening.

(d) Tacks should be equally spaced as follows:

(i)	For 65 NB pipe and smaller	2 tacks
(ii)	For 80 NB to 300 NB pipe	4 tacks
(iii)	For 350 NB and larger pipes	6 tacks

26.6.15.3 Welding Technique

(a) Root pass shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

(b) Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxy-acetylene welding is recommended.

26.6.17 CLEANING AND PROTECTION

(a) All fabricated piping shall be cleaned as per relevant SSPC cleaning technique/practice such that both inside and outside surface of the piping are free of sand, loosely adhering scale, dirt and other foreign matters.

(b) After cleaning outside surface shall be coated with enamel or other protective paint, the weld end preparation shall be coated with deoxyaluminate paint and protected adequately. Use of grease or oil. Other than light grade mineral oil is not allowed.

(c) After desiccating and preservation, the fabricated sections shall be covered, boxed, capped, or others shielded from further contamination or corrosion.

26.6.18 MARKING

26.6.18.1 All piping shall be marked clearly and legibly at the shop with its identifying pipeline description and piece no. as per the appropriate component or spool piece fabrication drawing.

26.6.18.2 Marking shall be by any method which does not produce sharp discontinuities and the marking does not get erased until the piping is erected. Piping 6 mm and thicker may be marked by stamping using round nose or dot interrupted die stamps with minimum nose radius of 0.8mm.

26.6.18.3 Item too small to be marked shall have metal tags securely attached to each bundle or container of such items such that it does not get erased until the item has been erected.

26. 6.19 SPECIFIC REQUIREMENTS- ERECTION

26.6.19.1 Where control valves, flow nozzles, orifices and other piping appurtenances are to be installed, they shall be installed only after steam blowing and chemical cleaning operation. After the completion of the steam blowing / chemical cleaning the contractor shall cut spool pieces of required length and install the components.

26.6.19.2 Field run piping shall be erected only after completion of the erection of all other piping system structures and equipment unless otherwise approved/directed by the Owner.

26.6.19.3 When C clamps are tack welded to the pipe for the purpose for the alignments of a joint, preheating for the tack welding shall be performed. If a main joint is adjacent to this weld, it shall be preheated as per the requirement of this specification. Otherwise preheating for the tack weld may be omitted after the joint is completed, all tack weld shall be removes, flushed with the adjacent of pipe by chipping and /or grinding. The areas where C clamps were attached shall be subjects to stress reliving as required.

26.6.19.4 The hydrostatic testing of the piping system shall be done after proper installation of all permanent hangers/supports. Springs hangers shall be locked during hydrostatic test. Prior to steam blowing all hangers which had been locked for the hydrostatic testing shall be unlocked.

26.6.19.5 The setting and logging of all supports, restraints/limit stop, spring hangers, etc, is the responsibility of the contractor. The initial setting on all hangers and supports and clearance on restrains and limit stops shall correspond to the design cold values. The contractor shall check all readings after completion of erection of piping system and application of insulation and carry out readjustment as necessary to be in line with the design cold values. After satisfactory setting of all hangers/restraints. Hangers reading / clearance shall be logged by the contractor in proper format and a joint protocol be made.

26.6.19.6 The contractor shall monitor the behavior of all hangers, supports, restrains etc. during the initial stage of plant operation. When the piping system(s) have attained their rated temperature the contractor shall log, hanger reading, snubber deflection, restrains/limits stop clearances as specified elsewhere.

26.6.19.7 All gaskets shall be asbestos free material and suitable for the service application.

26.6.20 SPECIFICATION FOR POWER CYCLE PIPING

S. No.	Description	Alloy Steel	Carbon Steel
A	**PIPES**		
	Material	X20 Cr Mo V 121 to DIN 17175 or ASTM A335 Gr P91 (For all temp above 510 deg C) ASTM A 335 Gr P22	ASTM A 106 Gr B/ ASTM 106 Gr C (A 106 Gr C for BFD design parameters, CRH design parameters & above) ASTM A 672 Gr B 60 CLASS-12/ 22
	Construction	Seamless	Seamless
B	**FITTINGS**		
	Material for 65 NB & Above	X20 Cr Mo V 121 to DIN 17175 or ASTM A 234 Gr WP91 (for temp above 510 Deg C) ASTM A 234 Gr WP 22	ASTM A 234 Gr WPB with A 106 gr B piping
	Material for 50 NB & Below	ASTM A 182 Gr F 91 (For all temp above 510 deg C) ASTM A 182 Gr F 22	ASTM A 105
	Construction	Seamless (forged for 50 NB & below)	Seamless (forged for 50 NB & below)
	Basic Standards	ANSI B 16.9 ANSI B 16.11 ANSI B 16.25 ANSI B 16.28	ANSI B 16.9 ANSI B 16.11 ANSI B 16.25 ANSI B 16.28
	Rating/wall/ thickness	To match with that of pipe	To match with that of pipe
C	**WELDING**		
	Backing rings	Not permitted	Not permitted
D	**MATERIAL ANALYSIS**		
	MANDATORY REQUIRMENTS	All tests, as given in respective material code (other than supplementary requirements).Shall be carried out as minimum. This includes the tests wherein it is specified in the respective material code that "the test is to carried out when specified by the purchaser" or any such indication, in the code.	
E	**HYDROSTATIC TEST PRESSURE**		
	Piping system under IBR purview	At shop	All piping including fabricated piping shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However, non-destructive testing in lieu of hydro test is also acceptable subject to regulation 343 (3)of IBR
	Piping system under IBR purview	After erection	All piping system shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However for such systems where it is practically not possible to do hydro tests. The test as called for in ANSI B 31.1 & IBR in lieu of hydro test shall also be acceptable.
	Piping system under IBR purview	Hydro test of boiler feed piping:	since isolating valve is not provided at economizer inlet, contractor to make all necessary arrangement of hydro testing of BFD piping beyond HP heater downstream

			heating isolating valve upto TP either by blanking or providing a temporary valve. NDT as per the provision of IBR & ASME B 31.1 can be carried out for the joint at TP between SG & TG contractor.
	Non- IBR piping system	At shop	All piping including fabricated piping shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However, non-destructive testing in lieu of hydro test is also acceptable subject to regulation 343 (3)of IBR
	Non- IBR piping system	After erection	All piping system shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However for such systems where it is practically not possible to do hydro tests. The test as called for in ANSI B 31.1 & IBR in lieu of hydro test shall also be acceptable.

Note

1. EFW pipes as per A 672 are acceptable if the design pressure and design temperature are such that it calls for ASME 300 class & below piping and size is 550NB and above. The fitting shall correspond to ASTM A 234 with grade corresponding to the pipe. Material. Welded construction fitting are also acceptable with A672 piping. However all requirements as per ASME B31.1 including the requirements given in mandatory appendix-D, IBR & respective material code shall be fully complied with, in respect of welded firings
2. EFW pipes as per A 672 are acceptable if the design pressure and design temperature are such that it calls for ASME 300 class & below piping and size is 550NB and above. The fitting shall correspond to ASTM A 234 with grade corresponding to the pipe. Material. Welded construction fitting are also acceptable with A672 piping. However all requirements as per ASME B31.1 including the requirements given in mandatory appendix-D, IBR & respective material code shall be fully complied with, in respect of welded firings
3. Material X20 or P91 is applicable for Main Steam and HP Bypass line up to HPBP valve. However, for pipes sizes 150 NB & below in these piping systems, A335 P22 shall also be acceptable.
4. Material P22 or P91 are applicable for Hot Reheat, and LP bypass.
5. In case design temperature is above 5500 C and up to 6050 C, then P91 or equivalent material only shall be applicable (for 1 & 2 above).
6. EFW pipes as per ASTM A 691 2-1/4 Cr. Class 22 are acceptable for alloy steel piping of size 550 NB & above if the design pressure and design temperature are such that it calls for ASME 300 class or below.
7. EFW Pipes as per A 672 Gr. B60, Class 12/22 are acceptable for carbon steel piping of size 550 NB & above if the design pressure and design temperature are such that it calls for ASME 150 class or below.
8. The fittings for ASTM A672 piping shall correspond to ASTM A 234 with Grade corresponding to the pipe material. Welded construction fittings are also acceptable with A672 piping. However, all requirements as per ASME B31.1 including the requirements given in mandatory appendix-D, IBR & respective material code shall be fully complied with, in respect of welded fittings.
9. Pipe material for CRH piping from HPT exhaust nozzle up to CRH NRV shall be alloy steel to ASTM A335 Gr.P22/ Gr.P11. Fittings shall also be corresponding to ASTM A 234 Gr. WP22/ Gr.WP11.
10. Pipe material for HP Bypass and LP Bypass downstream piping up to the mixing length as per recommendation of valve manufacturer shall be of Alloy steel to ASTM A335 P11/ P22. Fittings shall also be corresponding to ASTM A 234 Gr. WP11/ WP22. Standard Technical Features of BTG System for Supercritical 660/800 MW Thermal Units.
11. Material P-22 is applicable for piping with temperature > 5100 C and up to 5500 C and P11 is applicable for all other alloy steel piping below 5100 C.
12. Materials for fittings, specialties and valves shall be corresponding to piping material or equivalent.

26.6.21 SPECIFICATION FOR POWER CYCLE VALVES

26.6.21.1 General Requirements

All the control station configuration shall be as follows.

(a) For Continuous Service requirement:

(i) One (1) pneumatically/hydraulically operated control valve.

(ii) One (1) motor operated isolation valve at the upstream side of control valve.

(iii) One (1) manual operated isolation valve at the downstream side of the control valve.

(iv) One (1) pneumatically/hydraulically operated bypass control valve.

(v) One (1) motor operated isolation valve at the upstream side of the bypass control valve.

(vi) One (1) manual operated isolation valve at the downstream side of the bypass control valve.

(vii) Non return valve in the common downstream line, for spray piping.

(viii) Drain valves at upstream and downstream of the control valves.

(b) For Intermittent Service requirement:

(i) One (1) pneumatically/hydraulically operated control valve.

(ii) One (1) motor operated isolation valve at the upstream side of control valve.

(iii) One (1) manual operated isolation valve at the downstream side of the control valve.

(iv) One (1) motor operated inching type regulating bypass valve.

(v) One (1) motor operated isolation valve at the upstream side of the bypass valve.

(vi) One (1) manual operated isolation valve at the downstream side of the bypass valve.

(vii) Non return valve in the common downstream line, for spray piping.

(viii) Drain valves at upstream and downstream of the control valves.

- All valves shall have cast/forged steel bodies with covers and glands of approved construction. The valves shall be provided with electric motors/ solenoids and actuators as required.
- Locating the valves on vertical runs shall be avoided as far as possible

- All valves shall, unless otherwise approved, have ends prepared for butt-welding and the internal diameter shall be the same as the internal diameter of the pipes to be joined.

- All valves shall receive tests at Manufacturer's or Contractor's works in accordance with the specific requirements of the approved Codes of Practice so that the same is acceptable to IBR where applicable. Valves shall be rising stem or otherwise as approved by the Owner.

- All valves shall function smoothly without sticking, rubbing or vibration on opening or closing.

- Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the codes as specified or approved equivalent and acceptable to IBR.

- By-pass valves shall be provided for high pressure and larger size valves (including control valves) as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.

- Valves subjected to vacuum shall have sufficient long deep-seated packing. Valves in general shall preferably be of such design as to permit repacking while in service by providing back seating arrangement duly tested during manufacture.

- All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.

- Valves requiring sealing water shall be adequately deep and shall be equipped with lantern ring to admit pressurised water for gland-sealing. Gland sealing water shall be tapped from one tapping point on the condensate extraction pumps discharge header and shall be reduced in pressure as per the requirement.

- The stops which limit the travel of any valve in the "Open" or "Shut" position shall be arranged exterior to the valve body.

- All regulating valves shall be designed to prevent erosion of the valve plugs and seats when the valves are operated partially opened. The valves shall have contoured plug.

- Approved access arrangements shall be provided for all valves and particular attention shall be given to those valves fitted with gearing, which require lubrication of the valve itself.

- Valves which cannot be operated from the floor or walkways shall be provided with suitable extension rods and linkages. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also. The extension shall be such that the hand wheel is at a height of approximately one metre above the level of the floor or platform from which the valve is to be operated. Where required, valves shall be provided with head-stocks and pedestals of rigid construction and where gears or level wheels are used, these shall be of cast steel or suitable quality cast iron with machine

cut teeth. Where extension spindles are fitted, all thrust when opening or closing the valves shall be taken directly on the valve body. The extension linkage shall be so designed to take care of the thermal movements of the valve body with the pipe on which the valve is installed. The connection of the extension spindle to the valve stem shall be through a flexible coupling.

- The extension spindle shall be of the same material as that of the valve stem. The floor stands shall have column, not less than Group-B of ASTM-126. Necessary nuts and bolts for mounting the floor stands on foundation shall have to be provided. Adequate means of easy lubrication shall have to be provided for valves and operating extension components.

- Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.

- Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Contractor shall supply the first fill of oil or grease for these parts. The Contractor shall supply a suitable manually operated grease gun for the standard type of nipple provided.

- The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

- All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

- Plastic or bakelite valve hand wheels are not permitted.

- All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words `Open' and `Shut' with arrows adjacent to indicate the direction of rotation to which each refers.

- Each valve hand wheel shall be fitted with a circular nameplate of approved material indicating the valve tag number, duty or service intended and the function of the valve. The nameplates shall incorporate the colour code corresponding to the service of the piping.

- Wherever practicable, heavy valves of total weight including actuator, drive motor, integral by-pass etc equal to or greater than 500 kg shall be provided with suitable lugs to permit direct suspension by hanger rods or direct resting on bottom support, as applicable.

- Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

- The Bidder shall supply during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure /temperatures. They should include a parts list referring to the various materials used in the valve construction.

- Gate valves below 100 NB shall be solid wedge/Flexible wedge type. Valves of 150/300 and size 100 NB and above shall be flexible wedge type. However, for sizes 100 NB and above for temperature 300oC above, parallel slide gate valves shall be used.

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

- For butterfly valves, Contractor shall guarantee that in the closed position and with a disc differential pressure as specified, the valves shall be water tight.
- Contractor shall guarantee that the operating mechanism shall open and close the valve under the specified maximum differential pressure within the time specified.

A. CAST STEEL VALVES (GATE/ GLOBE/ CHECK 65 NB & Above)

S. No.	Description	Alloy Steel		Carbon Steel		Stainless Steel
		600 lbs & below	600 lbs & above	600 lbs & below	600 lbs & above	400 lbs & below
1.0	Basic Standard	ANSI B 16.34				
2.0	Construction					
a	Bonnet/ cover	Bolted Type	Pressure Type	Bolted Type	Pressure Type	Bolted Type
b	Disc					
	Globe Valves	Throttling Type Plug				
	Check Valves	Twilting/ swing type				
	Gate Valves	Solid/ flexible wedge below 100 NB				
		Flexible Wedge for 100 NB & above				
c	Seat	Integral Type				
3.0	Material					
a	Body, Bonnet & Cover	ASTM 216 Gr WCB	ASTM 216 Gr WCC	ASTM A 217 WC9 ASTM A 217 Gr C 12A		ASTM A 351 CF 8
b	Stem	13% Chrome Steel ASTM A 182 Gr F6A				ASTM 182 F316/ F 304
c	Hinge Pin (for check valves)	13% Chrome Steel ASTM A 182 Gr F6A				ASTM 182 F316/ F 304
d	Disc & Seat ring (heat treated & hardened	ASTM A 216 Gr WCB minimum Hardness 250 BHN	ASTM A 216 Gr WCC	ASTM A 217 Gr WC9 ASTM A 217 Gr C12A		ASTM 182 F316/ F 304
			Seating surface hard faced with satellite 350 BHN			
e	Back seat/ stem guide bushing	ASTM A 182 gr F6a 13% Cr SS with stellite hard facing				ASTM 182 F316/ F 304

B. FORGED STEEL VALVES (GATE/ GLOBE/ CHECK 50 NB & Below)

S. No.	Description	Carbon Steel	Alloy Steel	Stainless Steel
1.0	Basic Standard	ANSI B 16.34		
2.0	Construction			
a	Bonnet/ cover	Bolted Type for 600/ 800 lbs Seal welded for 900 lbs & above		Seal Welded/ Bolted Type gor 600/ 800 lbs Seal welded for above 800 lbs
b	Disc			
	Gate Valves	Solid Wedge Type		
	Globe Valves	As per mfg std		
	Check Valves	Piston Lift		
c	Seat	Integral Type		
3.0	Material			
a	Body, Bonnet & Cover	ASTM A 105	ASTM A 182 Gr F22 ASTM A 182 Gr F91	ASTM 182 F316/ 304
b	Stem	13% Chrome Steel ASTM A 182 Gr F6A		ASTM 182 F316/ F 304
c	Hinge Pin (for check valves)	13% Chrome Steel ASTM A 182 Gr F6A		ASTM 182 F316/ F 304
d	Disc & Seat ring	ASTM A 105 with stellite minimum Hardness 350 BHN	ASTM A 182 Gr F22/ F 91 hard faced with satellite minimum hardness 350 BHN	ASTM 182 F316/ F 304 hard faced with satellite minimum hardness 350 BHN

C. ANGLE GLOBE VALVE

S. No.	Description	Alloy Steel	Carbon Steel
1.0	Design Standard	ASME B 16.34	
2.0	Material		
a	Body & Bonnet	A 182 Gr F22/ F 91 or better	A 105 or better
b	Spindle/ disc	Stellited	
c	Body Seat & Back Seat	Stellited	
d.	Gland Packing	Graphite	
3.0	Construction		
a	Valve Type	Outside Screw & yoke Type	
b	Body & Bonnet	Forged body with integral/ welded bonnet connection	
c	Disc type	Taper plug or parabolic type to suit system requirement	
d	End connection	Socket weld (ANSI B 16.11) for sizes 50 Nb & below Butt weld (ANSI B 16.25) for sizes 65 NB & above	
e	Pressure rating	To suit the service condition. However minimum pressure rating shall be corresponding to ANSI Class 1500	

D. OTHER VALVES (65 NB & Above)

S. No.	Description	Safety Valve		Relief Valve	BF Valve
		Alloy Steel	Carbon Steel		
1.0	Design Standard	ASME B 16.34			AWWA C 504
2.0	Pressure Class	400 lbs & below			75 B & above
3.0	Accumulation	10% (max)			
4.0	Blowdown	5% (max)		10% to 15%	
5.0	Construction				
a	General	Spring loaded with weld end inlet, pop up type		Spring loaded with flanged inlet & outlet	Long body butt welded
b	Bonnet	Bolted type			
c	Seat bushing	Renewable type screwed on and held in position type			
d	Shaft seat				O ring type
6.0	Material				
a	Body & Bonnet cover	ASTM A 217 WC 9/ C 12A	ASTM A 216 Gr WCB/ WCC		ASTM A 216 Gr WCB
b	Spindle/ Shaft	Stainless Steel			ASTM A 182 Gr 304
c	Disc, nozzle, seat ring	ASTM A 182 F 316			ASTM A 216 Gr WCB Seal & O Ring : EOT/ BUNA – N/ Neoprene for water service EOPT/ EPDM for steam service
d	Spindle Guide	17% Chrome steel or monel, heat treated and hardened to minimum hardness 250 BHN			
e	Spring	Stainless Steel or Tungsten Steel	Carbon Steel		
f	Retainer Rings and Internal Bolts				SS 304
g	Bearing				Sleeve type self lubricated

Note the material of body, bonnet/ cover & disc shall be corresponding to that of pipe material on which valve is installed.

26.6.22 SPECIFIC REQUIREMENTS

1. Valve of size 65 NB and above shall have butt welded ends as per ANSI B16.25 and valves 50 NB and below shall have socket weld ends as per ANSI B16.11

2. Locking arrangement, wherever specified shall be of non-detachable type.

3. Valve shall be tested in accordance to ANSI B 16.34, however, for butterfly valves; the requirements of AWWA C-504 shall also be met.

4. All gates and globe valves shall be without side screw and yoke with rising stem.

5. Gate valve below 100 NB shall be solid wedge/flexible wedge type, valve of size 100 NB and above shall be of flexible wedge type. However, for sized 100mm NB and above for temperature above 300 ^{0}C, parallel slide valves are also acceptable.

6. Specification for valve shall be as indicated in C&I subsection.

7. Stem for all valves shall be heat treated and hardened- minimum, hardness 200HB and surface finish of 16 RMS or better in area of stem packing.

8. Gland packing for gate and globe valves shall be alloy steel/SS wire reinforced graphite with stem corrosion inhibitor.

9. All bolts and nuts shall be ASTM A-193 Gr. B 7 and ASTM A-194 Gr. 2H respectively.

10. Hand wheel for valves shall be of malleable iron / carbon steel.

11. Minimum differential hardness between seat and other disc material shall be 50 HB in case of 13 % chrome hardened with heat treatment of steel.

12. Valves closure test shall be as per supplied complete with discharge elbow and drip pan along with drain.

13. For valve of size 65 NB and above in vacuum service, water gland-sealing arrangement shall be provided. For valve of size 50 NB and below, deep gland packing shall be provided. Butterfly valves, subjected to vacuum, shall be tested for vacuum as per relevant code.

26.6.23 SPECIFICATION FOR HANGERS/SUPPORTS

26.6.23.1 Design and manufacture of hangers/supports shall conform to ANSI B 31.1 MSS-SP-58, MSS-SP-89

26.6.23.2 Where hangers rod angularity exceed 4 degree from cold to hot position (at rated parameters), the hanger and structural attachments shall be offset in the cold position in such a manner that the hanger rod is vertical in hot position unless otherwise specified.

26.6.23.3 The contractor shall furnish, detailed arrangement sketches for each support, restrains, anchor, etc. the sketches shall include the key plan identification no.

bill of quantities, design load , operating load, spring stiffness, amount of precompression, centre line elevation of pipe, spring box position/orientation, etc.

26.6.23.4 Hangers support tag no. shall be marked on all pipe hangers/support, restraints and anchor assemblies, the design loads, hot and /or cold loads shall be stamped on respective constant and variable springs**.**

26.6.24 TECHNICAL REQUIRMENTS

(a) Each threaded connection and adjustable rod shall be provided with lock nuts.

(b) Each rod of a double rod hanger support shall be designed for the full hydro test load coming on the double rod hanger assembly.

(c) Hanger support rods of less than 10mm diameter for supporting pipes of 50 NB and smaller and less than 12mm diameter for supporting pipes of 65 mm NB and larger, shall not be used.

(d) Parts of the hanger or support which move relative to the pipes during operation shall be connected to the pipe attachments in such a manner that they lie entirely outside the pipe thermal insulation.

(e) Attachment to piping shall be as far as possible by clamps.

(f) Where axial movement is to be restricted or riser clamps are used, suitable lug stops to prevent pipe movement shall be designed for welding on to pipe.

(g) Bolted pipe clamps shall have a minimum thickness of 5mm for weather protected locations and 6 mm for locations exposed to weather.

(h) Beam clamps shall be forged steel equipment with a rod to fix a nut.

(i) All sliding surface of supports and restrains shall have Teflon lining on one surface coming in contact with stainless steel lining on the other surface.

(j) All piping hangers and supports shall be designed to carry the weight of the piping fitting, thermal insulation, self weight of the hanger assembly and medium transported or test medium whichever is heavier. In addition all rigid rod hangers and variable spring shall be designed to carry the operation load in hot condition.

(k) All design and fabrication including loading and allowable stresses shall be in accordance with ANSI B31.1. Note shall be taken of the requirements against earthquake at site. Hangers and supports for systems shall be completely engineered and prefabricated for all piping 50 NB and above. Sufficient random materials shall be furnished for field support of all lines of smaller diameter.

(l) For pipes of design temperature 100 dec C and more, bottom supports shall be avoided as far as possible and hanger type supports shall only be used. However, where bottom support cannot be avoided, the same shall be provided with suitable shoes along with balls/rollers/rockers (if movement is more than 50 mm) and SS/Graphite is to be used (if the

movement is more than 20 mm) to minimise frictional resistance against thermal movements. The material of shoe as well as the ball/rockers/rollers shall be suitable for the design temperature of the supported pipe and shall be of sufficient hardness so as to permit a reasonably long life keeping its roundness and maintaining a low friction factor. Where a constant load type support is required, the bottom support shall also be of constant load type.

(m) Provision shall be made for support of piping which may be disconnected during maintenance work.

(n) Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.

(o) Double nuts or lock-nuts shall be used on hanger rods and bolts in all cases.

(p) Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.

(q) Spring hangers should not be loaded more than 80% of the spring travel range.

(r) Both constant load and variable spring support/hanger shall be provided with outside indicators for deflection and load. Provision for the site adjustment of load at least $\pm$ 10% shall be incorporated. Also spring locking arrangement and turnbuckles of load/position adjustment shall be provided for all hangers.

(s) Constant load type spring support/hangers shall be so selected as to permit, for the specific load, an over-travel of at least 25 mm or 20% (whichever is greater) of the specified range of vertical travel. The initial setting of the hangers/supports shall be such that half of the "over-travel" is allowed in either direction. Constant support hangers shall have a support variation of not more than 6% throughout the total travel range.

(t) Rigid hangers & restraints shall be judiciously selected, without exceeding the stipulated limits of terminal forces & moments & stress level. Struts shall be considered where compressive load is expected.

(u) Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves (SV), hanger design shall include provision for shock absorbing devices of approved design.

(v) Vertical restraints near safety valves shall be preferred for taking SV discharge thrust, provided equipment terminal reactions remains within allowable limit.

(w) Attempts shall be made to avoid use of shock absorbers, dampers etc as far as possible to take care of occasional loading like seismic effect etc by proper engineering of the piping design and effective use of restraints. However, shock absorbers, VISCO- dampers, wherever felt necessary are to be supplied and erected by the bidder.

(x) Layout of piping shall be properly designed to avoid excessive vibration by effective use of restraints. However, wherever felt necessary, shock absorbers, VISCO- dampers may be employed.

(y) Hanger rods (except rigid hangers where both tension and compression may occur) shall be subjected to tensile loading only. At hanger locations where lateral movement is anticipated, suitable linkage and rocking washers shall be provided to permit swing.

(z) For all hangers, the length of suspension shall be so selected that the hanger rod may never make an angle of more than 40 with vertical due to horizontal pipe movements. If this cannot be avoided by erecting the hanger vertically for cold condition, it shall be suitably off set so that the above requirement is fulfilled in cold as well as hot conditions. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

(aa) Hanger support rods of less than 10 mm diameter for supporting pipes 40 NB and smaller and less than 13 mm diameter for supporting pipes of 50 NB and larger, shall not be used.

(ab) Supports, guides and anchors shall be so designed that excess heat will not be transmitted to the building steel.

(ac) Tie rods/struts shall preferably be used for restraints to achieve low friction restraining.

(ad) The Tie-rods/struts shall have proper arrangement and adequate length, so that, thermal movements in other directions, which are intended to be free are not constrained and there is no appreciable shift in centreline of pipe or the elevation of the supporting point on pipe due to sway. The design shall have provisions for adjusting the length to take up any slack and securely locking in position permanently once adjustment is done.

(ae) Snubbers & dampers shall be designed to take seismic/dynamic loads, thrust due to safety valve discharge. Effort shall be made to limit its use by judicious placement of rigid hangers.

(af) Bottom support spring hangers to be avoided as far as possible.

26.6.25 SPRING HANGERS

(a) Constant load hangers shall generally be used when vertical displacement exceeds 40 mm or where the supporting effort variation of available variable spring exceeds 25%.

(b) Constant load hanger shall be of moment coil spring counter balanced design or cam & spring type. Variable spring hangers shall be of helical spring design. Spring hanger/ assembly shall be constructed such that complete release of piping load is impossible in case of spring miss alignment or failure.

(c) Constant load hangers shall have a minimum field adjustment range of 15% of the load. The total travel for constant speed load hangers shall be design travel plus 20% but in no case shall be difference between total

travel and design travel be less than 15 mm. The supporting effort variation throughout the travel range of constant load hangers shall not exceed 6%.

(d) Variable spring hangers shall have supporting effort variation of not more than 25% throughout the total travel range.

(e) All springs shall remain under compression throughout their operating regime and never under tension.

(f) Spring hangers shall have provision of rlocking the hangers in any position of the travel.

(g) Spring hangers shall be adjusted to the cold position before shipment and locked in that position. The cold and hot position shall be clearly marked on the travel indicator scales.

(h) All spring hangers shall be locked before performing the hydro test. The locking shall be removed before the line is placed under operation.

26.6.26 SNUBBERS

(a) Snubbers shall be designed to allow normal movement of pipe due to thermal expansion and shall require minimum maintenance.

(b) Snubbers shall be of hydraulic type of Lisega/ ITT Girnell, Germany or owner approved eqvt.

(c) Axes of snubbers/ restraints shall be parallel to the direction of the expected reaction force in operating condition.

(d) Snubbers shall be designed to withstand twice the rated load without loss of structural integrity and shall be convenient means for determining rod extension.

26.6.27 RESTRAINTS & ANCHORS

(a) All anchors shall be designed for direct rigid fastening to the structural steel member.

(b) Anchors, guides and restraints shall be capable of withstanding the forces and moments due to thermal expansion and dynamic effects.

26.6.28 STEAM STRAPS & STRAINERS

(a) Steam traps shall be of inverted bucket/ thermostatic type with integral or separate Y type strainers.

(b) Traps shall have stainless steel internals.

(c) All Y type strainers shall have stainless steel screen of not more than 20 mesh size. Screen open area shall be at least four (4) times the pipe cross sectional area.

(d) Strainer shall have screwed blow off connection with removable plug.

(e) Y type strainers shall be provided along with each steam trap in case the strainer does not form an integral part of the trap.

26.6.29 SPECIFICATION FOR THERMAL INSULATION, INSULATION MATERIAL, CLADDING, & ACCESSORIES

(a) The insulating material and cladding material shall be as per the tables of material given in the subsequent clauses.

(b) All insulating materials, accessories and protective covering shall be non-sulphurous, incombustible, low chloride content, chemically rot proof, non-hygroscopic and shall be guaranteed to withstand continuously and without deterioration the maximum temperature to which they will be subjected under the specification conditions.

(c) The use of insulation of finishing materials containing asbestos in any form is not permitted.

(d) Insulation mattress/section shall be supplied in thickness of 25,40,50 and 75 mm. insulation of higher thickness shall be made up in multiple layer using mattress/slabs of thickness specified above. However; if the required thickness is not achieved, the mattress/slabs in increment of 5mm shall be acceptable. The min. & the innermost layer shall be thickest.

(e) Special fire protection measures shall be taken for the steam lines running in the immediate vicinity of oil lines. The sheet metal jacketing shall be made oil proof by inserting self-adhesive flexible tapes.

26.6.30 INSULATION MATERIALS

(a) Rock/glass insulation mattress shall be of long fibered rock or glass processed into fibrous form bonded with a binder. No kind of slag wool inclusion is acceptable.

(b) Calcium silicate pipe insulation shall be composed principally of hydrous calcium silicate reinforced with mineral fibre. It should be asbestos free.

(c) All insulation shall conform to the quality requirements laid down below and test certificates on samples from the lot to be supplied shall be furnished to Owner for approval.

(d) The thermal insulation for the turbine casing shall consist of sprayed insulation produced by projecting specially prepared mineral wool along with a fine liquid spray. This shall be covered with prefabricated 'blanket' type insulation. Voids around the blankets should be avoided. However, unavoidable voids shall be filled with loose mineral wool.

26.6.31 OTHER ACCESSORIES

The contractor shall also provide other accessories such as ceramic boards. Sealants and washers as required.

26.6.32 INSTALLATION

(a) All surface to be installed shall be cleaned of all foreign materials such as dirt, grease, rust etc, and shall be dry before the application of insulation.

(b) Before applying the insulation the contractor shall check that all instrument tapings, clamps, lugs and other connections on the surface to be insulated have been properly installed as per the relevant erection drawing.

(c) All flanged joints shall be insulated only after the final tightening and testing.

(d) The insulation shall be applied to all surfaces when they are eat ambient temp. ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied so as to avoid breaking/ telescoping due to alternate periods of expansion and contraction

(e) All cracks voids and depressions ahall be filled with finishing cement suitable for the equipment operating temp. so as to form a smooth base for the application of cladding.

26.6.33 INSULATION MATERIALS

	Type#1	Type#2	Type#3	Type#4	Type#5
Type	Lightly resin bonded mineral (rock wool)	Resin bonded mineral (rock) wool pre-formed pipe sections/ blocks	Calcium silicate pre-formed pipe sections/ blocks	Rockwool for spray insulation	ceramic fibre blankets/ blocks
Apparent density	100 Kg/m^3 for temp. 60-400^0 C and 150kg/m^3 for above 400^0 C	100-150 Kg/m^3	200-250 Kg/m^3	200-250 Kg/m^3	128 Kg/m^3
Material standard and testing code	IS: 8183	IS: 9842	IS: 9428	IS: 9742	IS: 15402
Applicable service	Piping system & equipment with operating temp. range of 60-650^0 C	Piping system of 350 NB and below with temp range of 60-400^0 C	Piping system & equipment with operating temp. range of 400- 650^0 C	Steam turbine & valves with operating temp. range of 400-650^0 C	Steam turbine, boiler surfaces & valves with operating temp. of 400- 650^0 C

26.6.34 CLADDING MATERIAL & ACCESSORIES SHALL BE AS SPECIFIED HERE UNDER:

S No.	Item	Basic specification	Description
1.	cladding	Aluminium ASTM B-209-1060 temper H14 or IS:737 Gr.19000/H2	Thickness of sheathing (a) 18SWG (1.219) for diameter for insulated surface 450mm and above and for flat surfaces. (b) 20 SWG (0.91mm) for diameter of insulated surface 150mm and above upto 450mm. (c) 22 SWG (0.71mm) for diameter of insulated surface 150mm and below. (d) For steam generator outer casing: 1.219 mm (18 SWG) ribbed Aluminium. (e) For ESP, 0.71 mm (22 SWG) ribbed Aluminium.
2.	Binding & lacing wire	Galvanized steel wire to IS: 280 for temp. below 400^0C and stainless steel to IS:6528 for temp above 400^0C	20 SAWG for all insulation interface temperature.
3.	Straps & brands	(i) Aluminium where interface temperatures are below 400^0 C (ii) Stainless steel where temperatures are above 400^0C	Band shall be 20 mm wide & 0.6 mm for securing aluminium sheathing anodized aluminium bends shall be used.
4.	screws	Stainless steel	Self tapping, chese headed
5.	Hexagonal wire mesh	(i) Galvanized wire to IS :280 mesh for interface temperature upto 400^0C (ii) Stainless steel wire for temperature above 400^0C	Wire mesh netting shall be 10 to 13mm aperture at least 0.71 mm diameter wire

26.6.35 INSTALLATION ON PIPING

(a) All vertical pipes shall be provided with the suitable insulation supports to prevent collapsing/ crushing of insulation due to its self weight. Support rings shall be provided on all vertical piping with a difference in elevation of 4 meter or above, and there shall not be more than 3 meter straight length between support ring.

(b) Longitudinal joints of insulation mattresses section of horizontal piping shall be on the bottom or at the sides of the pipe.

(c) When more than one layer of insulation mattress/section is required on piping the circumferential joints on adjacent layer shall be staggered by at least 150mm and longitudinal joints shall be fitted on pipe using binding wires.

(d) The mattress type insulation shall be formed to fit the pipe and applied with the mattress edges drawn together at the longitudinal joints and secured by lacing wire pipe section insulation shall be fitted on pipe using binding wires.

(e) The mattress type insulation is applied in two or more layers each layer of mattress shall be backed with hexagonal wire mesh. For the first layer of insulation and in case of single layer insulation, hexagonal wire mesh shall be provided on both the surface of the mattress. For pipe sections, the sections shall be held in place by binding wires without any wire mesh.

(f) The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of insulation. Any gap in the insulation shall be filled with loose mineral wool or finishing cement.

(g) Insulation mattress/section ends shall be terminated at a sufficient distance from the flanges to facilitate removal of bolts.

(h) The insulation shall be held in place by fastening over with binding wire for insulation surface with diameter upto and including 550mm and with metal bends for insulation surfaces with diameter over 550mm. the fastening shall be done at intervals of 250mm except where specified otherwise. The ends of the binding wire shall be hooked and embedded in the insulation the straps shall be mechanically starched and fastened with metallic clamping seals of the same materials as the strap.

(i) Insulation for the application on bends and elbows shall be cut Into mitred segments, sufficiently short to form a reasonably smooth internal surface. after the application of insulation material in place, insulating cement shall be applied as required to obtain a smooth surface.

(j) Weather hoods shall be provided for insulated piping passing though floors/walls.

(k) All pipe attachments coming on horizontal pipes, included pipes and bends shall be insulated along with pipe such that there will be no insulation applied to hanger rod and the component connecting hanger rod to pipe attachment. All pipe attachments exposed to weather shall be provided with weather proof.

(l) Upstream of all drain lines and the lines connected to steam traps, shall be insulated upto and including first isolating valve for heat conservation. Rest of such lines such as downstream of the drain valves, traps etc. and other lines such as safety valve discharges, vents, etc. shall be insulated for personal protection.

26.6.36 INSTALLATION ON VALVES AND FITTINGS

(a) All valves fittings and specialties shall be insulated with the same type and thickness of insulation as specified for the connected piping with the special provision and or exceptions as given below.

(b) All valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminum sheets of thickness same as the connected pipe cladding. Adjoining pipe insulation shall be believed back to permit removal bolts and nuts or bends. The portion of the valve which cannot be covered by box type insulation shall be filled by loose insulating material of packing density at least equal to that of the insulating material of adjoining pipe. The insulation for valve/flanges shall be applied after the finishing has been applied over the connected piping. The cladding shall be applied in such a manner that the bonnet flange can be exposed easily without disturbing the complete insulation and cladding.

(c) Expansion joints, metallic or rubber shall not be insulated unless otherwise specifically indicated.

26.6.37 INSULATION ON EQUIPMENT

(a) The insulation applied to the equipment shall be reinforced with hexagonal wire mesh. One layer of wire mesh shall be provided on the equipment surface prior to application of insulation.

(b) Installation on horizontal cylindrical vessel/tanks (including heaters, deaerator, heat exchanger etc.)

(c) All the surface of insulation layer, applied on horizontal cylindrical al vessel shall be securely fastened by brands upto vessel/tanks outer diameter of 150mm and below. Where vessel/tank outer diameter exceeds 1500mm, binding wire passing through insulation clip provided both longitudinally and circumferentially at 500 centers shall be used. Gaps in the insulation shall be filled with insulation mineral wool and finished with finishing cement so as to obtain a smooth surface for the supplication of cladding.

(d) The contractor shall provide a support ribs/lugs on the surface of the vessel/tank as necessary. The the contractor shall obtain the approval of the Owner and the equipment supplier's field engineering representative before performing any wlding on equipment. Any heat treatment equipment as per recommendation of equipment supplier shall be performed by the contractor.

(e) Installation on vertical cylindrical vessel/tanks (including flash tanks etc.)

(f) All vertical vessels/tanks shall be provided with support rings/ribs with other necessary frame work to take up the weight of the insulation prior to HT. the contractor shall obtain the approval of the Owner and the equipment supplier's field engineering representative before performing any welding on equipment. Any heat treatment of vessel/equipment that is required after welding of rings/ribs on the vessel/equipment shall be as per recommendation of equipment supplier and shall be as per recommendation of equipment supplier and shall be performed by the contractor.

(g) The mattresses shall be held in position by means of 9 SWG steel wire nails, the nails being 25 mm longer than the thickness of insulation to be applied. After the mattresses have been placed over the nails, the nails shall be bent and embedded in the insulation. Alternative, wire loops may be tack welded at 250mm centers to hold the insulation in place.

26.6.38 INSTALLATION OF CLADDING

(a) All insulation shall be protected by means of an outer covering of aluminium sheathing. All insulation/cladding joints shall be sealed and made effectively weather and waterproof. All flat surfaces shall be given suitable slope to prevent collection of pools of water on the cladding surface. All sheathing shall be protected internally by the application of two coats of bitumenastic paint.

(b) All longitudinal joints shall have a minimum overlap of 50mm and shall be located at 45 deg or more below the horizontal for horizontal equipment joints shall be made with cheese headed self tapping galvanized steel screws at 150mm centers.

(c) All circumferential joints shall have a minimum overlap of 100mm and shall be held in position by stainless steel or anodized aluminium bands, stretched and clamped.

(d) Removable box type cladding for valves and flanges shall be fitted on the connected pipe cladding, with bands.

(e) Aluminium cladding shall not come directly into contact with either the equipment surface or with the supporting arrangement on the equipment surface. to this end, adequate layers of 3 mm thick ceramic board shall be provided between the cladding and any supporting arrangement equipment surface, and fitted with self tapping screws/metal bands, as applicable.

(f) For bends, fittings etc. the cladding shall be provided in segments as to ensure a smooth finish of the cladding.

(g) For cladding on vertical pipes/equipment, provision for load take up shall be made at every 2 to 4 meters along pipe/equipment axis.

(h) All joints shall be sealed with acrylic emulsion weather barrier.

(i) Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminium cladding with copper, copper alloys, tin, lead, nickel or nickel alloys including monal metal.

26.6.39 REFRACTORIES

i) The refractory material shall comply with relevant Indian Standards. The refractory selected shall ensure perfect sealing, and shall have good thermal cycling properties allowing quick start-up/shut down of steam generators.

ii) The refractory material shall:

a) have high bulk density and minimum moisture content.
b) be capable of withstanding service temperature of 1700^0C.

c) be resistant to slagging products due to coal, and to impurities of oil like V_2O_5, Fe_2O_3, K_2O etc. and to erosion due to fly ash.

d) be chemically inactive towards alkalis, iron, silica etc.

e) shall pose no health hazard to working personnel, and shall not have any explosive properties.

f) have sufficient strength to withstand forces generated in boiler, without any rupture or damage.

26.6.40 TESTING AND GUARANTEE

(a) All tests, as per the applicable material standards and as specified shall be carried out in accordance with the methods prescribed. Owner shall have the right to witness any or all of the tests conducted by the contractor at the shop or laboratory.

(b) The contractor shall guarantee that if on actual measurement the specified maximum insulation surface temperatures are exceeded, the contractor shall either replace the insulation with a superior material or provide additional insulation thickness at no extra cost subject to approval of Owner.

26.6.41 SPECIFICATION FOR HYDROSTATIC TEST OF PIPING SYSTEM

26.6.41.1 On completion of insulation/erection of the piping systems a hydraulic test in accordance with the requirements of the Indian boiler regulations, shall be performed by the contractor, the procedure adopted for hydraulic test shall have the prior approval of the Owner, the detailed schemes and procedure for carrying out hydraulic testing shall be prepared and furnished by the contractor and it shall be discusses and finalized during detailed engineering stage.

26.6.41.2 Cutting/welding/edge preparation and re-welding required for blanking, temporary piping connection and /or for replacements by spool pieces including reinstallation of components after hydraulic testing shall be the responsibility of contractor.

26.6.41.3 The water for the hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the steam generator and high pressure external piping shall be suitably drained and preserved.

26.6.41.4 All the valves, high pressure piping and interconnected pipes connecting the pressure parts, shall be subjected to hydraulic test along with the pressure parts, all blank flanges, removable plugs, temporary valves, piping and fittings, spools other accessories and services required for carrying out hydraulic testing of piping shall be furnished by the contractor, the the pressurization equipment including water piping from the supply, needed for the above test shall also be furnished b the contractor, any defect noticed during the testing shall be rectified and the unit shall be retested by the contractor.

26.6.41.5 The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting authority as per the provision of the IBR and the project manager.

26.6.42 SPECIFICATION FOR CHEMICAL CLEANING OF PIPING SYSTEM AND EQUIPMENTS

26.6.42.1 The following piping systems shall be cleaned through steam blowing operation:

a) Main steam, HRH, CRH, HP bypass & LP bypass piping.

b) Auxiliary steam piping including TG gland sealing lines.
c) Steam lines feeding turbines of boiler feed pumps.

Steam blowing shall be carried out for removal of particles (rust, scales, weld splatter etc.) from various piping systems to avoid damage to turbine blading. Cleanliness of system shall be checked by means of test plates made of steel, which will be installed in the center line of the piping system.

Cleaning shall be achieved by steam purging i.e. by blowing of steam through the piping such that the momentum of flow is greater than that of steam flow during normal operation of unit (at TMCR). The disturbance factor during steam blowing (ratio of momentum of flow during purge to that during TMCR) shall be more than 1.4.

26.6.42.2 Before introducing chemicals, all the piping system and equipment listed above shall be water flushed, water flushing will be followed by alkaline cleaning acid cleaning and passivation

(i) By EDTA (Ethylene Diamene Tetra Acid) and passivation.

(ii) Strict safety precautions shall be exercised at all times during the chemical cleaning and during storage and handling of the chemicals. Protective clothing, apparatus and equipment along with necessary first aid kits as required shall be envisaged for handling the chemical and for carrying out the cleaning operation.

26.6.42.3 However the bidder shall submit along with the offer his usual procedure and practices for chemical cleaning of the piping and equipment specified. The bidder shall submit all schematics, write-up, details of chemical to be used etc. and detailed procedures he intends to follow, these schematics and procedures shall be subjected to the approval of the Owner.

26.6.43 **PRE-CLEANING PROCEDURE**

Prior to starting any phase of cleaning operation the following procedure shall be ensured.

(a) Installation of all temporary piping valves, pumps and equipments as required for the flushing and chemical cleaning operations.

(b) Temporary piping shall be routed at floor level as far as possible and secured in place to prevent movement /vibration beyond applicable limits.

(c) Installation of the instruments as required to ensure satisfactory monitoring and control of the cleaning process. The contractor shall also determine and arrange location for sampling of the cleaning solution during cleaning.

(d) Bypassing all regulation/control valves coming in the cleaning circuit or installation of temporary spool pieces.

(e) Installation of special end covers and temporary suction strainers, for boiler feed pumps and condensate pumps. Pump internals shall not be installed.

(f) Installation of the plastic seal in the condenser neck to protect the turbine from alkaline fumes.

(g) Blocking and securing of all spring hangers in the steam lines which may be flooded during the cleaning operation.

(h) Hand cleaning of the interiors of all vessels which are included in the cleaning operation.

26.6.44 GENERAL CLEANING PROCEDURE

(a) Seal water lines to pump shall be broken and flushed.

(b) Where pipe lines terminate in spray headers, these headers shall be inspected after each phase of the cleaning operation and cleaned if necessary.

(c) All strainers shall be observed closely during the cleaning operation by reading differential pressure gauges, and shall be cleaned when the differential pressure exceeds a predetermined value.

(d) All high points, vents shall be opened periodically to ensure full system flow.

(e) Upon completion of each stage of cleaning, the waste products shall be drained and transferred to the waste treatment basins, the contractor shall then supply and add the necessary chemicals to the basin to neutralize all waste solutions and rinses generated by the cleaning process, and arrange for its disposal to an area to be indicated by the Owner/engineer.

(f) Strictest safety precautions shall be exercised at all times during the chemical cleaning and during storage and handling of the chemicals, the contractor shall ensure provision of all protective clothing, apparatus and equipment along with necessary first aid kits as required for handling the chemical and for carrying out the cleaning operation.

26.6.45 SPECIFICATION FOR FLASH TANKS

26.6.44.1 The flash tanks and accessories shall be designed, manufactured and tested in accordance with ASME boiler and pressure vessels (B&PV) codes (latest) and other applicable ANSI standards referenced in the above codes.

26.6.45.2 NUMBER AND SIZING

Flash tank shall be provided into which all recoverable drains from turbine casing extraction lines, valves, strainers, main steam, CRH and HRH line drains, cascaded drains from heaters etc. shall be led. Number of flash tanks shall be as per tender drg. Requirement/details of various flash tanks are given below.

(a) High pressure HP flash tank for accommodating high pressure (above and including hot reheat design pressure) steam drain and HP heater emergency drains, as included in the tender drawing.

(b) Low pressure LP flash tank for accommodating low pressure (below hot reheat design pressure) steam drain and LP heater emergency drains, as included in the tender drawing.

(c) Atmospheric flash tank to accommodate alternate drains of steam lines, feed water safety valve discharge and aux. steam line drains, as indicated in the tender drawing.

26.6.45.3 **CONSTRUCTIONAL FEATURES**

(a) Flash tanks shall be vertical cylindrical design and of welded construction with torispherical or hemi spherical heads.

(b) Drains/hot water inlet nozzles shall be tangential to the vessel periphery. Suitable vortex breaker arrangement shall be made at the liquid outlet to the vessel. In the contractor finds better alternative arrangement, the same can be submitted for the Owner acceptance & approval.

(c) The drain & the vent of the flash tanks shall be adequately sized and lead to the condenser. There shall not be any valve on the drain and vent lines. Loop seal shall be provided on the drain if required.

(d) A man hole shall be provided on the flash tanks for inspection purpose, it shall be diameter of 500mm minimum. The man hole shall be of davit type and shall be provided with grip.

(e) The flash tanks shall be located on the ground/mezzanine floor of the power house. Necessary structural supports including anchor bolts shall be provided. Three (3) support lags at 120 degree spacing shall be provided on each flash tank. Necessary lugs for handling by the TG hall EOT crane shall be provided.

(f) The flash tanks shall be provided with a full length level including gauge glass complete with protective rods. Isolation valves and drains. Temperature indicator and temperature switches shall be provided on the flash tanks.

(g) The flash tanks shall be provided with access ladders. If required for the access to the instruments, valves, main holes etc.

26.6.46 **SCHEDULE OF MATERIAL**

Shell and head	ASTM A 285 Gr.C
Wear plate/baffle	ASTM A 285 Gr.C
Nozzle neck	ASTM A 106 Gr.B
Manhole nozzle flange and cover	ASTM A 285 Gr.C
Couplings	ASTM A 105
Bolts and studs	ASTM A 193 Gr.B7
Nuts	ASTM A 194 Gr.2 H
Gaskets	spiral wound SS 316 with graphite

However the material as per ASTM A 516 Gr. B shall be acceptable subject to the relevant codes / standards permitting so for the design parameters of various flash tanks.

26.6.47 **SPECIFICATION FOR METALLIC EXPANSION JOINTS**

26.6.47.1 The expansion joint shall be metallic multi-bellows construction shall be used to reduce the reactions (force and moments) at the connected equipment terminals due to thermal expansion / contraction and/or vibration of connected equipment and piping.

26.6.47.2 the design material, construction, manufacture, inspection testing and performance of the expansion joints shall comply with the currently applicable requirement of EJMA, boiler and pressure vessel code section III, ANSI B-31.1 and all statutes, regulations and safety codes.

26.6.48 **CONSTRUCTION DETAILS**

(a) Bellows

- The bellow shall be hydraulically or roll formed from perfect cylinders of single ply, 304 grade stainless steel.
- The number of longitudinal weld seams shall be minimum and there shall be no circumferential weld seam.
- Cold formed stainless steel bellows shall not be heat treated.
- All bellow elements shall be pickled after forming.
- Equalizing rings, where required, shall be either from high quality casting of from fabrication metal.
- Flanged expansion joints shall be provided with adequate pipe stubs.
- Butt welded expansion joints shall have adequate length of pipe so that site welding dose not impair or reduce the joints efficiency.

(b) Sleeves

- Expansion joints will be furnishes with internal sleeves of the same material as the bellows and installed with sufficient clearance to allow full rated deflection. The sleeves shall be welded on the flow inlet end of the joint only.
- Bellow shall have external sleeves with an arrow including the direction of flow on the outside. The external steel covers provided to protect bellows from physical damages, shall be suitable for supporting insulation where necessary and shall be detachable.

(c) Tie bars

- Joints shall be shipped at neutral length. They shall be provided with suitable erection and knock-off type temporary tie bars to prevent damage and misalignment during transit and also with permanent tie bars along with necessary nuts, bolts, etc.
- The rod on pressure balanced type expansion joints shall be adequately sized to prevent buckling in vacuum services or services other than external loads.

26.6.49 **TYPE TEST OF METALLIC EXPANSION JOINT**

Following tests (type tests) shall be carried out for metallic expansion joints as per the procedures given in EJMA.

(a) Life cycle test

(b) Meridonal yields-rupture testing

(c) Squirm testing

26.6.50 For the purpose of carrying out type tests: metallic bellows shall be grouped based on the parameters as give below. The bellows conforming to the same combination of these parameters shall constitute one group. Type test shall be carried out on one or specific above.

i. Material of bellow: based on material of bellow, bellow shall be categorized in to three category namely carbon steel, stainless steel (Eg. SS304, 316, 321 etc.) & high alloy steel (Eg. inconal).

ii. Profile of convolutions: each profile shall be considered as separate category (e.g. U profile, V profile & Lyra profile etc.)

iii. Dimension of bellows: based on the size, the categories shall be as under:

- Nominal diameter of metallic expansion joint up to and including 800mm NB.
- Nominal diameter of metallic expansion joint greater than 800mm NB up to and including 1600mm NB.
- Each size above 1600mm NB shall be a separate category.

iv. Design pressure: based on the design pressure, bellows shall be categorized as under:

- Deign pressure from full vacuum up to 5Kg/cm^0 (g).
- Design pressure above 5Kg/cm^0 (g) and up to 10Kg/cm^0 (g) with or without vacuum.

26.6.51 **NUMBER OF CYCLES**

For the life cycle test, the number of test cycles shall be minimum 10,000 cycles.

Other tests for the metallic expansion joint shall be carried out as per the approval QP/QA section. Further, other terms and conditions for type test shall be as specified elsewhere in the specification.

26.6.52 **SPECIFICATION FOR SURFACE PREPARATION & PAINTING**

26.6.52.1 Surface preparation methods and paint/ primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified specific approval shall be obtained by the contractor in writing from the Owner for using substitute material.

26.6.52.2 All paints shall be delivered to job site in manufactures sealed containers, each container shall be labeled by the manufacture with the manufacture's name type of paint, batch no. and color.

26.6.52.3 Unless specified otherwise paint shall not be applied to surface of insulation, surface of stainless /nickel/copper/brass/ monal/aluminum/ hastelloy/lead/

galvanized steel items, valve stem, pump rod, shaft gauges, bearing and contact surface, lined or clad surfaces.

26.6.52.4 All pipelines shall be colour coded for identification as per the colour-coding scheme indicated in Volume II and which will be furnished to the contractor during detailed engineering.

26.6.53 SURFACE PREPARTION

26.6.53.1 All surfaces to be paints shall be thoroughly cleaned of oil, grease and other foreign matter, surfaces shall be free of moisture and contamination from chemicals and solvents.

26.6.53.2 The following surfaces scheme are envisaged here, depending upon requirement any one or a combination of these may be used for surface preparation before application of primer.

SP1	solvent cleaning
SP2	application of rust converter (Ruskil or equivalent grade)
SP3	power tool cleaning
SP4	shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer)
SP4*	shot blast cloning /abrasive blast cleaning to SA 21/2 (near white metal) 35-50 microns
SP5	phosphating
SP6	Emery sheet cleaning/ manual wire brush cleaning.

26.6.54 APPICATION OF PRIMER /PAINT

26.6.54.1 The paint/primer manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The dry film thickness (DFT) of primer/paint shall be as specification herein.

26.6.54.2 Surface prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surface

26.6.54.3 Where primer coat has been applied in the shop, the primer coat shall be carefully delaminated, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared, primer coat shall be applied prior to intermediate and finish coats.

26.6.54.4 Steel surface that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.

26.6.54.5 Following are the primer/painting schemes envisaged herein:

PS3 - zinc chrome primer (Alkyd base) by brush/Spray to IS104.

PS3* - zinc chrome primer (Alkyd base) by dip coat.

PS4 - synthetic Enamel (long oil alkyd) to IS2932.

PS5 - red oxide zinc phosphate to IS-12744.

PS9 - aluminum paint to IS 2339.

PS9* - heat resistant aluminium paint to IS-13183 Gr.-I (for temperature 400^0C– 600^0C), IS -13183 Gr.-II (for temperature 200^0C-400^0C) and IS-13183 Gr.-III (for temperature up to 200^0C)

PS13 - Rust preventive fluid by spray, dip or brush.

PS14 - Wieldable primer-Deoxaluminate or equivalent.

PS16 - high build Epoxy CDC mastic `15'.

PS17 - aliphatic acrylic polyurethane CDE134, %V=40.0 (min.)

PS18 - Epoxy based TiO2 pigmented coat.

PS19 - Epoxy based zinc phosphate primer (92% zinc in dry film (min.) % VS=35.0 (min.)

PS20 - Epoxy based finish paint.

26.6.54.6 All weld edge preparation for site welding shall be applied with one coat of wieldable.

26.6.54.7 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

26.6.55 **Primer/painting schedule**

S. No	Description		Surface preparation	Primer coat			Intermediate coat			Finish coat			Total min. (microns)	Colour shade
				System	Coat	Min. DFT/coat (microns)								
1	All insulated piping's. Fittings/ components, pipe clamps, vessels/tanks, equipments etc.	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40		as per colour shade/ coding scheme in Volume II
2	All insulated piping's. Fittings/ components, pipe clamps, vessels/tanks, equipments etc.	Design temperature <60^{0}C	SP3/SP4	PS 5	2	25	-	-	-	PS4	3$	35$	155$	
		Design temperature 60^{0}C-200^{0}C	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature >200^{0}C	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	
3	Constant load hanger (CLH). Variable load		SP4*	PS 19	1		-	-	-	PS17	1	30	70	

S. No	Description		Surface preparation	Primer coat			Intermediate coat			Finish coat			Total min. (microns)	Colour shade
	hanger (VLH) and other supports					40								
4	Valves													
	Cast/forged	Design temperature <95^{0}C	SP1/SP2/SP3	PS 9	1	20	-	-	-	PS9	1	20	40	
		Design temperature 95^{0}C-200^{0}C	SP1/SP2/SP3	PS 9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature >200^{0}C	SP1/SP2/SP3	PS 9*	1	20	-	-	-	PS9*	1	20	40	
5	All structural steel components	outside TG building and in SG envelope	SP4*	Inorganic Ethyle Zinc Silicate	1	75	PS18	1	75	a) epoxy coat	2	25	250	
										b) final coat of paint PS1	1	30		
		Within TG building	SP4*	---do---	1	35	PS18	1	35	a) epoxy	2	25	150	

S. No	Description		Surface preparation	Primer coat			Intermediate coat			Finish coat			Total min. (microns)	Colour shade
										coat				
										b) final coat of paint PS1	1	30		
6	Weld edges	SP6(hand cleaning by wire brushing)	PS13 (wieldable primer)	1	25	-	-	-	-	-	-	-		

$ The first 2 finished coats (total min. DFT of 70 microns) shall be done at shop and the 3rd finish coat (min. DFT 35 microns) shall be applied at site.

26.6.56 **Testing requirements**

The detailed testing requirements for power cycle piping and its components are given in the subsection for quality assurance (QA). The requirements pertaining to testing given in this subsection if in variance with that given in QA subsection, then the more stringent of the two shall be followed.

ANNEXURE 1: LIST OF POWER CYCLE PIPING

The following list of power cycle piping is an indicative one and is provided for the guidance of the Bidder only. Items not mentioned but deemed necessary for making the system complete shall also be included.

S. NO.	NAME	DESCRIPTION
1.0	Main Steam lines	From SH outlet to inlet of turbine
2.0	Main Steam Equalising line	Between RHS and LHS Main Steam lines
3.0	HP By-pass line	Between Main Steam line and CRH line
4.0	Cold Reheat line	Between HP turbine outlet and Reheater
5.0	Extraction line from CRH	Between CRH and Deaerator
6.0	Extraction line from CRH	Between CRH and H.P. heater
7.0	Extraction line from MS equalizing line	From MS equalizing line to auxiliary steam header
8.0	Steam supply to BFP Turbine	From the main and alternative source point to BFP Turbine Inlet
9.0	Extraction from BFP discharge	1. Between BFP discharge and H.P. By-pass 2. Between BFP discharge and PRDS
10.0	Warm up line for HP By-pass	Between MS line and H.P. By-pass line
11.0	Hot Reheat lines	Between Reheater and I.P. turbine
12.0	HRH equalizing line	Between LHS and RHS Hot Reheat lines
13.0	LP By-pass line	Between HR line and condenser
14.0	Warm up line for LP By-pass	Between LP By-pass line and HR line
15.0	CEP Suction line	Between condenser hot well and CEP.
16.0	Main condensate line	Between CEP outlet and Deaerator through GSC, CPU, Drain Cooler, L.P. heaters.

S. NO.	NAME	DESCRIPTION
17.0	CEP Minimum Recirculation line	Between main condensate line after CEP to condenser.
18.0	GSC Minimum Recirculation line	Between main condensate line after GSC to condenser.
19.0	Deaerator filling line	Between Condensate Transfer pump discharge and deaerator
20.0	Boiler filling line	Between Condensate Transfer pump discharge and Boiler bottom ring header /economizer inlet.
21.0	Fill up and Emergency	From Condensate Transfer pump discharge to make-up to condenser.
22.0	DMCW make-up tank	From Cycle make-up pump discharge to DMCW make-up tank.
23.0	Gravity Make-up to condenser	From condensate storage tank to condenser.
24.0	Condensate Dump Line	Between M.C. line after GSC and condensate storage tank.
25.0	Cycle make-up Pump Recirculation	Between Cycle make-up pump discharge header and Condensate Storage Tank.
26.0	Cycle make-up Pump Suction Line	From condensate storage tanks to Cycle make-up pump suction header.
27.0	By-pass line	For all control valves
28.0	By-pass lines for heaters (group bypass/individual bypass)	GSC, LP Heaters and HP Heaters.
29.0	CEP sealing line	Bidder's choice.
30.0	All extractions from main condensate line	For
		(a) Exhaust Hood spray
		(b) Turbine Flash Tank spray
		(c) L.P. By-pass spray
		(d) Water sealing of valves
		(e) Vacuum breaker line sealing

S. NO.	NAME	DESCRIPTION
		(f) CEP sealing
		(g) Analytical measurements
		(h) Alkali flushing
		(i) Spray water to GSC desuperheater
		(j) Sampling
		(k) Instrument seal pot
		(l) Water sealing of valves & water washing of BFP Turbine
		(m) Spares
31.0	Turbine flash tank drain and vent line	From turbine Flash Tank drains to condenser hot well From flash vessels vent to condenser steam space
32.0	BFP Suction lines	Between Deaerator and individual BFP suction
33.0	Main Feed Water Line	From BFP discharge through HP heaters, control station up to economizer inlet header
34.0	Steam turbine drive for BFP	Associated piping
35.0	Inlet line to attemperation water header	From main feed water line to attemperation water header
36.0	Extraction from BFP	From BFP suction to sample cooler suction, BFP warm-up & Balance Leak- off line.
37.0	All extraction from Main Feed Water line	(a) To Auxiliary Steam pressure reducing de-superheating station
		(b) Stub for alkali flushing
		(c) HP By-pass spray
		(d) Blind Stub
		(e) Minimum re-circulation lines

S. NO.	NAME	DESCRIPTION
38.0	Extraction lines	From various stage of turbine/CRH to L.P. Heaters, H.P. heaters, Deaerator and BFP Turbines.
39.0	All vents of H.P and L.P. heaters	(a) L.P. Heater vents to Condenser
		(b) H.P. Heater vents to Condenser
40.0	All cascade drain connection between heaters	(a) From each HP Heater to next lower pressure HP Heater
		(b) From the lowest pressure H.P. heater to Dearator
		(c) From each L.P. Heater to next lower pressure L.P. heater
		(d) From lowest pressure L.P. heater to flash vessel through drain cooler.
41.0	All Drip connections to Flash Tanks	(a) From H.P. Heaters
		(b) From L.P. Heaters (except the lowest pressure L.P. heater)
		(c) From Gland Steam condenser
42.0	Air Steam mixture line from Turbine Glands	(a) To GSC
		(b) To Atmosphere
43.0	Vapour extraction line for GSC	From GSC through vapour extractors to atmosphere
44.0	By pass Line to GSC	Through desuperheater to atmosphere
45.0	Air steam mixture line from condenser	To vacuum pumps
46.0	Drip connections to Deaerator	From H.P. Heaters
47.0	Connections for air outlet from vacuum pump	From vacuum pumps to atmosphere
48.0	Steam connection to Auxiliary steam header	From final superheater outlet
49.0	High Temperature Auxiliary Steam Header	One with interconnection

S. NO.	NAME	DESCRIPTION
50.0	Auxiliary Steam from High Temperature Header	(a) To Gland Sealing unit
		(b) For mill inerting (if required)
		(c) For soot blowing
51.0	Low Temperature Auxiliary Steam Header	One with interconnection
52.0	Auxiliary Steam from Low Temperature Header	(a) For Deaerator pegging
		(b) For atomising
		(c) For F.O. Heating
53.0	Extraction line from CRH line	From CRH line to auxiliary steam header

CHAPTER – 27

LOW PRESSURE PIPING, VALVES & SPECIALITIES

CONTENTS

27.0 LP PIPING, VALVES & SPECIALITIES

27.1 Equipment sizing Criteria

27.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

27.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.

27.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application

		Water Velocity in m/sec		
	Pipe Size	**Below 50 mm**	**50-150 mm**	**200 mm & above**
a)	Pump suction	-	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	-	1.5 - 2.4	2.1 - 2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 M/Sec inside the pipelines at pump discharge.

Pipe line under gravity flow shall be restricted to a flow velocity of 1 M/sec generally Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 M/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air – 15M/sec. (under Average Pressure & Temp. conditions)

27.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.

27.1.5 Based on the inside diameter so established, thickness calculation shall be made as per ANSI B 31.1. OD and thickness of pipes shall then be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.

27.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.

27.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.

27.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.

27.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.

27.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.

27.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.

27.1.12 Threaded joints shall be provided with teflon sealant tapes.

27.1.13 Following types of valves shall be used for the system/service indicated.

System	**Type of Valves**					
	Butterfly	**Gate**	**Globe**	**Check**	**Ball**	**Plug**
Water	x	x	x	x	x	
Air		x	x	x	x	
Drains & Vents			x	x	x	
Fuel oil		x	x	x	x	x

In water service, valves above 300 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as required. The recirculation pipe shall be sized for minimum 30% design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

27.1.15 All piping 450 NB & above shall be designated as large dia piping.

27.2 Technical Specification

27.2.1 General

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Chapter. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/ anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/ supports, tanks etc.

27.3 Pipes and fittings

27.3.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness shall be adhered to. The bidder shall furnish the pipe sizing/thickness calculations as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

27.3.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.3.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and shall submit the detailed drawings for thrust/anchor block. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

27.3.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

27.3.5 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

27.3.6 Piping and fittings shall be manufactured by an approved manufacturer. They shall be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

27.3.7 For rubber lined ERW pipes, beads shall be removed.

27.3.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.

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

27.3.10 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valves on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

27.4 **Material**

27.4.1 Alternate materials offered by bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the bidder and any standard code required for establishing the same shall be in English language.

27.4.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.

27.4.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.

27.4.4 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.

27.4.5 Material of construction for pipes carrying various fluids shall be as follows:

1	Raw water, Ash water, Circulating Water (CW), Aux. Cooling water (ACW), clarified Water, CW blow down, *Effluent disposal, service water, AHP Seal Water, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. At road crossings live loads shall be considered and pipe thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.
2	Dematerialized water, (condenser Make up water,	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm

	Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
3.	*Drinking (potable) water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
4.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system (* marked) Ductile Iron (DI) pipes conforming to IS 8329 and for fittings IS 9523 can be offered as an alternate to the mild steel/ galvanized mild steel pipes as specified above for standalone or outside plant boundary stretches. Various design aspects of DI piping is mentioned in Annexure-I.

27.4.6 In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS: 1239 Grade heavy except for dematerialized water, drinking water and condensate spill lines.

27.4.7 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).

27.4.8 In dematerialized water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.

Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e., dimensions, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.

27.4.9 Instrument air, service air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than Heavy grade, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).

27.4.10 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.

27.4.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard'' as minimum to be maintained.

27.4.12 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.

27.4.13 Buried CW Pipes shall be encased in 500 mm thick RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and adequately revised.

27.5 Piping Wall Thickness

27.5.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.0 mm shall be considered while selecting the thickness.

27.5.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	20 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm to 1400 mm	-	12.0 mm
> NB 1400 mm to 1600 mm	-	14.0 mm
> NB 1600 mm to NB 2200 mm	-	16.0 mm
> NB 2200 mm	-	18.0 mm

27.6 Piping Layout

27.6.1 Piping shall be grouped together where practicable and routed to present a neat appearance.

27.6.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.

27.6.3 Over head piping shall have a normal minimum vertical clearance of 2.5 M above walkways and working areas and 8 M above roads/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

27.6.4 Pipelines of NB 50 size and below are regarded as field run piping. It is bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved for the installation of the field run pipe work. Based on these approved layouts, the bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.

27.6.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.

27.6.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.

27.6.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.

27.6.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.

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

27.6.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

27.7 Slope/Drains and Vents

27.7.1 Suitable slope shall be provided for all pipelines towards drain points. It is bidder's responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vents shall not be less than 25 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.

27.7.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.8 Pipe Joints

In general, all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

27.8.1 Screwed Joints

(a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS: 554 unless specified otherwise.

(b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes an fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above.

(c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.

(d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate pasts. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.

(e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

27.8.2 **Welded Joints**

(a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

27.8.3 **Flanged Joints**

(a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.

(b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.

(c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

27.9 **Bends/elbows/mitre bends/Tees/Reducers & other fittings**

27.9.1 Unless otherwise specified elbows shall be of long radius type.

27.9.2 For pipe sizes 50 NB and below, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.

27.9.3 For steel pipes 65 NB and above, seamless long radius forged elbows shall be used. For pipe sizes 250 NB and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 degree bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS:2633/BS:534.

27.9.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.

27.9.5 For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of

compensation pads shall be kept as per ANSI B 31.1. The fittings shall conform to the dimensional standard of ANSI B-16.9.

However, for pipes upto 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.

For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.

27.9.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes upto and including 50 mm NB, i.e. the fitting shall be of seamless construction.

However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.

27.9.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

27.10 **Flanges**

27.10.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.

27.10.2 All flanges and-flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.

27.11 **Specific technical requirement of laying buried pipe with anti corrosive treatment**

The pipe in genera, shall be laid with the top of the pipe minimum 1 M below finished ground level.

27.11.1 **Trenching**

(a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822 or any international standard.

(b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.

(c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.

(d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.

(e) Coating and Wrapping shall be done as under.

27.11.2 **Preparation and cleaning of piping**

(a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.

(b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.

(c) On the internal surface for pipes 1000 NB and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.

(d) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 250 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

27.11.3 **Coating and wrapping/ Anti corrosive Protection Coal tar tape**

a. Buried piping shall be coated and wrapped, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are:

(1) Coating primer (coal tar primer)
(2) Coating enamel (coal tar enamel)
(3) Wrapping materials.

All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable.

Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated Kraft outer wrap or finish coat.

Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of Coats and wraps shall be decided based on soil corrosivity/resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available.

Total thickness of completed coating and wrapping shall not be less than 4 mm.

b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS:15337 or equivalent. These-tapes shall be applied hot over the cold coal tar primer in steps of 2 mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm min.

27.11.4 **Trench bed preparation and back filling**

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

27.11.5 **Laying of galvanized steel (GI) pipes**

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joints shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and "anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

27.12 **Cleaning and Flushing**

27.12.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

27.12.2 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.

27.12.3 After erection, all water lines shall be hydro tested at 1.5 times the design pressure.

27.12.4 All compressed air pipe work shall be cleaned by blowing compressed air.

27.13 **Painting of Pipes**

27.13.1 **Buried Piping**

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application: Bond/ Adhesion test, Holiday test

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.

(iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

(iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

NOTE: CW piping shall be encased in 500 mm thk RCC. Pipes external surface shall be applied with one coatsof coal tar primer before placing the pipes in position for RCC encasing. Thickness of paint shall be minimum 35 microns.

Tests to be carried out after application: Bond/ Adhesion test, Holiday test.

27.13.2 **Overground Piping**

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

External surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat - Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

27.13.3 **Other requirements**

(a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.

(b) The color of the finish paint shall be as per approved color-coding.

(c) If finish paint is applied in shop, one coat of finish paint shall be applied at site.

(d) The dry film thickness of paint shall not be less than 0.15 mm.

27.13.4 **Color code for identification**

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

27.14 **Specification for hangers and supports**

27.14.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

27.14.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

27.14.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.

27.14.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062 or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS: 4360. Insulation protection saddles shall be used at support point of all insulated piping.

27.14.5 The support shall be interspaced as to minimize sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.

27.14.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

27.14.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.

27.14.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

27.14.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.

27.15 **Design/Construction/Material Particulars of Gate/ Globe/ Check Valves/ Butterfly Valves**

27.15.1 **General**

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

(b) General requirement of valves are as indicated below:

(1) The valves as well as all accessories shall be designed for easy disassembly and maintenance.

(2) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.

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

(4) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.

(5) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.

(6) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.

(7) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.

(c) The actuator-operated valves shall be designed on the basis of the following:

(1) The internal parts shall be suitable to support the pressure caused by the actuators.

(2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.

(3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.

(4) All actuators operated valves shall open/close fully within time required by the process.

(d) Valves coming under IBR shall meet IBR requirements.

(e) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:

(1) Hand wheel

(2) Position indicator (for above 50 mm NB valve size)

(3) Draining arrangement wherever required.

(f) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.

(g) Check valves shall be used for non-return service. They shall be swing check type or Dual plate type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening/closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600 mm NB.

(h) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

(i) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.

(j) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(k) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary platforms for facilitating easy valve operation shall be provided wherever necessary.

(l) All valves except those with rising stems shall be provided with continuous mechanical position indicator; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.

(m) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS-1538 for fitting shall be applicable.

27.15.2 **Valve Body Material**

Valve body material for various services shall be as follows:

Valve body material for water application like circulating water, Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65 NB and above; gun-metal for sizes 50 NB and below.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water : SS body and disc alongwith SS internals.
Condensate : Cast Carbon Steel/Forged Carbon Steel.

27.15.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes n the locality where the valves will be installed.

The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504	Rubber seated butterfly valves
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.
BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves
ANSI B 16.34	Standard for valves
API-594	Standard for Dual-check valves
API-600	Steel gate valves
ANSI-B-16.10	Valves face to face and other relevant dimension
API-598	Valves inspection test

27.15.2.2 **End Connections**

The end connections, shall comply with the following:

Socket welding (SW)	–	ANSI B 16.11
Butt Welding (BW)	–	ANSI B 16.25
Threaded (SC)	–	ANSI B 2.1
Flanged (FL)	–	ANSI B 16.5 & AWWA-C-207

27.15.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections.

27.15.2.4 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.

27.15.2.5 All gun metal body valves shall have screwed ends.

27.15.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

27.16 **Check Valves**

27.16.1 Check valves shall comply with the following characteristics:

(a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);
(b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.

(c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.

27.16.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.

27.16.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.

27.16.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

27.17 **Globe Valves**

27.17.1 The globe valves shall have the following characteristics:

Straight conveyed flow; Right angle; Preferably, the valves shall be of the vertical stem type.

27.17.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

27.17.3 The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.

27.17.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

27.17.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

27.18 **Gate valves**

All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

27.19 **Air Release Valves**

(a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.

(b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.

(c) Body material of automatic air release valves shall comply generally with IS: 210 Gr. FG 260 and spindle shall conform to high tensile brass.

(d) Air release valves shall not have any integral isolation devise within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

125# ASA cast iron body, double ball construction air release valve with flanged ends to ASA B 16.10; and bolted cover to release the air.

Construction materials shall be as below:

Body, cover	:	Cast iron to IS: 210 Gr.FG 260
Bolts	:	Light weight leather/wooden balls
Seats	:	SS
Cover packing	:	Braided asbestos
Float	:	Wood/rubber

27.20 **Butterfly Valves**

27.20.1 **Design/Construction**

The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 NB diameter. In such a case, however, the

bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.

(1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable.

(2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.

(3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.

(4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

(5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

(6) The operating mechanism shall be mounted directly on or supported from the valve body.

(7) All valves shall be complete with:

Position indicator (located in a visible place)
Arrow indicating the flow direction;
Adjustable mechanical stop limiting devices to prevent over
Travel of valve disc in open/close position.
All valves shall be "tight shut off"

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 NB and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 NB and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

27.20.2 Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below:

(a) Cast Iron Butterfly valves

Body & Disc	ASTM A48, Gr. 40 with 2% Ni CI IS 210 Gr FG 260
Shaft	BS 970 431 S: 291/EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
Seat ring	18-8 Stainless steel
Seal	Nitrile Rubber

(b) Stainless Steel Butterfly Valves

Body & Disc	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304
Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/ Eq.
Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) Carbon Steel Butterfly Valves

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Eq
Disc & Seat Rings	EPT/BUNA-N/Neoprene

27.20.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shaft generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.

27.21 **Material Of Construction (Gate/Globe/Check Valve)**

(a) The materials shall generally comply with the following:

(1) Cast Steel Valves

Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return	ASTM A 216 Gr. WCB/
Trim.	ASTM A 182 Gr. F6 or Equivalent

(2) Stainless Steel Valves

Body & Bonnet/Disc	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body

(3) Cast Iron Valves

Body & bonnet	IS-210 Gr. FG 260
Seating surfaces and rings	13% chromium steel/13% Chrome overlay
Disc for non-return valves	IS-210 Gr FG 260
Hinge pin for NRV	AISI 316
Stem for gate globe valves	13% chromium steel or Equivalent
Back Seat	13% chromium steel / 13% Chrome overlay

(4) Gun Metal Valves

Body and bonnet	IS 318 Gr. 2/Eq.
Trim	IS 318 Gr. 2/Eq.

(b) Cast iron body valves shall have high alloy steel stem and seat.

(c) Material for counter flanges shall be the same as for the piping.

27.22 Float Operated Valves

(a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) Design And Construction Features

The following design and construction feature of the valve shall be the minimum acceptable.

(c) Valves shall be right-angled or globe pattern.

(d) Valves shall be balance piston type with float ball.

(e) Leather liner shall not be provided.

(f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or IS: 210 Grade 260, and float shall be of copper with epoxy painting of two (2) coats.

(g) Valves shall be suitable for flow velocities of 2 to 2.5M/sec.

(h) The valves shall have flanged connections.

27.23 Painting Of Valves

Two (2) coats of primer followed by two (2) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of paining shall be minimum 150 microns. If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel.

27.24 Rubber Expansion Joints

27.24.1 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.

27.24.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.

27.24.3 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60^0 A for outer and 50^0 A for inner cover.

27.24.4 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.

27.24.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.

27.24.6 Expansion joints shall be complete with stretcher bolt assembly. Expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.

27.24.7 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.

27.24.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

27.24.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.

27.24.10 Expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.

27.24.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.

27.24.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.

27.24.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

27.24.14 Bidder to note that any metallic part which comes in contact with DM/ Corrosive water shall be of stainless steel material.

27.25 Strainers

27.25.1 Simplex type

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition fitted with a removable plug. The material of construction of various parts shall be as follows:

(a)	Body	IS: 318, Gr. 2 up to 50 mm NB, and IS: 210 Gr. FG 260 above 50 NB (For DM water/ -Body: AISI 316 or equivalent)
(b)	Strainer Element	Stainless steel (AISI 316)
(c)	End connection	Screwed upto 50 NB, and flanged above 50NB

27.25.2 **Duplex type**

(a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.

(b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

Body	IS: 318, Gr. 2 up to 50 NB, and IS: 210, Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted for 65 NB and above.
Strainer element	Stainless steel (AISI 316).
End connection	Screwed up to 50 NB; flanged for 65 NB & above. Gasket shall be of full face type.

(c) The strainer shall have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.

(d) The size of the strainer and the flow direction will be indicated on the strainer body casting.

(e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

27.25.3 Two shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited.

ANNEXURE-I

SPECIFICATION FOR DUCTILE IRON PIPES, FITTINGS & SPECIALS

1.00.00 General

This specification covers the specific requirement of design, material, manufacture /fabrication, constructional features, inspection & testing, transportation, handling, laying, site testing and annual maintenance contract of Ductile Iron (DI) Pipes, Joints, fittings and specials.

2.00.00 Codes and Standards

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, "IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification)" or equivalent international standard unless otherwise specified elsewhere in this Technical Specification.

S. No.	Code No.	Code Title
1	IS 8329	Centrifugally cast (spun) ductile iron pressure for water, gas and sewage - specification
2	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage - specification
3	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6	IS 11606	Methods of sampling of Cast Iron pipes and fittings
7	IS 455	Portland slag cement
8	IS 12330	Sulphate resisting Portland cement
9	IS 6452	Specification for high alumina cement for structural use
10	IS 6909	Specification for supersulphated cement
11	IS 8112	43 grade ordinary Portland cement
12	IS 1387	General requirements for supply of metallurgical materials
13	IS 1500	Methods for Brinell hardness test for metallic materials
14	IS 1608	Mechanical testing of metals – tensile testing

15	ISO 2531	Ductile iron pipes, fittings,accessories and their joints for water applications
16	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure pipelines – Cement mortar lining
17	ISO 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipelines – Specification for materials
18	ISO 8179	Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer
19	ISO 8179	Ductile iron pipes – External zinc coating – Part 2:Zinc rich paint with finishing layer
20	ISO 8180	Ductile iron pipelines – Polyethylene sleeving for site application
21	ISO 10802	Ductile iron pipelines – Hydrostatic testing after installation
22	ISO 10803	Design method for ductile iron pipes
23	ISO 16132	Ductile iron pipe and fittings – seal coats for cement mortar linings
24	AWWA M 41	Ductile iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying& installation etc.)
25	BS EN 545	Ductile iron pipes, fittings,accessories and their joints for water pipelines – Requirements and test methods

3.00.00 **Ductile Iron Pipes**

3.01.01 Design Requirements: Pipeline shall be sized considering C value as 140 and velocity 2-3 M/sec.

3.01.01 Classification:

The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub-section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

3.02.00 Joints:

3.02.01 Generally, push-on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent international standard. However mechanical joints, flange joints and restrained joints can also be used.

3.02.02 Rubber gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 or equivalent international standard. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent international standard.

4.00.00 **Di Fittings & Specials**

4.01.00 The DI fittings shall be as per IS 9523 or equivalent International standard.

4.02.00 External layer: The DI fittings supplied shall be provided with external protection of metallic zinc coating or zinc rich paint coating with finishing layer of bituminous paint as per IS 9523 or equivalent international standard.

4.03.00 Internal lining: The fittings shall be provided with suitable cement mortar internal lining as per IS 9523 or equivalent international standard.

4.04.00 Joints between pipe and fittings:

4.04.01 Generally, Push-on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent international standard. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent international standard.

4.04.02 Rubber gaskets

All the Dl fittings shall be provided with rubber gaskets for each socket. Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382/ IS 9523 or equivalent international standard.

Rubber gaskets for use with flanged joints shall conform to IS 638 or equivalent international standard.

5.00.00 **Type Tests**

5.01.00 The manufacturer shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract.

5.02.00 The type tests shall be carried out in presence of the Employer's representative. The contractor shall obtain the Employer's approval for the type test procedure before 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.

5.03.00 In case the manufacturer has already conducted such specified type test(s), he may submit the type test reports during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract.

5.04.00 The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

5.05.00 **Type Tests**

5.05.01 Joint Leak Tightness Test:

a) Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with

respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.

b) Tests for Leak tightness and mechanical resistance of flanged joints shall be conducted as per ISO 2531.

5.05.02 Cement Lining Smoothness Type Test:

The manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the contractor / manufacturer within the scope of this contract.

5.05.03 Ring bend test:

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

6.00.00 **Laying and Jointing Of DI Pipes:**

6.01.00 Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced/ procured.

For underground laying, special provisions in trench shall be made for accommodating socket (bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

6.02.00 Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast-in-situ.

7.00.00 **Hydraulic Testing Of Pipelines**

7.01.00 After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections.

7.02.00 Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere. After filling, the pipeline shall be slightly pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as per the relevant standard. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

7.03.00 Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified in the data sheet attached with this sub-section. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in the data sheet attached with this subsection.

DATA SHEET

S. No.	Description	Units	Parameters
1	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint.
2	Applicable standards		IS/ISO/AWWA/BS as listed in technical specification
3	Hazen & Wliiam's Constant		140
4	Pipe class		K7/K9 as per IS 8329 or equivalent international standard. Compatible with system pressure requirement.
5	Pipe Joint type		Push-on flexible joints as per IS 8329 / Flanged/ Restraint
6	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS 8329 & IS 9523
7	Welded-on Flange (as applicabe) pressure class		Compatible with system pressure requirement.
8	DI fittings class		Compatible with system pressure requirement.
9	DI fittings flange (as applicable) class		PN 25
10	Restrain mechanism at bends, specials etc.		Thrust Blocks
11	Maximum field hydrostatic test pressure	N/mm^2	Shut-off pressure or (opearating pressure+surge pressure) whichever is higher for not less than 10 minutes
	At each section (not exceeding 1000m)		
	Complete pipeline		As per IS: 12288 Table-1
12	Other requirements		As per technical specification

CHAPTER – 28

CRANES AND HOISTS

CONTENTS

28.0 CRANES AND HOISTS

28.1 SCOPE

28.1.1 Cranes and hoists to facilitate the lifting and transporting of various equipment during construction, maintenance or replacement of the plant components shall be provided.

28.1.2 Each crane or hoist shall be complete with its accessories, supporting structure, power supply, safety devices and controls and shall conform to local statutory rules and regulation.

28.1.3 Equipment to be supplied:

- Two (2) nos. Double Girder Turbine Hall EOT Crane with auxiliary hoist. The turbine hall EOT crane shall be extended upto the maintenance bay.
- EOT cranes
  i. CW Pump House (double girder crane)
  ii. Ash Blower House (single girder crane)
  iii. Ash Slurry pumphouse (single girder crane)
  iv. Ash Water Pump House (single girder crane)
  v. Filtered Water/Fire Water Pump House (single girder Crane)
  vi. Air Compressor Room (double girder crane)
  vii. Raw Water Pump House (single girder crane)
  viii. If BFP cannot be handled by the TG Hall crane then separate EOT crane shall be provided for BFP Area.
  ix. Cranes as indicated in CHP Chapter
- Electric hoists/Manual chain pulley blocks in areas like boiler, CHP, mill reject silo, Ash Handling System including ash silos, Chlorination plant, DM Plant, FGD buildings, Ammonia unloading building, AC plant, Crusher house, gates & screens in CW pumphouse, Chemical house, chlorination room and any other area requiring handling.

28.2 EQUIPMENT SIZING AND DESIGN CRITERIA

28.2.1 TG Hall EOT Crane

Two (2) electrically operated overhead travelling (EOT) crane with associated auxiliaries, along with electrical equipment, control & instrumentation as required and specified shall be provided in the turbine hall for erection and maintenance of turbo generators and their auxiliaries.

The crane shall be capable of lifting at least 125% of the weight of single heaviest component/ equipment to be handled in TG hall for erection as well as maintenance of the equipment provided in AB bay.

28.2.2 If the Boiler Feed Pumps are installed in the BC bay and/or are not accessible to TG hall EOT crane as per layout requirement, one (1) electrically operated travelling crane with associated auxiliaries alongwith electrical equipment,

control & instrumentation as required and specified shall be provided in the BC bay for erection and maintenance of boiler feed pump and their auxiliaries. The main hook capacity of each crane shall be 25% over and above the heaviest component/ equipment to be handled (including lifting beam if applicable and slings etc) or 25 T whichever is higher. Further the EOT crane shall have necessary facilities such as lifting beam with swiveling arrangement and slings for erection as well as maintenance of the equipment. Auxiliary Hook of 5 T shall be provided in the cane for handling BFP.

28.2.3 The rated capacity of all the other cranes shall be 25% over and above the heaviest component/ equipment to be handled including slings. The CW pumphouse EOT crane shall be provided with an auxiliary hook of 5T capacity.

28.2.4 The lift for the CW Pumphouse EOT crane shall be based on lifting the circulating water pump out of the pump suction flume onto the maintenance floor area.

28.2.5 The EOT cranes shall be of the double girder plate box type construction.

28.2.6 The EOT cranes shall be designed as per Class M5 for mechanical and structural components and Class M5 for all electrical components IS: 807, IS 3177.

28.2.7 Tandem operation is envisaged. For this a suitable selector switch shall be provided in the cabin for selection of Tandem/normal operation. Lifting beam for tandem operation is also included in the scope of the bidder.

28.2.8 The turbine building EOT crane shall be able to be operated both from cabin located on the crane and pendant push button station hanging from the crane or with Radio Remote Control. Other EOT cranes shall be operated with pendant push button station hanging from the Crane.

28.2.9 Underslung cranes are not acceptable.

28.2.10 **Creep Speed for EOT Cranes**

10% of main speed shall be creep and shall be provided for all motions of the EOT cranes viz. long travel, cross travel, auxiliary hoist and main hoist.

28.2.11 **Layout Considerations**

The span of EOT cranes shall be derived based on the building layout with considerations to clearances and hook approach.

Access walkway of minimum 800 mm width with safety handrails shall be provided along the full span length of the building.

28.2.12 **Other Features**

The hook for hoists shall be plain shank type swiveling hook with locking device.

The EOT cranes shall be designed to operate with 125% of rated load without any permanent deformation.

The EOT cranes shall be designed with a maximum deflection of 1/900 of crane span at rated load.

Each crane shall be provided with weight display feature on push button station.

28.2.13 **Hoists and Trolleys with Monorails**

For items weighing 300 kg and above, hoists and trolleys along with monorails shall be provided throughout the plant where crane cannot be utilized. For items weighing less than 1000 kg, manual hoists shall be provided. For items weighing 1000 kg and more, electric hoists (lift & travel) shall be provided. In case the lifting height is more than 10M, electric hoist (lift & travel) shall be provided irrespective of the weight. All hoists shall be provided with trolleys.

28.2.14 **Capacity of Cranes & Hoists**

Capacity of cranes & hoists shall be selected considering a minimum margin of 25% over the maximum weight of the heaviest equipment / component to be handled by the Crane/Hoist

28.3 **TURBINE HALL EOT CRANE**

(a)	Capacity	Two (2) Electrically operated overhead travelling cranes capable of lifting single heaviest component/ equipment, including slings etc. (as applicable) to be handled in TG hall for erection as well as maintenance of the equipment provided in AB bay. Capacity of each crane : Minimum 130/40 T.
(b)	Auxiliary Hoist	Not less than 40 Tonne Capacity
(c)	Crane span	To suit the span of turbine hall (i.e. centre to centre of rail tracks)
(d)	Total height	Top most level of crane w.r.t. the top of runway rail level not to exceed 4.5 M
(e)	Main/Aux. hook	To suit handling requirements of equipment levels (Above operating floor level & below ground floor level). Main hook shall be Ramshorn Type and auxiliary hook shall be C shank type.

(f) Maximum full load speeds

- Main Hoist 1.6 m/min
- Auxiliary Hoist 7.5 m/min.
- Trolley travel 15 m/min.
- Crane travel 30 m/min.

(g) Creep speed — 10% of maximum speed for main/auxiliary hook
10% of the maximum speed for cross trave/long travel

(h) Type — electrically operated indoor travelling type.

(i) Applicable codes

(a) Design and duty of crane structure, main hoist, auxiliary hoist, cross travel, long travel in accordance with class M5 of IS: 3177 (latest edition).

(b) All other structure of cranes in accordance with IS-807.

(c) Main hook: Ramshorn type conforming to IS-5749 (latest edition) and auxiliary hook shank type conforming to IS 15560 (latest edition)

(j) Bridge structure

(a) Vertical deflection caused by safe working load and weight of trolley in central position not to exceed 1/900 of the span.

(b) Trolley stops of spring type to be mounted independently on bridge rails to prevent trolley from running off.

(k) Buffer

(a) Suitable buffer to be fitted to each end of carriage assembly and crab.

(b) Buffers to be designed to bring the loaded crane to rest from a speed of 50% of the rated speed.

(l) End trucks, wheels and axles

To be designed in accordance to IS: 3177 (latest edition)

(m) Bridge and trolley drive Mechanism

(a) One drive at each end of bridge.

(b) One drive for trolley drive.

(n) Operator's cabin and platform

(a) Open type for indoor service to be located at B-row column. Cabin shall be designed as per IS3177 so as to have unrestrictive view of load from operator's cabin.

(b) The area of cabin to be 2500/1850 mm with a head room of 2000 mm.

(c) A foot operated electric warning horn of double bell type suitable for 240 V AC. of noise level 95 dBA at 3.5 M.

(d) One brass gong suspended outside the Cabin and operated from inside.

(e) A distinct type alarm with conspicuous warning lights on either side of the crane bridge to indicate overloading of crane.

(f) Adequate carbon dioxide gas cylinders of 4.5 Kg.

(g) One non oscillating ventilating fan.

(h) Suitable inspection cages to accommodate two persons to facilitate inspection of down shop lead.

(i) Access walkways of not less than 800 mm (clear) with hand railing of height of 1100 mm along the both side of bridge girder and cross over walkways.

(o) Drums

Shall be in accordance with IS-3177 (latest edition).

(p) Lifting tackles

(a) Main hook of Ramshorn type conforming to IS-5749 (latest edition) with safety latches.

(b) Auxiliary hook of shank type conforming to IS 15560 (latest edition) with safety latch.

(c) Wire rope of extra flexible plough steel and of 6/36 or 6/37 construction conforming to IS: 2266 (latest edition).

(q) Bearings and lubrication

(a) The type of bearings for various parts as per IS: 3177 (latest).

(b) Bearing life not less than 10,000 working hours.

(c) Centralised grease lubrication with hand operated grease pump for all bearings as per bidder's standard proven practice.

(r) Guarding

(a) Suitable guard to push forward or off the rail track any object placed across.

(b) Suitable guards to live electrical wirings downshop lead.

(c) Other guarding as per relevant standard.

(s) Safety

(a) To meet the requirements of Factories Act.

(t) Runway/trolley Rails and rail joints: Rails shall be as per relevant Indian Standard and joints to be butt welded by thermit welding or fusion welding.

(u) Brakes

a.	Hoists (Main/Aux)	:	a)	Electro-hydraulic thruster operated shoe type brake for each hoist
			b)	Electro-magnetic load brake for each hoist
b.	Bridge travel	:	a)	Electro-hydraulic thruster operated shoe type brake (to cater also for foot operation from cabin)
			b)	Electro-magnetic load brake
c.	Crab travel	:	a)	Electro-hydraulic thruster operated shoe type brake
			b)	Electro-magnetic load brake
d.	Emergency/ parking brake	:	Operable from operator's cabin	

(v) Access: Necessary ladders shall be provided for access on to crane bridge platform form the gantry girder level, from crane bridge platform to trolley platform and from operating floor of pump to gantry girder level. Access staircase shall be provided from TG Building operating floor to the crane girder in the EOT Crane parking bay along Row B.

28.4 EOT CRANE FOR BOILER FEED PUMP

28.4.1 one (1) electrically operated travelling crane with associated auxiliaries, alongwith electrical equipment, control & instrumentation as required and specified shall be provided in the BC bay for erection and maintenance of Boiler feed pump and their auxiliaries. The capacity of each crane shall be 25% over and above the heaviest component/equipment to be handled (including lifting beam and slings etc., if provided) or 25 Tonne whichever is higher.

28.4.2 The EOT crane shall be pendent operated. The power shall be supplied from a single electrical power supply point at a suitable location on the operation floor of pump house.

28.4.3 The design code for EOT crane shall be IS: 3177 latest edition. However, the speed for the various motions shall be as follows:

Main hoist	-	1.6 m/min
Trolley Travel (Cross Travel)	-	4.0 m/min
Crane Travel (Long Travel)	-	10.0 m/min

28.4.4 Creep speed drives shall be provided for all the motions viz. bridge motion, trolley motion and hoist motion. This shall be 10% of the rated speeds. (Creep speed to be achieved through pony motor and planetary gear box or through variable voltage variable frequency (VVVF) system. Hoist brake shall not be used for this motion).

28.4.5 The crane shall be electrically operated, overhead travelling type. Design and duty of crane structure, main hoist, cross travel and Long travel shall be in accordance with class M5 of IS: 3177 (latest edition) and shall be suitable for indoor operation.

28.4.6 The crane shall be complete with trolley and truck, wheels and axles, Drive mechanisms, Hoisting Drums, Brakes, Creep Speed Arrangement, Lifting tackles, Buffers Electric Motors, Controls, Switch Board and cabling, horns, warning lights, Limit switches etc. Any item not mentioned herein but required to make the system complete for the satisfactory performance of the crane shall also be included.

28.4.7 The main hoist, trolley travel and crane travel for each movement shall be motor driven. Proper allowance shall be made for impact and wear in the design of the crane and in no case shall the factor of safety in any part be less than six (6), as per IS: 3177 based on the ultimate strength of the materials used at design duty. The design duty of crane structure, main hoist, cross travel and long travel shall conform to class M5 of the Indian Standard IS: 3177 (latest edition) or superior. The crane as a whole shall comply with the Indian Standard IS: 3177 / IS: 807 or approved equivalent international standard (latest edition).

28.4.8 Mechanical and Electrical equipment of each crane shall be of simple robust design, easy for correction adjustment, readily accessible for maintenance and elegant in appearance. All steel used in the crane shall be tested to requirements.

28.4.9 The hoist motors shall be provided with electro-magnetic brakes as well as Electro Hydraulic Thrust brakes. Electro - Hydraulic Thrust brakes shall be provided for cross travel & long travel.

28.4.10 2 X 100 % Brakes shall be provided for each motion. Each brake for hoisting motion, cross travel, long travel etc., shall be designed as per following:

Brakes to be as per IS 3177. The Capacity of hoisting motion brakes to be 150% of torque transmitted to the brake drum with full load and that of cross travel and long travel to be 125% of motor rated torque before deaerating.

28.4.11 Safe means of access shall be provided and to every place of crane where examination/maintenance of any component is involved. A platform shall extend to full length of the crane bridge on both sides of the bridge girder. The platform shall be made of checkered Steel plate. A double tire hand -rail of height 1100 mm shall be provided along the outer edge of the platform and 75mm high toe-guards shall be provided all along the platforms and wherever else required from safety consideration. The width of platform shall not be less than 800mm in width and Guard rails shall be provided on the crab side of the bridge platform.

28.4.12 LADDERS : Necessary access ladders shall be provided for access on to crane bridge platform from the gantry girder level, from crane bridge platform to trolley platform and from operating floor to gantry girder level.

28.4.13 The lifting tackle shall consist of a safety type lower pulley block, hook, necessary sheave and flexible steel wire ropes. The lower block sheaves and ropes shall be of adequate design and size to handle the specified loads. The hooks shall be of forged steel. The main hook shall be of shank type conforming to IS: 15560 (latest edition). The factor of safety for the rope shall not be less than six (6). The sheaves shall be of heavy duty with deep flanges made of cast steel and shall be properly grooved to fit the rope and adequately guarded.

28.4.14 Each crane shall be controlled individually for all its motions from the control pendent panel. Each crane shall have a permanent inscription of English on each side, readily visible from the ground level, stating the safe working loads in tonnes for both the hooks, year of manufacture, crane serial number and manufacturer's name.

28.4.15 The vertical deflection of crane girder shall not exceed 1/900 of the span, as per IS: 807. The girder shall be of box type and construction shall ensure non-accumulation of water/oil inside the box.

28.5 **Other EOT Cranes**

28.5.1 The EOT cranes for all other areas indicated in clause 28.1.3 above shall meet all the requirements indicated in clauses 28.3 and 28.4 above as applicable.

28.5.2 The EOT crane in CW pumphouse shall be provided with auxiliary hoist of 5 T capacity.

28.6 **Electrical Requirements**

28.6.1 Electrical equipment shall be adequately rated to permit simultaneous operation of nay combination of motions of the crane for it duty service.

28.6.2 **Motors**

28.6.2.1 Three phase Squirrel Cage Induction motors to be operated with VFD system shall be suitable for speed range and torque without exceeding temperature rise limits as specified elsewhere in this specification. These motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for Inverter duty.

28.6.2.2 Motors shall be energy efficient and shall conform to latest revision of IS 325, IS 3177 and motor subsection of this specification.

28.6.2.3 Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.

28.6.2.4 Motors shall suit the duty class S4, cyclic duration factor 60% and 300 starts per hour and shall be suitable for VVF operation. Motor pull out torque shall not be less than 2.75 times/ rated torque. Motor shall have class F insulation temperature rise limited to class B and enclosures shall conform to the degree of protection IP-55.

28.6.2.5 All motors shall be capable of the following:

- Operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.
- Withstand 120% of rated speed for two minutes.
- Current shall not exceed 6 times full load current for creep speed motor.
- Withstanding the stresses imposed if started at 110% rated voiltage.
- Start with rated load and accelerate to full speed with 80% rated voltage at motor terminals.
- The locked rotor motor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 3 seconds for motors upto 20 seconds starting time.
- Maximum torque shall not be below 200% of full load torque.

28.6.2.6 Each motor more than 30 KW rating shall be provided with space heater. All electrical equipment accessories and wiring shall have tropical protection.

28.6.2.7 The crane(s) shall be furnished complete with all electrical equipment, accessories, like drive motors with VVF drives, conductors, insulators, protective & operating devices, cables, current collectors, all protective devices, anti collision limit switches, mechanical overload and protection for electrical faults etc

28.6.2.8 The VVF drive control shall be used for control of each motion. The VVF drive shall be equipped at least with 1024 pulse incard, droop control for synchronization and crane software. The rating of VVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.

28.6.3 **Controls**

i) Speed control of EOT crane shall be through Variable Voltage Variable Frequency System (VVVF) with minimum 6 pulse design.

ii) Necessary input & output devices to be provided to reduce harmonics, as per IEE519, at supply side of the drive at the switchgear.

iii) All necessary protections e.g. Input Phase Loss, Earth Fault, Over Voltage, Output Short Circuit, Load Loss, Input Transient Protection, Overload etc to be provided.

iv) VVVF system shall be capable of generating suitable starting torque (upto 400% typical) with / without encoder, however starting current shall not exceed 150% of the rated torque.

v) VVVF system shall be capable of withstanding upto 50 deg C ambient temp without derating

vi) Provision for controlling the motion from operator cabin as well as remote control shall be available.

vii). Squirrel cage Induction motor with VPI insulation shall be provided With VVVF system.

viii) Master controller - Desk type having following features.

(i) Five speed control points in each direction of hoist motion.

(ii) Four speed control points in each direction of bridge and trolley motion.

(iii) Release of operator's hand from the controls shall stop motion and set brakes automatically.

ix) Protective Panel Provided with isolating switch, power contactor control and indication to switch ON/OFF power to starter panels, control and lighting transformer

x) Separate VVVF system panels to be provided for CT, LT and hoist motion (main and auxiliary drives).

a) Contactors: AC 4 duty for reversing application AC 3 duty for non reversing application

b) Switches: AC 23 for motor application, AC 22 for other application.

c) Fuses: HRC

d) Overload relay: Temperature compensated, bimetallic with single phasing preventor.

xi) Panel shall be fabricated out of 1.6 mm thick rolled sheet steel. IP 52 degree of protection. Paint shade shall be RAL 9002 for front & rear and RAL 5012 for side covers. Space heaters shall be provided.

28.6.4 **Radio remote Control of EOT Crane**:

i) The equipment should have facility to control EOT crane by radio frequency based wireless remote unit. The equipment shall be supplied with transmitter unit, receiver unit, encoder unit, decoder unit, interface panel, coupling system, battery unit and any other control gear if required.

ii) The equipment should be based upon the microprocessor based digital technology with almost nil hard wiring.

iii) The remote unit shall communicate up to the distance of approximately 100 M.

iv) The system has to integrate with the control system of crane, which operates at 110 V AC, Single phase.

v) The remote unit should have transmitter which can be mounted on shoulder by suitable belt. Main controls can be of single joystick movement or double joystick movement type stepped control with spring return. The Micro control should be toggle switch type or push control type.

vi) Frequency allotment for radio remote unit from Govt. of India, Dept. of Telecommunications or any other agency shall be the responsibility of supplier.

vii) The transmitter and receiver unit should have its own frequency and address code with each system having its own security code so that one particular set becomes unique and there is no interference from any other remote unit device. A microprocessor should check all security codes. The processor should have its own watchdog circuit. The receiver FM band should be sufficiently narrow to allow only passing of desired frequency and valid command. Any error should shut down the system immediately.

viii) The remote unit shall have safety key to prevent any unauthorized operation. All the crane operations shall stop at once the communication break down occurs.

ix) On local unit (receiver side), the system shall be provided with one selector switch so that EOT crane can be operated either from Operator cabin or radio remote unit.

x) The receiver unit along with I/O interface unit shallbe able to bear the vibrations and shocks encountered in normal usage of EOT crane.

xi) The system shall have very fast response time.

28.6.5 **Power Supply**

(a) Down shop Lead (DSL):

(i) Shall conform to IS: 282 and shall be szed to

- Cater to all cranes working simultaneously with 40% cyclic duration factor for load.
- Limit voltage drop at motor terminals within 2% at extreme positions.

(ii) DSL shall be sized with a margin of 10% over oad requirement.

(iii) Protective cover over DSL to be provided.

(iv) Two (2) isolating switches in enclosure shall be provided at extreme ends of operating floor for disconnecting supply to DSL while maintaining the crane.

(v) DSL shall be located on 'A'-Row side for Turbine hall EOT crane.

(b) Transformers

Dry type, with insulation class B or better. Following transformers shall be provided.

(i)	Control Transformers	:	2x100%, 415V / 110V
(ii)	Lighting Transformers	:	One 415V/240V
(iii)	Hand lamp	:	One 415V/24V

28.6.6 **Illumination**

LED lamps shall be provided under the bridge, over the bridge and inside the cabin.

28.6.7 **CABLES**

(a) EPR insulated, copper conductor trailing cables, as per IS: 9968, on the bridge.

(b) Extruded PVC insulated, copper/Aluminium conductor, 1100 Volt grade power cables. This shall include cable lengths between changeover switch & DSL and isolating switch & DSL.

(c) Extruded PVC insulated, copper conductor 1100 volt grade control cables. Mechanical overload protection - to be provided for hoist mode.

28.7 **MAXIMUM SPAN/DEPTH RATIO FOR GIRDER**

(a) Plate girders : 18

(b) Lattice girders : 12

28.8 **Material**

(i)	Structural steel plates	:	Mild steel, grade 'B' of IS 2062 in 100% killed olled section normalised and ultrasonically tested quality or high strength steel of IS 8500 as appropriate
(ii)	Nuts & Bolts	:	As per IS: 1363, IS: 1364 and IS: 1367. High Tension Friction grip bolts as per IS: 3757. High Tension Friction grip nuts as per IS: 6623.
(iii)	Electrodes	:	Radiography quality, covered electrodes with heavy covering as per IS : 814 and relevant requirements of ASME Sec. IX and IIC. Bare Electrodes as per IS: 7280 and flux wire combination as per IS: 3613.

(iv)	Chequered plates	:	IS: 3502 (Minimum 6 mm thick O/P)
(v)	Hand rail pipes	:	32 mm NB Medium class of IS : 1161 having top and bottom rail at height of 1050 mm and 600 mm and vertical post spacing not exceeding 1500 mm with provision of kick plate(100 mm high and 6 mm thick).
(vi)	Crane Rails	:	As per IS: 3443 Grade 50 C 12.

28.9 **Minimum thickness of Structure Members**

(a)	Load Carrying members	:	8 mm
(b)	Tubes with both ends sealed	:	4.9 mm (6 SWG)
(c)	Tubes with unsealed ends	:	8 mm
(d)	Chequered plate	:	6 mm O/P

28.10 **Dead Weights**

All dead weights for testing the cranes & hoists at site shall be arranged by the bidder.

CHAPTER – 29

ELEVATORS

CONTENTS

29.0 ELEVATORS

29.1 SCOPE

29.1.1 Scope covers design, engineering, fabrication, supply, installation, testing and commissioning of elevators as listed below.

29.1.2 The required equipment and services shall be as described below:

29.1.2.1 Two (2) 3000 kg passenger cum goods elevators for Steam Generator.

29.1.2.2 One (1) 2000 kg passenger cum goods elevator for Crusher House.

29.1.2.3 One (1) 2000 kg passenger cum goods elevator for JT – 7.

29.1.2.4 One (1) 1088 kg passenger elevator for Turbine building (BC Bay). This elevator shall travel upto Deaerator floor level.

29.1.2.5 Two (2) 1088 kg passenger elevators for Service Building.

29.1.2.6 One (1) 1088 kg passenger cum goods elevator for Absorber tower (FGD area).

29.1.2.7 One (1) 1088 kg passenger cum goods elevator for Limestone silos up to roof.

29.1.2.8 One (1) 1088 kg passenger cum goods elevator for Gypsum dewatering building.

29.1.2.9 One (1) 1088 kg passenger cum goods elevator for Limestone crusher house.

29.1.2.10 One (1) 884 kg passenger elevator for ESP Control Room.

29.1.2.11 Any other building/control room/ MCC room apart from the elevators listed above and having more than two floors (>G+2) shall also be provided with 680 kg passenger elevator.

29.1.2.12 One (1) 400 kg rack & pinion type stack elevator (Passenger cum Goods) capacity complete with all other accessories and associated steel works for RCC Chimney.

29.1.2.13 Electrical equipment such as motors, starters, switches, switch gears, control panels, interlocks, control & power cabling and earthing of electrical equipment.

29.1.2.14 Any other equipment or accessories not specified here in but required for the satisfactory and safe operation of the Elevator shall also be included in scope of work.

29.2 RACK & PINION ELEVATORS

29.2.1 Design Criteria for Rack & Pinion Elevators

29.2.1.1 Elevator shall be located inside the RCC stack and shall be capable of operating from the ground floor to the top interior platform with intermediate stops at all interior platforms.

29.2.1.2 All mechanical and electrical operating devices and trailing cable shall be designed for operation indoors with dusting and high humidity conditions and shall operate equally well in any ambient temperature from 3°C to 75°C. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100°C when the elevator is not operating.

29.2.1.3 Elevator shall be attached to the chimney shell using anchor bolts supplied and installed into the chimney shell.

29.2.1.4 Design and Operational Requirements

29.2.1.4.1 Design and operation of the stack elevator shall comply with the following requirements:

i.	Carrying capacity (kg)	:	400
ii.	Operating speed (m/min)	:	40
iii.	Cab floor size (inside) (mm) width x length	:	1100x1100 (minimum)
iv.	Landing levels (Nos.)	:	Minimum 22 (at all internal platform levels) (landing platform shall be provided)
v.	Landing elevations	:	As per requirement
vi.	Total vertical travel (M)	:	275
vii.	Electrical power supply system	:	415 Volts, 3 phase, 50 Hz
viii.	Type of loading	:	Passenger cum goods

29.3 Equipment Specifications for Rack & Pinion Elevators

29.3.1 Enclosures

A three-sided enclosure with one access door shall be provided for ground landing. At each platform landing above ground level, a one-sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh of suitable height (approx. 2.1 m) and primer coated with coats of the manufacturer's standard primer and finish paint. The ground landing shall be provided at a suitable height above the foundation slab to ensure a safety space underneath the cage. The space under the landing shall be surrounded by foundation enclosure. The staircase, bolted to the door front, shall be provided for access to the cage. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the cab is at a landing. Doors shall be bi-parting and swinging.

Base of the three sided enclosure shall be securely anchored to the ground level floor slab using expansion type anchors.

29.4 Mast

Mast shall be provided in flat sections of suitable length, consisting of tubular sections and/or structural shapes welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the concrete chimney walls.

29.5 Cab

a. Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.

b. Cab floor shall be of skid resistant chequered plate or fibreglass reinforced plywood or approved equivalent. Cab shall be attached to a framed structure and form an integral part with the drive mechanism located atop the cab.

c. Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinions to prevent cab disengagement in case of roller failure.

d. Cab roof shall be provided with an escape hatch electrically interlocked with the hoist control system. Tubular steel handrail shall enclose the cab roof for maintenance operations.

e. Cab door and landing level enclosure doors shall be electrically and mechanically interlocked to prevent the cab from being operated unless the cab door and landing level enclosure doors are fully closed and to prevent the doors from being opened while the cab is in motion.

29.6 Drive Units & Safety Device

a. Drive unit shall be located on top of the cab. It shall be a compact with pinion engaging into the rack of the mast. The pinion shall be mounted on a key joint & fitted to the secondary shaft of the worm gear which shall be driven by an AC squirrel cage induction motor.

Drive unit shall incorporate an Electro Hydraulic Thruster (EHT) type brake and an external manual brake release. The mechanical compression spring shall be held off by hydraulic pressure. This hydraulic pressure shall be provided by EHT brakes. In the event of power failure, the brake shall be automatically applied & will stop the cab. The brake shall be of self adjusting type and released by means of a special handle provided in the cab.

b. A safety device shall be provided in conjunction with the drive unit & shall have a separate flame hardened steel pinion engaging in the rack. The device shall be actuated by centrifugal weight & stops the hoist smoothly in case the normal travelling speed exceeds. The safety device shall remain locked on following this action & has to be manually reset before normal elevator operation can be resumed. For testing the safety device, the hoist shall be provided with a remote control facility. Bidder shall ensure that no person is in cab during the test.

c. The hoist shall be provided with a centrifugal brake to prevent accidental tripping of the safety device when the cage shall be taken to the ground by gravity in case of power failure. The motor brake shall be released mechanically by a lever in the cage to allow the cage to move down. The centrifugal brake shall keep the preset speed lower than the tripping speed.

29.7 Power and Control

All electrical components furnished with the elevator shall be completely wired, energized and checked as part of the work.

All electrical control devices shall be in enclosures. Equipment furnished shall also include the following:

a. Momentary contact push button for raise/lower control.

b. Reversing combination motor starter with a three phase thermal overload relay for motor protection. However, the control circuit in the elevator will have miniature circuit breakers.

c. Electric and mechanical interlocks on cab access door and landing level enclosure doors.

d. An ultimate three phase over travel limit switch, which cuts off power and control supply in the event of over travel. The switch can also be manually turned to off position.

e. Safety devices as described above.

f. An alarm push button shall be provided in the cage. Alarm signal will be transferred to elevator base by means of alarm facility incorporated within the tone frequency equipment.

The auxiliary panel at the base will have battery and battery charger for the alarm horn. In case the bidder does not have tone frequency equipment the alarm push button shall be connected to a battery operated alarm at the elevator base.

g. Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.

h. The cable shall be supported by brackets on the cage and guide rails. A cable trolley will keep it in the tension and will be guided on the same rail as the cage. The traveling cable shall run through cable guides.

i. One auxiliary panel shall be furnished and mounted on the ground level enclosure. Panel shall be in enclosure equipped with a main "ON-OFF" selector switch, main contactor, relays, control transformer and MCB's, tone frequency transmitter, terminal blocks, and all other accessories required for normal operation of the elevator.

j. One main control panel shall be furnished and mounted on the top of the cab. Panel shall be in enclosure equipped with necessary equipment like rectifier, battery, battery charger, tone frequency receiver, contactors, breakers, control transformer and MCB's, thermal overload relays and all other equipment and accessories required for normal operation of the elevator.

k. Cab shall be controlled by a semi-automatic control system with push buttons for 'UP', 'Down' and 'Stop next landing'. Cab shall be furnished with grounding type receptacle, emergency alarm push button with a normally open contact rated one ampere at 1 volts Dc, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Multicore cables shall be used and installed in accordance with latest applicable IS or equivalent international standards. Cable guides shall be installed every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level, the main control panel on the cab, and the landings shall be provided with the tone frequency receiver. However, tone frequency receiver system is not available, system with trailing control cable is acceptable.

l. Each landing assembly shall include a limit switch and push button control station installed and wired to a landing, junction box.

m. Cab shall be equipped with a 220 volt AC interior light & duplex outlet

29.8 EQUIPMENT SPECIFICATIONS FOR CONVENTIONAL ELEVATORS

29.8.1 Elevators shall be of conventional type for Service building, TG building, ESP Control room, Boiler area, junction tower, crusher house and FGD area. The elevators shall meet the quality of international standard.

29.8.2 No. of floors/ landings served shall be decided during detailed engineering based on the approved layouts.

29.8.3 Elevators shall be designed based on following criteria:

i)	Design/ Construction codes	:	Latest edition of IS:14665
ii)	Load carrying capacity	:	As indicated above
iii)	Rated speed	:	1 M per second
iv)	Position of machine room	:	Directly above elevator shaft
v)	Machine room	:	Machine room shall be provided with minimum 2T capacity split type air conditioner
vi)	Total Travel	:	As per Layout and as per the height of the buildings
vii)	Method of Control	:	Variable voltage variable frequency (VVVF)
viii)	Specification code	:	As per IS: 14655 (5 parts) latest Edition.
ix)	Size of platform	:	As per IS14655 & manufacturer's standard
x)	Size of lift well	:	As per IS14655 & manufacturer's standard
xi)	Design seismic coefficient	:	According to IS 1893-1977

29.9 Automatic Rescue Device (ARD) – (Battery drive)

Bidder to provide a modern advanced electronic drive system of "Rescuing passenger trapped in an elevator".

29.10 Emergency Safety Devices

The lift shall be provided with safety devices 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 the governor tripping speed with full rated load in car.
Elevator shall have Floor announcement system & Braille switches.

29.10.1 All steel embedment for fixing landing doors/indicators etc to the elevator well shaft and fascia plate shall be supplied by the bidder.

29.10.2 Guide rails complete with supporting brackets for the car and counter weights. Bidder to take care of granite tiles (approx. 80 Kg) to be provided for cabin flooring in selecting counter weights.

29.10.3 Elevator drive machines complete with electric motor, reduction gear unit, suspension ropes, buffers for the cars and the counter weights and other drive and control mechanism. All foundation anchor bolts sleeves, anchoring steel and any item required to complete the job satisfactorily shall be provided by the bidder. The bidder shall also provide for the grouting of anchor bolts, sleeves, anchoring steel etc and other anchorages. Bidder shall provide hoist and hoisting beam in the machine room ceiling.

29.10.4 Any other steel works as well as all other accessories/ components not specified in the specification but necessary for making the elevator complete.

All work including the supply of steel items, associated with installation of equipment in the machine room hoist way door, elevator-well complete with foundation and brick walls around the lift well together with overhead machine room (with R.C.C. floor slab with necessary pockets for anchor bolts and slots), frames and elevator pit, complete shall form part of bidder,s scope.

29.11 **Operation**

29.11.1 Elevator shall have provisions to meet the following operational requirements

1. Selective duplex collective, automatic operation with or without attendant through illuminated push button station located inside the lift car.

2. Door opening shall be automatic door operation and electronic door protection system for opening/ closing of car and landing doors.

3. Car operating panel with luminous buttons, car position indication in car (both visual and audio) combined with direction arrows, overload warning indicator, battery operated alarm bell and emergency light and fan & hands free speaker telephone set with suitable battery charger & controls.

4. Emergency indicator to indicate the location of elevator in case of elevator being stuck up between the floors through automatic flashers (both audio and visual).

5. Electronic door detector (infra red curtain type).

6. Two push button stations, one for upward movement and the other for down ward movement at each intermediate landing and one push button at each terminal landing shall be provided in order to call the car. Digital hall position indicator at all floors, tell lights at all floors shall also be provided by the bidder.

7. For facilitating movement of visually & hearing impaired persons, hall lantern and car arrival chimes shall be provided.

8. All fixtures shall be in stainless steel face plates.

9. Push buttons shall be fixed in the car holding the doors open for any length of the time required.

10. All other safety/ protection/ operation interlocks as required by IS: 14665 (latest edition).

29.12 Construction

Construction of the elevators shall specifically meet all requirements of the codes indicated and shall have the following additional features.

i)	Flooring of cabin	:	Vitrified ceramic tiles of mat finish
ii)	Car enclosure and panels	:	Stainless steel
iii)	Handrails on 3 sides	:	Mirror stainless steel
iv)	False ceiling	:	Powder coated
v)	Car opening & hoist way opening	:	Protected by central opening sliding stainless steel door.
vi)	Cabin accessories	:	LED light fittings on car floor. Car control station Emergency stop switch 15/5A plug socket with switch on top of lift car.

29.13 Design Requirements

29.13.1 Car Platform

a. The car platform shall be constructed of structural steel sections treated with anti-corrosive paint, securely fastened together with 6 mm thick stainless steel chequered plate. The top flooring shall consist of chequered plate flooring 5 mm thick over two (2) layers of wood.

29.13.2 Car Enclosure

a. The car shall be constructed of sheet steel panels, properly braced and supported, equipped with 400 mm dia cabin type ventilating fan and adequate lighting. Car entrance shall be provided with SS sheet metal panel doors of approximately 1000 mm x 2000 mm. Concealed openings shall be provided to allow ventilation as the car travels up and down. 32 mm dia. mirror stainless steel handrails shall be provided on three (3) sides of the car.

b. The entire elevator car including the platform shall rest on a number of 'live' rubber blocks mounted on a steel supporting structure. Lateral and upward motion shall be restrained by 'locking' blocks, isolation buffers and pads but there shall be no metal to metal contact. At the top, the car shall be held firmly to the upright members of the car frame by rubber faced clamps welded to each side of the car canopy. As an added noise protection, the side panels of metal cars shall be coated with 60 microns thick anticorrosive paint.

c. To avoid dirt and dust collection, the inside panels of the car shall be of SS and covered with anti-rust paint and three (3) coats of paints to approved colour.

d. LED electric light fixtures shall be provided in the car, consisting of a suitable light outlet, with light and substantial lamp guard. Car light shall be connected by means of flexible travelling cable to light outlet in the hoistway. Lux level inside the elevator car shall be 100 lux.

e. The car entrance shall be provided with a set of power operated centre opening sliding metal doors. Car doors shall be of SS flush type construction as per manufacturer's practice. Door panels shall be reinforced for power operation and shall be hung on two point suspension hangers with rubber or plastic tired sheaves not less than 82 mm (3- 1/4 inch) in diameter running on a polished stainless steel track. Doors shall be guided at the bottom by non-metallic shoes sliding in a smooth threshold groove. The leading edges of car doors shall be provided with a flexible rubber protective safety device to prevent injury to any person upon automatic gate closure.

f. Inside the car, there will be furnished flush type attractively finished metal panel containing a series of push buttons numbered to correspond to the landings served, an emergency stop switch and an emergency call button connected to a bell which serves as an emergency signal.

29.13.3 **Counter-weights**

a. The elevator shall be suitably counter balanced for smooth and economical operation. Cast iron weights shall be provided in a structural steel frame properly guided with suitable guide shoes. The counter-weight shall be equal to the weight of complete elevator car and about forty five (45) percent of the specified capacity load. Steel guides for elevator/car & counter-weight shall be furnished by the contractor.

b. The design of the counter-weight is such that the cast iron filler weights are not subjected to any stresses or loads being carried by the steel frame. Two (2) tie rods shall pass through each counter-weight filler to ensure that they are not misplaced even if broken.

c. Substantial expanded metal counterweight screen guards of required length at the bottom of the hoistway shall be furnished.

29.13.4 **Guides and Fastenings**

a. Guides for car and counterweights shall comprise of planned steel tees, erected plumb and securely fastened to the hoistway framing by heavy steel brackets and stiffeners. Guide rails from the car and those for the counterweights shall be located at sides of hoistway. The ends of all guides shall be tongued and grooved forming perfectly matched joints and connected with steel splice plates. Steel backing for car guide rails shall be securely fastened to the rails and extend from floor to floor.

b. Guide rails shall be lubricated from the top of car and counter-weights during servicing to distribute oil evently to the guide rails.

29.13.5 **Car Safety and Governor**

a. The elevator shall be equipped with a safety system complying with the code requirement to protect the car from over-speeding downward beyond a predetermined speed. The system shall be separate from the driving machinery and the service brake and shall consist of a rugged fly-ball type speed governor or pendulum- operated type governor driven by the elevator car. The governor shall conform to IS:4066. Suitable means shall be provided to cut off the power from motor and apply the brake on application of safety.

b. Should the elevator begin to overspeed the governor shall operate a "safety switch' and cut off the power to the hoisting machine. This initial action shall apply the service brakes. Should the car's downward speed continue to increase, the governor shall trip and clutch the governor rope with enough force to set both safety clamps on the elevator car and bring the safety jaws into contact with the guide rails. Instantaneous cam grip safety devices for governors are acceptable.

c. After the car comes to a stop, the safety jaws shall continue to grip the rails and hold the car stationary.

d. Two (2) safety shoes shall extend the full height of and project beyond, the front edge of the car doors. Should the shoe touch a person or object while the car door is closing, the car and hoistway doors will return to the open position. The doors will remain open until the expiration of predetermined interval and then close automatically.

e. Renewal of the doors shall be accomplished by pressing the 'open' door button in the car operating panel.

29.13.6 Ropes & Sheaves

a. Suitable traction steel, hoist ropes of size and number complying with the factor of safety requirements of the American Standard Safety Code A17.1-1965 for elevators or approved equal standards shall be supplied. Governor ropes shall be off plough steel.

b. All ropes shall be preformed sealed construction 8 wire 19 strands. The full details of ropes, the maker's name, trade name, breaking strength, designed factor of safety of all ropes shall be submitted with the tender. The hoist ropes shall include adjustable self-aligning hitches.

c. Car and counterweight sheaves shall be furnished as needed. The sheaves shall be of close grained aged cast iron free from defects, grooved for hoist ropes, rotating in grease lubricated bearings and shall be carried by steel shafts supported steel beams or channels.

29.13.7 Buffers

Substantial spring buffers shall be supplied as means of stopping the car and counterweight at the extreme limits of the travel. If buffers are installed in the pit, they shall be mounted on continuous channels, fastened to the guide rails or fixed on concrete pillar foundations. Pipe struts for buffers shall be provided, as required.

29.13.8 Automatic Terminal Stops & Self-Levelling

a. The elevator shall be equipped with an automatic stopping device, arranged to bring the car to a stop at the terminal landing independent of the regular operating device in the car. Final limit switches shall be provided in the hoistway operated by the car and arranged to cut off power to stop the car and prevent operation, should it travel beyond the zone of the normal stopping device.

b. The elevator shall be provided with a self-levelling feature that will automatically bring the car to the floor landing. This self-levelling shall, within its zone, be entirely independent of the operating device and shall automatically correct

over-travel and maintain the car level approximately (± 12 mm) with the landing regardless of change in the load affecting the stretch of the cables.

29.13.9 **Elevator Entrances**

a. The frames shall be made from best grade steel and shall comprise square head and rounded jamb sections with integral casing and welded corners to form one-piece frame. Frames shall contain suitable material or effective sound deadening. All frames shall be returned on the hoistway side to present a neat appearance.

b. The doors shall be of centre opening type flush construction and shall contain suitable material for sound deadening. Entrance doors shall also be of hollow SS sheet panel flush type construction not less than 25 mm thick. The leaves when open shall remain concealed in the door frame. Bottom of doors shall be provided with removable laminated phenolic guides which run in the sill slots with minimum clearance. All doors shall be provided with keyways as required for door operating mechanism.

c. The sills shall be cast iron or extruded aluminium with approved non-slip wearing surface. Grooves for the door guides shall be machine planed with minimum clearance for the guides. The sills shall be supported on steel anchors securely fastened to the floor construction.

d. Fascia plates shall be of stainless steel, reinforced to ensure a flat even surface throughout and shall be securely fastened to hanger housing and sills above. Hanger supports shall be 5 mm thick formed sections, securely bolted to the strut angles or support angles.

e. Structural steel angles shall be furnished of sufficient size to accommodate the door closure. Angles shall be continuous and securely bolted to the sills and building beams above.

f. Entrances shall also include emergency keyways and cover plated with V-slotted blocks to meet local code requirements. Hardware finish shall be anodised aluminium.

g. At the hoistway landings, there shall be provided an "up" push button and a "down" push button at each intermediate landing and a single button at each terminal landing.

29.13.10 **Hoist Machine and Controller**

a. The hoisting machine shall be of single wrap traction type consisting of a motor, electro-mechanical brake forged alloy steel worm, bronze gear steel sheave shaft and alloy steel sheave all completely mounted on a single base or bed plate. The hoisting machine shall also comprise of, but be not limited to, the following:

i) A reversible squirrel cage induction electric motor specially designed for elevator service with high starting torque and low starting current, class-B insulation with IP-55 degree of protection and for continuous elevator duty shall be furnished. The generator shall be wound for direct current with degree of protection to IP-21 and shall be of the multipolar type provided with interpoles. The motor shall be wound for power supply. The motor generators set shall operate at moderate speed with high efficiency and low power consumption and shall have sufficient capacity to handle

without overheating the peak current typical of elevator service. It shall be provided with necessary cable entry boxes, foundation bolts, grounding lugs, lifting hoist and tapered roller bearings of ample size.

ii) The motor shall comply with the requirements of the enclosed "Standard Technical Specification for Induction Motors'. The motor shall be of indoor type with IP-55 degree of protection. The MG set shall also be of fully enclosed type to avoid entry of dust.

iii) The traction motor shall have an extended shaft, coupled to an enclosed, oil-cooled worm gearbox. The worm shall be forged alloy steel machined and ground integral to the shaft and provided with double tapered roller bearings designed to take care of end thrust in both directions.

iv) The worm gear shall be hobbed from a bronze ring accurately bolted to the gear spider. The gear spiders shall be integral with the rope sheave spider and shall be keyed to rope drum shaft which shall be carried in double heavy tapered roller bearings enclosed in pillow blocks. The rope sheave rim shall be cast iron machined and ground grooves accurately fitted to the spider. The driving sheave will be grooved to ensure sufficient traction and minimise rope wear.

v) Adequate means of standard lubrication will be provided for all bearings and worm gear.

b. The brakes shall be DC operated electro-magnetic type spring applied and electrically released to permit hand winding in the event of a power failure or alternately motor operated positive action type. The coil and terminals shall be totally enclosed. The brake shall be designed with Ferrodo liners on cast iron shoes operated with DC brake with re-levelling system to provide smooth stops under variable loads. It should be possible to lift or lower the cage manually through winding arrangement from the machine room with ease. Alternately the contractor shall quote additional price (if any) for bringing stranded lift to the nearest floor by automatic winding arrangement.

c. The controller shall be of the microprocessor based to control starting, stopping and to regulate the speed of the elevator motor and also to automatically apply the brake if any of the safety devices operate or if power fails. The controller shall be provided with reverse phase relay to protect the elevator motor against phase reversal, low voltage and phase failure.

d. For supplying DC power to the brake and controller, provision shall be made for a metal rectifier of adequate capacity to handle without overheating the peak currents typical of elevator service. DC Generator shall be multipolar type provided with interpoles. The conversion equipment shall be provided with protective relays, controller, switches, interlocks, all mounted on a panel.

e. The hoisting machine and control equipment shall be placed directly over the hoistway. The structures for machine room and its supporting beams shall be securely fastened to the supports provided by the Purchaser. Necessary fastening bolts and nuts shall be furnished by the contractors..

f. The system shall provide smooth and practically constant acceleration and retardation under all operating conditions. During acceleration and retardation periods, the voltage applied to the elevator motor is gradually changed by varying the field strength of the generator without interruption of power to the motor.

g. Overload relays shall be supplied to protect the driving motor against overloads and the elevator traction motor and generator armature against overload.

h. Suitable magnet switches for starting the motor generator set shall be furnished on the controller. These switches shall include contacts provided with springs to maintain proper contact pressure and arc chutes or blowouts to quickly extinguish arcs and prolong the life of the contacts.

29.14 Controls and Indications

29.14.1 The control scheme for the elevator shall be such that on pressing one or more car or hall buttons, the car shall start automatically, provided the interlock circuits are established, and shall stop at the first floor for which a car button has been pressed, or for which a hall button has been pressed corresponding to the direction in which the car is travelling. The car shall stop at all floors for which such calls have been registered and these stops shall be made in the order in which the floors are reached by the car, irrespective of the sequence in which the buttons have been pressed, provided the button for a given floor has been pressed sufficiently in advance of the arrival of the car at the floor to permit the stop to be made.

29.14.2 The control shall be so arranged that if no car button have been pressed and the car starts up in response to several "down' calls, the car shall travel to the highest "down" call first and then reverse to collect the other "down" calls. The "up" calls shall be collected in the same way when the car starts down in response to "up" calls by first stopping for the lowest "up" call registered. Further more, if the car has stopped in response to the pressing of the hall button and the passenger presses a car button for the corresponding direction and within a predetermined interval of time after the stop, the car shall carry the passenger in that direction regardless of other hall calls registered.

29.14.3 If while the car is making its upward trip, 'down' landing buttons are pressed, no effect shall take place during the "up" trip although the calls shall remain registered. After the last passenger travelling in the "up" direction has left the car, and the interlock circuit is established, the elevator shall start automatically and respond to the 'down' landing calls. Likewise, the downward trip of the car shall not be affected by 'UP' landing button call, but such calls shall remain registered and be answered on the next upward trip.

29.14.4 A time limit relay shall be provided, arranged to hold the car at the landing, at which it has stopped, for a predetermined period of time, to enable passengers to enter or leave the car unless the hoistway or car door is held open, before it will again start automatically in response to other calls.

29.14.5 Door operation for service building elevator shall be automatic with electronic door detector. The car cannot be started unless the car door is in the closed position and all hoistway doors are locked in the closed position. "Door open" buzzer shall be provided.

29.14.6 An emergency stop switch shall be provided in the car to interrupt the power supply and supply the brake independently of the regular operating device. The opening of the stop switch shall not cancel the registered calls; and after this switch is again closed, the car shall continue to answer its calls.

29.14.7 The motor generator set, when not in operation, shall be started automatically by the registration of a car or landing call and shall continue to run for a predetermined period after the car has answered the last registered call.

29.14.8 A motor driven electric operator shall be provided to open and close the car door and hoistway doors when the car is at a landing. The car door and hoistway door at any landing shall be opened and closed simultaneously.

The electric operator shall open the door in a maximum time of four (4) seconds and shall close the doors in a maximum of four (4) seconds. The doors shall be considered open when they are within 80 mm of full open position, and closed when the interlock circuit is established. Door movement shall be cushioned or checked at both limits of travel. An electro-mechanical interlock shall be provided at each opening to prevent the operation of the elevator unless all doors are closed and locked. The door operator shall be so arranged that, in case of interruption or failure of electric power from any cause, the doors can be readily operated by hands from within the car. Emergency devices and keys for opening the doors from the landing shall be provided. The doors shall open automatically when the car is levelling at the respective landing and shall again close after a predetermined time interval has elapsed. A 'door open' button shall be provided in the car, the momentary pressure of which shall reverse the motion, reopen the doors and resettle the time interval. The car door shall be provided with a protective device extending the full height and projecting beyond the front edge of the door. This device shall be so arranged that should it just touch a person or any obstruction in its path, while the car door is closing, it shall automatically cause both the car door and the hoistway door to return to the open position. The doors shall remain open until the expiration of a time interval and then close automatically. The pressing of a car button, once the doors are fully open, shall cause the doors to close immediately.

29.14.9 Hall position indicators shall be provided at each landing served by the elevator. It shall include the necessary mechanism and connections so that the fixture will indicate the position of the car in the hoistway, the direction in which the elevator is travelling by the illumination of frosted glass strips at all times. These indicators shall be incorporated in hall push button fixtures in stainless steel face plates.

29.14.10 Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings and final limit switches shall be furnished automatically cut off the power and apply the brake, should the car travel beyond the terminal landings.

29.14.11 Dust protective equipment shall be provided on brake; controller cabinet (totally enclosed); selector; limit switches; hall button fixtures with signals; car operating panel; car position indicator in car; hall position indicator at each landing; safety operating switch; wiring materials; and car door switches.

29.14.12 All exposed steel items in the hoistway shall be given epoxy paint to withstand the corrosive atmosphere.

29.14.13 Fungicidal treatment shall be provided on equipment such as Machine; Brake; Motor; MG Set; Controller and Selector to withstand the hot humid and tropical atmosphere.

29.14.14 The machine shall be pressurised by the contractor to supply reasonable clean filtered air to minimise dust in the machine room.

29.14.15 The elevator car shall be provided with battery- operated emergency light with 9V DC dry cells as well as telephone cabinet alongwith requisite leads in the travelling cables for communication during emergency. Telephone instrument as well as wiring from junction box in the hoistway to the instrument shall be provided by the contractor.

29.15 **Electric Motor**

The driving motors shall conform to IS 325 and suitable for variable voltage variable frequency (VVVF) application. All motors shall be squirrel cage induction type, suitable for operation at 415 V (+/- 10% variation), 3 phase, 50 HZ (+3 % to -5% variation) supply. Motors shall be provided with class F Insulation.

29.16 **Electric Wiring**

29.16.1 Complete necessary insulated wiring 650/1100 V grade to connect all parts of the equipment shall be furnished.

29.16.2 Insulated wiring of 650/1100 V grade shall have flame retarding and flame proof with moisture resistant outer cover and shall be run in metal conduit, metallic tubing or wire ducts. All wiring shall be derated for the ambient temperature of 50 deg.C and the type of laying provided by contractor in accordance with ISS. Flexible stranded copper conductor flame resistant. Control and power cables to IS:694 shall be furnished as per Standard Technical Specification for Induction Motors. The laying of cables shall be made as per IS: 2274 and 732.

29.16.3 Travelling cables between car and hoistway shall be of 250 V grade and shall have flame retarding and moisture resisting outer cover conforming to IS:4289. They shall be flexible and shall be suitably suspended to relieve strains in the individual conductors.

29.16.4 All insulated conductors and conduit or tubing as well as fittings including metal boxes trough and ducts shall comply with the requirements of the approved codes.

29.16.5 All the equipment required to be earthed shall be earthed as per relevant Indian Standards and Indian Electricity Rules and connected to the Purchaser's neutral wire earthing in the machine room switch.

29.17 **Earthing**

The elevator structures and all equipment including metal conduits shall be effectively earthed with earth conductors provided in the machine room as per IS 3043.

29.18 **Permits and Inspection**

The contractor shall obtain and pay for necessary Municipal or State inspections and permits as required including licence fees for installation and inspection of elevators equipment, also make such tests as called for by the regulations of such authorized representatives of such authorities as well as in the present of the Owner’s representative. The contractor shall be responsible to obtain license for operating the elevators at site.

CHAPTER – 30

FLUE GAS DESULPHURISATION (FGD) SYSTEM

CONTENTS

FLUE GAS DESULPHURISATION (FGD) SYSTEM

SECTION – 1

1.0 SCOPE OF WORK

The Flue Gas Desulphurisation (FGD) System shall be based on Wet Limestone Forced Oxidation process. The FGD system shall be installed downstream of the Induced Draft (ID) fans. The flue gas shall be drawn from air preheater outlets of the balanced draft, pulverised coal fired Supercritical type Steam Generator and guided through adequately sized duct work into the specified number of independent gas streams of Electrostatic Precipitator. The flue gas after the Electrostatic Precipitator shall be led to the suction of the ID fans. The flue gas temperature may approach the economiser outlet temperature of about 300°C (for a short period) in case the regenerative air preheaters fails to operate. The bidder shall take this aspect into account while designing the Flue Gas Desulphurisation (FGD) System

The scope of supply identified for FGD system here are minimum requirements and unless specifically excluded from the Bidder's scope in Exclusions, any equipment/system not included in this specification but integral to the system offered by the Bidder to meet the intent of this specification, shall also be included in the scope of the Bidder. The scope shall include but will not be limited to the following:

1.1 Description

The FGD system shall be based on Wet Limestone Forced Oxidation process. The unit shall be provided with an independent/dedicated absorber. Bidder will conduct CFD model of the FGD system gas path.

1) Gas from suitable points on ID fan discharge duct shall be taken to the absorber. The ID fan shall be capable of handling the pressure drop in the FGD system & ducting and maintain required inlet pressure at terminal point. Absorber shall be capable of handling the pressure drop in the FGD system. The chimney height shall be as described in Volume VI.

2) In the absorber, SO_2 in flue gas shall be removed by a spray of limestone recirculating slurry, pumped by slurry recirculation pumps. Alternatively, the gas shall be bubbled through the absorber slurry to remove SO_2 from the gas. In any case bidder shall offer only his proven system which is in successful operation.

3) Compressed oxidation air shall be blown through the slurry in the oxidation tank, to oxidize the Calcium sulfite to gypsum. The oxidation system provided may be either grid spurge type or lance jet type as per the proven practice of the FGD vendor.

4) Clean gas from the absorber shall be taken through multi-stage mist eliminators.

   Treated flue gas from the absorber shall be discharged to flue gas duct. Provision shall be made for facilitating operation of unit with FGD bypass. This shall also facilitate the online maintenance of absorber system and associated equipment.

5) Limestone slurry to the absorber shall be supplied by a wet limestone grinding system. Each wet limestone mill shall be fed from an independent silo through a gravimetric feeder. The classified limestone slurry from each mill shall be stored in two nos. common limestone slurry storage tanks, from where the slurry shall be pumped to the absorber by limestone slurry pumps. Refer flow diagram for FGD Lime Stone Preparation System (Dwg 111-13-5211).

Each mill shall complete with following items, as a minimum requirement:

a) A bunker Outlet gate.
b) A gravimetric limestone feeder along with its drive and its other auxiliaries.
c) Rod Gate and manual gate. Bunker outlet gate shall be motorized.
d) Two nos. ball charging devices including hopper & chute.
e) 1 no of mill separator tank with agitator(s).
f) 2 x100% Mill Circuit Pumps.
g) One set of hydro cyclone
h) A peripheral/ central drive system with motor, speed reducer gearbox and other auxiliaries.
i) An auxiliary motor for inching operation with speed reducer.
j) Complete lubricating system with appropriate lubricating medium storage Facility (including lube oil tank for storage of lube oil)
k) Lube oil pumps, coolers, duplex oil filters, connecting piping and necessary load & remote indicating instruments. Each lube oil pump and cooler shall have a 100% identical stand by.

All connecting pipes/chuted along with necessary valves between various system of the mill and from hydro cyclone to common storage tanks shall also be in the scope of bidder. Necessary pipe, pipe supports, trestles as required for the routing of the pipe shall be under the bidder's scope. Bidder shall include any other item not stated above for safe and reliable operation of milling system.

Complete limestone grinding system shall be installed inside a building provided by the bidder as specified elsewhere in the specification. The building must be complete in all respect specially ensuring the smooth operation and maintenance of the system proposed by providing adequate maintenance space, handling facilities, walk way stair case and elevator as specified elsewhere in the specification. The building shall be sufficiently ventilated.

6) The gypsum from absorber shall be pumped by dedicated gypsum bleed pumps to a Gypsum Dewatering system through primary hydro-cyclone feed water tank consisting of dual streams (in series) of primary and secondary dewatering equipments. The overflow water/slurry removed from the absorber to Absorber sump and other drains shall be recycled to the absorbers.

The waste water from the system shall be discharged to effluent treatment plant as specified elsewhere in the specification.

Washed and dewatered gypsum from the dewatering system shall be fed to a belt conveyor. The Bidder shall discharge the gypsum cake above the belt conveyor and transferred to Gypsum storage yard.

7) One (1) number Emergency absorber tank shall be provided for storage of absorber slurry of absorber along with slurry pumps for pumping the slurry back to the absorber.

1.2 Limestone Handling & Grinding System

The Bidder's scope shall include a common limestone handling & grinding system and shall comprise of:

S. No.	Item Description	Qty	Remarks
1.	Truck Weighbridge	2	To weigh incoming trucks carrying limestone
2.	Front End Loader	4	To feed limestone from stockpile into Surface feeder
3.	Bulldozer	2	For stockpile formation/management of stockpile in limestone shed.
4.	Surface feeder	2	It shall feed (-)250mm limestone into Belt Conveyor
5.	EOT Crane# EOT-1	1	For maintenance of equipment/ components within under shed
6.	Belt Conveyors# BCN-1A/1B/ 2A/2B	4	To transport Crushed Limestone from Storage Shed to Day Bin
7.	Fixed tripper# FT-1A/1B/2A/2B	4	Mounted above Day Bin.
8.	Discharge chute	Lot	As per flow diagram/ system requirement
9.	Debris chute/ tramp iron chute	Lot	As per system requirement
10.	Flap Gate (FG)	Lot	As per flow diagram
11.	In line Magnetic Separator# ILMS-1A/1B complete with Electric Hoist & Tramp Metal Trolley	2	One Tramp metal collection trolley shall be provided for each In line Magnetic Separator.
12.	Suspended Electro Magnet# SEM-1A/1B complete with Manual Hoist with Electric Trolley.	2	One Tramp metal collection trolley shall be provided for each suspended electromagnet.
13.	Belt Weigher # BW-1A/1B	2	To know feed rates to Day Bin
14.	Metal Detector # MD-1A/1B/ 2A/2B	4	-
15.	Crusher# CR-1A/1B	2	Necessary RCC Deck, Vibration Isolation System along with temperature detection system &

S. No.	Item Description	Qty	Remarks
			vibration monitoring system shall be provided for each crusher.
16.	Electric Hoist/ Manual Hoist with monorail	Lot	For equipment/ component removal for maintenance purpose.
17.	Sump Pumps# SP-1A/1B/ 2A/2B complete with discharge piping upto nearest drain	4	As per flow diagram/ system requirement
18.	Belt Vulcanizing Machine# BVM-1	1	-
19.	Dry Type Dust Extraction [DE] System	Lot	DE system shall be provided for LHS
20.	Water dust suppression system	LOT	Water dust suppression system for Gypsum storage area
21.	Mandatory Spares	Lot	Refer enclosed list
22.	Limestone Sampling System	Lot	Automatic Limestone Sampling System
23.	Sump Pit	2	
24.	Limestone shed	1	Capacity of shed shall be minimum 15 days storage requirement of limestone. For other details refer Volume VI of specification
25.	JNT-1	Lot	JNT-1 shall be provided by the bidder.

All connecting pipes / chutes along with necessary valves between various systems of the mill and from hydro-cyclone to common slurry storage tanks shall also be in the scope of the Bidder. Necessary pipes, pipe supports, trestles etc. as required for the routing of the pipes shall be under the Bidder's scope. Any item not included above but necessary for safe and reliable operation of the milling system shall also be in scope of the Bidders.

1.3 Absorber System

An independent Limestone Forced Oxidation (LSFO) type absorber system shall be provided. The absorber system shall be complete with:

a) Complete Ducting system for FGD plant from the terminal points in the flue gas ducts after ID Fan discharge to the terminal point as specified elsewhere in the specification.

b) Motor operated gas tight guillotine type isolation dampers shall be provided at following locations:

i) At inlet of absorber

ii) Clean gas duct at outlet of absorber.

c) One number hydraulically operated multi louver/bi-plane damper shall be provided in the FGD bypass duct.

d) Seal air fans shall be provided to minimize the leakage across the seals. 2x100% seal air fans with motorized isolation gates at the discharge of each fan shall be provided for each gate/dampers.

e) Absorber complete with re-circulating slurry spray header(s) and nozzles, multi stage mist eliminators, wash water nozzles oxidation tank integral to tower, oxidation headers and nozzles, agitators and all internal systems integral to the working of the absorber.

f) Absorber will have multi-level spray arrangement with 1x100% slurry, recirculation pump for each level of spray. One spray level zone at topmost layer with single side nozzle arrangement shall be provided by the Bidder as standby. Absorber should be capable of meeting the guaranteed performance without this spare level in operation.

g) 1x100% slurry, recirculation pump shall be for each level of spray.

Recirculation pump of this level (alongwith all necessary attachments) shall be provided by the Bidder.

In case bidder offer single level of spray, one number of standby pump of same capacity and head as the working sloppy recirculation pump shall be provided.

In case the bidder offers an absorber with gas bubbling through the slurry, the complete gas distribution system will be in bidder's scope. No recirculation pumps, spray headers, nozzles shall be required in such case.

The absorber spray system shall be from top or bottom of the absorber as per standard and proven practice of manufacturer.

a) 2x100% centrifugal/positive displacement type oxidation blowers / compressors.

b) One (1) no. Emergency Absorber Tank.

c) 2 x 100% Emergency Absorber Tank Pumps.

d) All connecting piping and valves required by the system.

e) 2x100% Gypsum Bleed Pumps.

f) 2 x 100% Emergency Absorber Drain Pumps shall be provided.

g) Piping from gypsum bleed pumps to gypsum dewatering system, along with recirculation lines (if required) necessary isolation and control valves.

h) Routing of the duct/piping system complete with supports, structures, trestles as required shall be in the Bidder’s scope of supply.

i) All slurry recirculating slurry pumps & oxidation blower/compressor shall be installed inside a building provided by the bidder as specified elsewhere in the specification. All pumps & oxidation blowers/compressor shall be in straight

line. The building shall be complete in all respect specially ensuring the smooth operation and maintenance of the system by providing adequate maintenance space, handling facilities walkways staircase etc. the building shall have sufficient ventilation.

1.4 Gypsum Dewatering System

1) The Owner envisages gypsum dewatering system for the unit. The dewatering system shall receive the gypsum slurry from the absorber through 2x100% Gypsum bleed pump and shall comprise of 2 sets of dewatering equipments i.e. primary dewatering and secondary dewatering.

2) 2 x 100% Primary hydro- cyclones, each suitable for handling / dewatering of unit and receiving feed from one (1) Primary hydro cyclone Feed tank through 2x100% Primary hydro-cyclone feed pumps

3) 2 x 100% Vacuum belt filters, each suitable for handling / dewatering of the unit.

4) One (1) number receiver tanks dedicated to each vacuum belt filter.

5) 2X100% vacuum pump for each vacuum belt filter. Water separators shall be provided in the vacuum receiver tank

6) 2 x 100% Secondary hydro- cyclones, each suitable for handling and receiving feed from one (1) Secondary hydro cyclone Feed tank through 2 x100% secondary hydro-cyclone feed pumps

7) Complete piping and valves for the system along with wash water line.

8) The overflow from each primary set of hydro-cyclone shall be taken to 2 x 100% Secondary hydro- cyclones, each suitable for handling gypsum of the unit and receiving feed from one (1) Secondary hydro cyclone Feed tank provided with Agitator(s) through 2x100% secondary hydro-cyclone feed pumps.

9) The under flow from the secondary hydro-cyclones shall be taken to one (1) Filtrate water tank provided with Agitator(s). 2 x100% Filtrate Water pumps (1W+1S) shall be provided to recycle the water to the absorber.

10) 2 x 100 % (1W + 1S) Belt/ Wash Cloth Water pumps shall also be provided in the filtrate water tank for cleaning & washing of belt cloth in vacuum filter.

11) The over flow from the secondary hydro-cyclone shall be taken to one (1) fines thickener followed by One (1) waste water tank. 2x100% waste water pumps shall be provided to discharge the waste water, after neutralization, to CMB.

12) All the piping with supports, trestles as required as well as in the Bidders' scope. The Bidder shall also include any other item not included above but necessary to make the system complete.

13) The complete gypsum dewatering system shall be installed inside a building provided by the bidder as specified elsewhere in the specification. The building

shall be complete in all respect specially ensuring the smooth operation and maintenance of the system by providing adequate maintenance space, handling facilities walkways staircase etc. the building shall have sufficient ventilation.

1.5 Emergency Absorbent Tank

1) The Bidder shall provide One (1) number Emergency Absorbent tank and tank shall have sufficient capacity for storage of absorber slurry of one unit.

2) The bidder shall provide 2x 100% pumps to transfer the slurry from the emergency tank back to absorber in maximum time of 8 hrs. Each pump capacity shall be suitable for one unit. All agitator(s), piping, valves, fittings and other structures required for the system shall be included.

1.6 Waste Water Treatment Plant

The over flow from the secondary hydro-cyclone in gypsum dewater system shall be taken to one no. fines thickener followed by One (1) waste water tank. 2x100% waste water pumps. The treated water from the waste water pumps discharge shall be taken to the CMB.

The scope shall include the following

a) Two (2) reaction chambers (Reaction Chamber # 1 & Reaction Chamber # 2 before thickener. Alkali & Lime shall be dozed in Reaction Chamber # 1 and Alum & Polyelectrolyte shall be dozed in Reaction Chamber # 2.

b) One (1) Thickener (over ground), complete with rake mechanism, flocculator mechanism along with drive and drive motors, telescopic type continuous sludge discharge arrangement, intermittent timer operated by- pass sludge disposal system, flushing arrangement etc.

c) Coagulant (Alum) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.

d) Coagulant aid (Polyelectrolyte) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.

e) Lime dozing system consisting of 2 nos. dozing tanks and 2 x 100% capacity dosing pumps complete with associated piping and valves.

f) Alkali dozing system consisting of 2 nos. dozing tanks and 2 x 100% capacity dosing pumps complete with associated piping and valves.

g) Acid dozing system consisting of 2 nos. measuring tanks and 2 x 100% capacity measuring pumps complete with associated piping and valves.

h) One (1) - Chemical house (two storeyed) for housing various chemical solution tanks and chemicals (30 days chemical storage space) with toilet block.

The various chemical handling and dosing equipment in the plant shall be designed for the following dosing rates:

i)	Coagulant (FeCl3)	:	40 ppm (max.)
ii)	Lime	:	10 ppm (max.)
iii)	Polyelectrolyte	:	1 ppm (max.)

A minimum of 300 mm freeboard shall be provided for all the units and chemical solution tanks etc.

All pipes shall be routed through pipe racks only (applicable for external piping only). DDE. If buried suitable protection shall be provided from impact.

i) One (1) complete sludge handling system consisting of sludge sump (effective capacity of 1 hour storage), two (2) nos. vertical sludge pumps (1Working+1Stand-by). The capacity of each sludge pump shall be fixed so as to empty the sludge sump in 20 minutes. Sludge flushing arrangement shall also be provided.

j) One(1) no. platform dial type weighing scale of 0-500 kg capacity and an electric hoist of suitable capacity in the chemical house.

k) All RCC channels/ ducts and hume pipes as required.

l) All pipe, or RCC channels/ ducts and hume pipes required for sludge disposal drain water shall be led to sludge sump.

m) One (1) centrifuge shall be provided at outlet of sludge sump.

n) Necessary flushing arrangement for the sludge pipes and filter back wash water disposal pipes.

o) The water from the thickener shall be led to waste water tank. Each Waste water tank shall be sized for 8 hours and 20% margin; storage of waste water with unit operating at BMCR and no out flow from the tank. The liquid collected from two wet flue cans of chimney and ducts shall also be considered in waste water tank design. 2 x 100% (1W+1S) horizontal centrifugal pumps shall be provided for recirculation & discharge of waste water to existing guard pond.

p) Provision to correct the pH of the waste water by chemical dosing shall be provided.

q) The waste water tanks shall be of steel construction with epoxy painting and shall be provided with agitator. MOC of equipment shall be as below :

Pumps – Body impeller, shaft, shaft sleeves and all internal & external fasteners shall be duplex stainless steel.

r) Piping, valves & instrumentation as specified and required.

s) One Bulk Acid Storage Tank with 2 x 100% Acid Unloading Pumps with associated piping & valves.

t) One Bulk Alkali Storage Tank with 2 x 100% Alkali Unloading Pumps with associated piping & valves.

u) Safety Showers as required

v) Dyke area from bulk storage of acid & alkali.

1.7 Process Water for FGD System

Process water for FGD plant shall be provided from filtered water tank by installing FGD Make up pumps in the Filtered water pump house. The following equipment shall be supplied for process water system:

1) 2 x100% (1W+1S) FGD Make up Water Pumps shall be provided to cater to process water requirement.

2) 2 x 100% (1W+1S) Absorber Mist Eliminator Wash Water Pumps shall be provided. Alternatively, Bidder may use process water pumps for mist eliminator washing if it is the standard & proven practice of the OEM / Bidder.

3) One (1) number overhead Emergency Quenching Water Tank.

4) For normal quenching of flue gas, water shall be tapped from process water pumps.

5) One (1) no. Cake Wash Water tank along with 2 x 100% cake wash water pumps shall be provided.

6) Vacuum belt filter flushing water shall be tapped from process water tank through process water pumps.

1.8 Sump Pumps

1) The Bidder shall provide sumps of adequate capacity in each of the following area:

   a. Absorber Area.

   b. Limestone Grinding and Slurry Preparation system.

   c. Gypsum dewatering system.

2) The Bidder shall provide agitators and 2 x 100% sump pumps of required capacity in this area along with necessary pipes, isolation / control valves etc. for pumping back the water in the sump into the respective system.

1.9 Gypsum Storage & Handling System

Gypsum will be feed directly from the gypsum dewatering system to the gypsum storage yard through gypsum transfer conveyor. Conveyors & travelling trippers shall be provide for handling gypsum.

Gypsum shed of 15 days storage shall be considered. Shed shall be provided with side protection. Adequate space inside shed for truck movement shall be provided. Dozer (1 No.) and Pay loader (1 no.) required for gypsum storage and loading into the truck, road connectivity, shall be included in the Bidder's scope.

Operator room/Maintenance area/maintenance storage room with arrangement required for the Dozer (1 No.) and Pay loader (1 no.) along with toilet shall also be included in Bidder's scope.

1.10 Elevators

One (1) passenger cum goods elevator shall be provided for the following building/tanks for easy access & movement of man/materials:

a. Absorber
b. Limestone silos up to top level
c. Gypsum dewatering building upto top level
d. Limestone crusher house.

Capacity of each elevator shall be 1088 kgs. Each elevator shall have proper approach and landing.

1) The scope shall include all items / accessories, service along with all electrical equipment etc. required to meet all design, installation, operation, safety, protection and other requirements of IS: 14665 (latest edition) (all parts), 'Lift' and service lifts'. This scope shall include all items / devices needed to comply with the requirements indicated elsewhere in the specification. The scope shall include provision of fireman's switch.

2) Complete erection, testing and commissioning including all testing and commissioning materials, consumables and other tools and tackles required for erection.

3) To obtain necessary local administration permits / approvals and make arrangements for inspection and tests required thereby.

4) For all other technical details refer Volume III Chapter: 29

1.11 Buildings

Bidder shall provide buildings for Limestone grinding System, slurry recirculation pumps & oxidation blowers/compressors, Gypsum Dewatering system, FGD control room, process water pump house, Waste Water Building, Chemical House, Dozer Shed, Waste Water Control Room, DMCW Pump house, electrical panel room, control cubical & Analyser room (if required) etc. The buildings must be complete in all respect specially facilitating the smooth operation and maintenance of associated equipments of above systems by providing adequate maintenance space, handling facilities, walkways, staircase etc.

Interconnecting platforms between elevator and various levels of the scrubber/absorber.

Internal roads and surface drains/ Storm water drains inside of the FGD package area, sewerage connectivity.

The location of trestle support for the conveyors shall avoid interference with the existing below ground structures, roads and drains. In the event of any disturbance

to the existing roads and drains, bidder shall lay again the roads and drains to the original condition.

Rest room with bathroom, toilet, lighting, fan facilities shall be provided in truck parking.

1.12 **Thermal Insulation, Lagging, Cladding & Refractories**

Thermal Insulation alongwith aluminum cladding, lagging, reinforcement wiremesh, cleats and supports, shall be provided for all the equipments/surfaces having skin temperature more than 60 degree Celsius. The insulation thickness shall be designed based on criteria specified in elsewhere in the tender specification.

1.13 **Air Conditioning and Ventilation System**

All Control Rooms, Elevator Machine Rooms and Analyser Room (if applicable) shall be provided with air conditioning system.

Switchgear/MCC Rooms shall be provided with pressurized ventilation system comprising of supply air fans with filters, louvers, dampers, ducting, grilles and gravity louver.

Battery Room shall be provided with supply (through intake louvers) and exhaust ventilation system (through exhaust fans) similar to switchgear/ MCC rooms but with slightly negative pressure.

Stores, Toilets and any other miscellaneous rooms shall be provided with suitable wall mounted exhaust fans.

For all other technical details refer Volume III Chapter: 25

1.14 Corrosion protection painting for structures as described in the specification.

1.15 Platforms, walkways, staircase, safety rails for access of each equipment, valves, dampers, gates, instruments etc. handling facilities adequately each component of FGD system.

1.16 The Bidder scope shall also include of FGD trestle for routing of air & water lines, slurry lines, waste water, etc. required for the complete process operations.

1.17 Bidder shall provide Limestone & Gypsum handling & storage system for FGD as specified in elsewhere in the tender specification.

1.18 Supply and erection of Lining/cladding/wallpaper of 2 mm (minimum) thickness of alloy 276/ Alloy-59 or better material in the FGD duct down stream of absorber upto chimney inlet and complete FGD bypass duct shall be in the scope of the bidder.

1.19 All type of compressed air requirement (Instrument and service air and any other) for FGD shall be met from plant air compressors as specified in Volume III, Chapter 23 of specification .

1.20 Equipment cooling water system as specified in Chapter 16, Volume III of tender specification

1.21 Cranes & Hoists as indicated in Chapter 28, Volume III of specification

1.22 Piping as indicated in the specification

1.23 Clarified Water System as indicated in the specification

1.24 Waste Water Treatment System as indicated in the specification

1.25 ACW & DMCW System as indicated in Chapter 15 & 16, Volume III of specification.

1.26 Service Water System as indicated in Chapter 7, Volume III of specification

1.27 Potable Water System as indicated in Chapter 7, Volume III of specification

1.28 Mandatory spares as indicated in Volume II of specification.

1.29 Any other mechanical equipment/ system indicated elsewhere in the specification.

1.30 Fire fighting system as indicated in Chapter 24, Volume III of specification

1.31 The scope of civil works shall be as per specified in Volume VI of tender specification.

1.32 The scope of Electrical and Control & Instrumentation systems for FGD shall be as per Volume IV & Volume V of specification respectively.

1.33 General Scope is defined in Volume II of specification including terminal points, mandatory spares etc.

1.34 Operator room, maintenance room, maintenance store, toilet and other facilities in all buildings shall be provided.

1.35 Requirements of chimney are indicated in Volume VI of specification.

1.36 **Wet Stack Condensate Collection System**

a. Wet stack shall be provided with a stack condensate collection system to avoid the carryover of the condensate/acidic dews/water droplets/Gypsum coming out of the stack. Design of the wet stack condensate system should be such that all the condensate are collected in the stack itself and no water droplet/condensate come out of the chimney and preventing falling of the acidic dews/water droplet/gypsum from the chimney in the plant/nearby area.

b. Drain piping shall be of suitable material from corrosion point of view.

c. All Stack liquid collection shall be easily accessible for O&M.

d. The design of the stack condensate collection system shall be provided by the bidders in its bid.

e. Bidder should provide the condensate collection system such that the condensate collected shall be routed to the absorber by gravity, bidder should ensure safe discharge to the absorber. However, in-case of the distance between absorber and wet stack is

considerably far, bidder should provide the condensate collection system such that condensate shall be collected in a storage tank and pumped to absorber. Tank shall be placed at zero meter with a capacity 5 m3/hr along with associated pumping system. Storage tank shall be complete with stack condensate collection to be pumped to absorber. Contractor shall provide 2 X100% pumps for the tank, complete with valves, piping fittings, level control/monitoring etc. Alternatively, bidder may propose its proven system for disposal of the condensate system in its bid for Employer's consideration. All the material in contact with the condensate shall be of suitable material for the operating duty.

f. Stack outlet liquid collector shall be designed in such a way so that the liquid condensate film near the exit of the stack is collected instead of carrying with the exit gas

1.37 Precommissioning & Commissioning Activities

a) Bidder's Scope shall include all pre-commissioning and commissioning activities, required for successful performance of all equipment and systems under this package. Bidder's scope shall also include supply of all materials and services including the following for successful conductance of pre-commissioning and commissioning activities.

b) Complete pre-commissioning work including tests of facilities and all other tests as mutually agreed in the Bidder's quality assurance program as well as those identified in the specification.

c) Commissioning and initial operation of the facilities.

d) Supply of all consumables as may be required for above pre-commissioning/ commissioning activities.

e) Supply of all temporary equipment such as piping including supports, valves, blowers and all necessary instrumentation for successful conductance of pre commissioning and commissioning activities. All temporary equipment, blowers, valves etc. brought to sites, by the Bidder for pre-commissioning/commissioning purpose shall be in good working condition to ensure its safe and reliable operation at site. All such temporary equipment/ components shall be brought to site at least three (3) months prior to commencement of relevant pre-commissioning/ commissioning activities. On receipt of the temporary equipment/ components at site, operation and if in the opinion of the Owner the temporary equipment/ components are not in satisfactory conditions to ensure it's safe and reliable operation the same shall be immediately replaced by the Bidder.

f) The temporary equipment specifically brought by the Bidder solely for the pre commissioning and commissioning work shall on completion of these activities, remain the property of the Bidder.

g) The selection of material of all the temporary equipment/ instruments shall be compatible with the service conditions expected during pre-commissioning/commissioning activities.

h) All temporary equipment and instruments shall be clearly listed out in the bid.

i) Supply of all labour, skilled/ semi skilled supervisors, engineers and any other manpower.

j) The scope of Bidder shall also include necessary approach & platforms for all the instruments required during commissioning and testing. These approach platforms shall be provided to meet all required safety norms and these shall be permanent nature.

SECTION – 2

GENERAL REQUIREMENTS FOR FGD SYSTEM

1.0 GENERAL

The design/specifications/sizing of various plants/systems/equipment offered for Flue Gas Desulphurisation (FGD) System shall comply with the requirements detailed hereinafter:

1.1 System Description

The Flue Gas Desulphurisation (FGD) System shall be based on Wet Limestone Forced Oxidation process. The FGD system shall be installed downstream of the Induced Draft (ID) fans. The flue gas shall be drawn from air preheater outlets of the balanced draft, pulverised coal fired Supercritical type Steam Generator and guided through adequately sized duct work into the specified number of independent gas streams of Electrostatic Precipitator. The flue gas after the Electrostatic Precipitators shall be led to the suction of the ID fans. The flue gas temperature may approach the economiser outlet temperature of about 300°C (for a short period) in case the regenerative air preheaters fails to operate. The bidder shall take this aspect into account while designing the Flue Gas Desulphurisation (FGD) System.

In case distance from Limestone Grinding system/ Gypsum Dewatering and Absorber is more than 500 M, Bidder shall provide the following:

Flushing system at intermittent locations for the lime stone slurry pipeline which shall contain tank and pumps. Intermittent location distance of flushing system shall be based on their proven practice.

For volumetric computations of limestone handling system the bulk density of limestone shall be taken as 1400 kg/M^3. However for torque & drive requirements the density of lime stone shall be taken as 1700 kg/M^3.

For gypsum handling system, the bulk density shall be taken as 900 kg/m3 for volumetric computation and 1250 kg/M^3 for torque and drive requirements.

All documents shall be vetted by the technology provider of the FGD system.

Moisture separation shall be indicated in the vacuum system.

1.1.01 FGD System Service Conditions

The Steam Generator is designed to burn pulverised coal having properties as indicated in subsequent chapter of tender specification. Also LDO shall be used during startup and at low loads for warm up and flame stablization. The steam generator has been designed so that this shall not call for any oil support for flame stabilization beyond 40% load when firing any coal. Further, the frequency and duration for startup and low loads operation may be quite long during the first year of unit commissioning and operation. The Steam Generator has been designed for cyclic/three shift operation. Expected numbers of steam generator start-ups during 25 years of deign life are as follows.

S No.	Type of Starts	Number of Starts
i.	Hot start (after shut down period less than 10 hours)	4500
ii.	Warm start (after shut down period between 10 hours and 72 hours)	1000
iii.	Cold start (after shut down period exceeding 72 hours)	455

The bidder, shall take into account the entire characteristics of expected combination of fuels to be fired while designing the FGD system.

1.2 General Design Criteria for FGD System

1) The Flue Gas Desulphurisation (FGD) System shall be designed to meet all the conditions specified above. Representative coal and ash analysis for the expected coal and oil are given in elsewhere in the specification. The FGD system & its auxiliaries shall be designed to comply with the requirement as specified elsewhere in the specification.

2) The values indicated for FGD sizing shall be considered as minimum design criteria. These shall be modified to more conservative values if bidder's experience warrants the same. Utilization of these values in no way relieves the Bidder of his responsibility to meet all the guarantee requirements. The Bidder shall also furnish along with his offer the detailed calculations and data along with his Bid to establish as to how the Bidder will meet the efficiency requirements both at design and guarantee point as specified in FGD sizing criteria. The FGD system shall also be capable of operating with partial bypass of flue gas. Bidder shall submit with the offer a write-up highlighting the capability of operation of FGD system with partial bypass of flue gas and the range for operating in partial bypass mode.

1.3 Description of Proposed Design

1) 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, shall be considered for the design of FGD system.

2) The Bidder shall submit with the offer, comprehensive information on how the L/G ratio, mass balance, spray nozzle cone angle, spray nozzle arrangement, limestone consumption etc. of the proposed design has been arrived at. The Bidder shall also submit alongwith the offer, a detailed write up on the proposed design features with recent design modifications, if any, and their specific advantages over the previous designs.

3) The complete FGD system and the associated auxiliaries shall be designed by the standard industrial practices. The FGD system shall be designed to achieve the required SO_2 capture without the use of oxalic acid or any other additives. Only field proven materials for similar application shall be used for the system. The complete installation of liners shall be made under the

supervision of the FGD manufacturer. In the execution of the welds bidder must ensure that welding material has same corrosion resistance as the actual plate surface.

4) The FGD and the auxiliary's facilities shall be suitable for unlimited operation with all transients and at any load point between the minimum and maximum load point of the Steam Generator. Further, the FGD plant shall be suitable for an unlimited operation at any pollutant concentrations between minimum and maximum without exceeding the guaranteed figure as specified elsewhere in the specification.

5) The FGD plant shall be brought automatically to the off-load operation without restriction by the current load case by suitable measures in case of failure of steam generator & its auxiliaries.

6) The FGD auxiliaries (like. agitator(s) in absorber and limestone slurry tanks, flue gas dampers, agitator(s) in absorber, process water (as applicable), mist eliminator wash pump(s) (if applicable), lube oil system of mills etc.) which may impact serious damage to the FGD System shall be connected to the emergency power supply system for total power failure condition. Bidder shall furnish a list of all such Auxiliaries in their bid proposal.

7) Bidder shall ensure draining and flushing of limestone slurry and gypsum slurry pipe work, tanks and all other items being in contact with limestone slurry or gypsum slurry shall be possible without restriction and without necessity of extensive or unusual preparation and activity in case of shutdown/outage period. Draining and flushing which are required even during short time outages or an emergency shutdown shall be started automatically and by remote control from the Control Room.

8) All items or equipment which are subject to wear, abrasion or failure (e.g. nozzles, pumps, pipe work, etc.) shall be designed and installed for easy replacement, repair and maintenance.

9) The design and the construction shall be performed so as to avoid stress corrosion cracking, galvanic or other types of corrosion. Especially when using two different alloys, appropriate measures shall be taken to avoid corrosion subject to approval by the Owner.

10) All items of equipment including flue gas ducts, expansion joints, etc. shall be designed considering thermal and mechanical strength as a function of the maximum temperature which might occur in case of a failure of any upstream equipment.

11) Waste water which might be generated during flushing and cleaning procedures of the equipment (e.g. lime slurry binds, pipes etc.) shall be collected in sump and shall possibly be reused in the wet absorber.

12) Alloy to carbon steel welds must either be hidden behind a covering strip of alloy material, or be executed by a special welding procedure ensuring the same quality at the weld surface as the alloy lining. All welding which shall be in the contact with process fluids shall be executed under the supervision of the designer/manufacturer.

13) The absorber slurry tank/ storage shall be designed for retention time as per standard and proven practice of the bidder.

1.4 Statutory Requirement of Codes and Standards

The engineering, design, supply and installation of FGD system and the associated auxiliaries shall comply with the applicable safety code and regulation of the locality where the system is being installed.

In addition to comply with the applicable safety code and regulation of the locality where the system is installed, all the other required statutory codes and standards for complete FGD package shall be mentioned.

1.5 Layout Consideration

The Bidder shall offer the best design to accommodate the Flue Gas Desulphurisation (FGD) System and Lime stone & Gypsum handling & storage system within the confines of the space available in layout. The indicative layout of FGD System has been indicated in the plot plan. FGD bidder is expected to offer most compact layout accommodating the entire scope of supply and meeting all functional requirements.

1.6 Capital Overhaul of FGD System & Maintenance

Owner envisages to carry out the capital overhaul of unit once in three (3) years. The design and materials for various equipment/auxiliaries etc. shall be selected by the Bidder keeping in view the above requirement of the Owner, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.

The Bidder shall provide adequate handling facilities & approach as for carrying out on-line and off-line maintenance of the FGD system 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.

1.7 Noise level

The equivalent weighted average of sound level measured at a distance of 1.5 m above floor level in each elevation and one meter horizontally from the base of any equipment furnished and installed under these specifications, expressed in decibel to a reference of 0.0002 microbar, shall not exceed 85 dB(A), except for:

a) Wet Mill ≤ 90dB(A) &
b) Crusher ≤ 90 dB(A).

SECTION - 3

DESIGN CONSIDERATION

The Flue Gas Desulphurisation (FGD) System shall be designed for the requirements stipulated in the table below:-

TABLE-I

S. No.	ITEM	Guarantee Point	Design Point
1.	Boiler Load	TMCR (800 MW)	BMCR
2.	Type of Coal	Design Coal	Design Coal
3.	Ambient air condition	27 Deg.C & 50% RH	45 Deg.C & 50% RH
4.	Gas Flow at FGD inlet Nm^3/s * & m^3/sec (wet)	By Bidder	By Bidder
5.	Gas Temp. at terminal point (inlet to FGD)±5 Deg.C (+5 deg.C considered over predicted value)	By Bidder	By Bidder
6.	Flue gas composition at terminal point (inlet to FGD)		
a)	O_2 (% V/V wet)	By Bidder	By Bidder
b)	CO_2 (% V/V wet)	By Bidder	By Bidder
c)	H_2O (% V/V wet)	By Bidder	By Bidder
d)	SO_2 (% V/V wet)	By Bidder	By Bidder
e)	N_2 (% V/V wet)	By Bidder	By Bidder
f)	Inlet SO_2 mg/NM^3 - wet	By Bidder	By Bidder
g)	NO_x (mg/NM^3) (wet)	By Bidder	By Bidder
h)	Dust (mg/NM^3)	By Bidder	By Bidder
i)	SO_3 (% V/V wet) at 1.5% conversion	By Bidder	By Bidder
j)	Outlet SO2 concentration at FGD outlet mg/Nm3 (6% O2 dry basis)	By Bidder	By Bidder
k)	HCl (ppm-w)	By Bidder	By Bidder
l)	HFl (ppm-w)	By Bidder	By Bidder

S. No.	ITEM	Guarantee Point	Design Point
7.	Particulate distribution in Flue Gas at FGD inlet (Sieve Analysis of Fly Ash - % by weight)		
	Less than 10 microns	By Bidder	
	10 - 20 microns	By Bidder	
	20 - 30 microns	By Bidder	
	30 - 40 microns	By Bidder	
	Greater than 40 microns	By Bidder	

Note:-

a) The absorber shall be sized considering 100% BMCR (Design condition) Operation with design coal firing. However, Bidder to note that absorber shall be able to accommodate 115% of BMCR flow (Peak Condition) and all its equipment's / parts accessories shall be suitably designed to accommodate this flow.

b) Bidder shall consider raw gas inlet pressure of 0 mmwc at terminal point for FGD system design at operating condition.

c) The FGD shall be designed considering 0.6% Sulphur content in coal.

TABLE - II

FOR PARTIAL LOAD

The flue gas desulphurization (FGD) system shall also be designed for check points to achieve SO_2 emission of less than 80 mg/NM^3 (at actual level O_2 dry) for the range of loads at different operating conditions specified below.

S. No.	ITEM	Check Point-I	Check Point-II	Check Point-III
1.	Boiler Load	80% TMCR	60% TMCR	40% TMCR
2.	Type of Coal	Design Coal	Design Coal	Design Coal
3.	Ambient air condition	27^0C & 72% RH	27^0 C & 72% RH	27^0C & 72% RH
4.	Gas Flow at FGD inlet NM^3/s * (wet)	By Bidder	By Bidder	By Bidder
5.	Gas Temp. at terminal point (inlet to FGD)±5 DegC (+5 deg.C considered over predicted value)	By Bidder	By Bidder	By Bidder

S. No.	ITEM	Check Point-I	Check Point-II	Check Point-III
6.	Flue gas composition at terminal point (inlet to FGD)			
a)	O_2 (% V/V wet)	By Bidder	By Bidder	By Bidder
b)	CO_2 (% V/V wet)	By Bidder	By Bidder	By Bidder
c)	H_2O (% V/V wet)	By Bidder	By Bidder	By Bidder
d)	SO_2 (% V/V wet)	By Bidder	By Bidder	By Bidder
e)	N_2 (% V/V wet)	By Bidder	By Bidder	By Bidder
f)	Inlet SO_2 mg/NM^3 - wet	By Bidder	By Bidder	By Bidder
g)	NOx(mg/NM^3) (wet)	By Bidder	By Bidder	By Bidder
h)	Dust (mg/NM^3)	By Bidder	By Bidder	By Bidder
i)	SO3 (% V/V wet) at 1.5% conversion	By Bidder	By Bidder	By Bidder

DESIGN LIMESTONE ANALYSIS (TYPICAL)

S. No.	Constituents	Unit	% By weight	
			Analysis # 1	Analysis # 2
1.	Silica as SiO2		7.5	4-6
2.	Iron as Fe2O3		8.0	1.5-2.2
3.	Aluminium as Al2O3		1.0	1.8-2.8
4.	CaCO3		70.0	85-89
5.	MgCO3		3.4	
6.	Acid Insoluble		7.0	Below 1%
7.	Others		2.42	-
8.	Inherent Moisture Content		Max 0.5	-
9.	Bond Work index	KWH/T	11.61	13

SECTION – 4

FLUE GAS SYSTEM

1.0 DUCT WORK AND DAMPERS

1) The entire flue gas system including flue gas ducts, absorber etc. shall be designed to meet the following conditions:

i)	Design internal pressure at 67% yield strength (mmwc)	+660,-150 mm of WC or maximum conceivable head of ID Fan, whichever is higher
ii)	Design Inlet Gas Temperature (^{0}C)	150
iii)	Short temp excursion temperature of inlet gas for approx. fifteen (15) minutes at a time (^{0} C)	300 for upstream of absorber and 200 for downstream of absorber
iv)	Inlet Dust Burden in Gas (mg/Nm3)	100
v)	Maximum flue gas velocity through the Absorber (M/sec)	4.0-4.5 m/s at design Point Conditions.
vi)	Recirculation Slurry pH	Not less than 5.5 under all operating conditions

2) Design features

i) All ducts with operating temperature above 60°C shall be insulated in accordance with relevant section of the tender specification.

ii) The duct layout shall ensure that there is no accumulation of acid mist on the duct floor. The absorber outlet duct shall not have any horizontal section for this purpose.

iii) The duct to Absorber inlet shall be made of Carbon steel of minimum 7mm thickness. The duct from Absorber outlet to bypass duct shall be made of Carbon steel of minimum 7mm thickness with 2 mm (minimum) thickness lining / cladding / wall paper of Alloy C276 / Alloy 59 or better material. The absorber wet-dry interface shall be of solid Alloy 59 or C276 of minimum 6 mm thickness.

iv) Wherever required, Expansion Joints of proven design shall be provided in the ducts to take care of differential expansion in the system. The material chosen for expansion joints shall suitable for the duty conditions and the corrosive atmosphere of the FGD system and shall be field proven for similar applications. The expansion joint shall have a minimum guaranteed life of not less than 20000 hours of operation. During this guarantee period any defects notice in the duct due to faulty material and workmanship shall be rectified by the bidder free of cost.

v) Duct from ID Fan to absorber Inlet, flue gas bypass duct. Absorber outlet duct damper to bypass duct connection shall be designed for flue gas temperature of 2000C. Absorber including mist eliminator shall be designed for flue gas temperature of 600C.

For short excursion duration of 15 minutes, duct from ID Fan Outlet to absorber Inlet, flue gas bypass duct. Absorber outlet duct damper to bypass duct connection shall be designed for flue gas temperature of 3000C.

vi) All necessary inspection access, observation and cleaning doors shall be provided. These doors shall be perfectly gas tight under all working conditions. Each inspection door has to be equipped with observation flaps which can be opened and closed without any tool. The inspection doors have to be provided for inspection of each heating surface at flue gas inlet and outlet.

3) Duct Work

Main Duct, Bypass Ducts, necessary duct support structures, expansion joints, dampers, bypass damper), connecting duct to main ducts etc. Supply and installation of lining material as necessary in the existing duct is also in bidder's scope.

1.1 Sizing Criteria

a) Bidder to estimate the flue gas velocity considering the FGD bypass duct size and the size of duct shall be same as the Main duct.

b) The flue gas velocity in individual duct entry/discharge to fan with single fan running shall be in matched with 'a' above.

1.2 Loads for Duct and Structure Design

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

1) Wind loads as specified.

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

3) All ducts to be designed for one tenth of duct full of ash. The ash density for the purpose of loading shall be at least 1300 kg/m^3.

4) Expansion joint reaction.

5) 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

1.3 Duct Design Pressure

All flue gas ducts shall also be designed for +660,-150 mm of WC, or maximum conceivable pressure of the relevant fans, whichever is higher at 67% of yield strength of material

1.4 Duct Slope

All ducts shall have a sufficient slope with respect to horizontal so that any chance of accumulation of ash particles or water in the duct can be avoided under all normal/abnormal operating conditions. The inlet duct shall be sloped towards the absorber.

Bidder to provide proper drain chambers / hoppers on clean gas duct at the outlet of absorber. Atleast one number drain collecting hoppers shall be provided based on CFD modelling Analysis.

Man-hole (size - min 800 x 800 mm) for Inlet, outlet and bypass dampers shall be provided.

1.5 Type of duct construction

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

a) Minimum 7 mm thick steel plates for gas ducts & Duct stiffening shall be by means of rolled sections of duct material.

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

c) Duct stiffening shall be by means of rolled sections. No internal stiffeners shall be used for the ducts from the absorber outlet to chimney inlet.

1.6 Insulation & Cladding

a) Thermal insulation shall be applied to all air/gas ducts to comply with the requirements of as specified in this chapter.

b) Acoustic insulation shall be used, if required, in gas ducts to restrict the noise level to specified values.

1.7 Specific Requirements

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

b) The flanges at the bolted joints shall have adequate stiffeners to avoid damages to the flanges.

c) All necessary wall boxes and floor collars shall be provided where the ductwork pass through walls, floor and roof.

d) The floor collars shall be fitted with a high combing to prevent water and dust falling through the hole.

e) The ductwork shall be fitted with a steel hood to cover the opening.

f) Weatherproof flashing shall also be provided wherever necessary.

g) The configuration and design of ducts shall be coordinated with the pulveriser parts removal requirement.

h) Ducts shall not counter internal bracings, which cause excessive pressure drop.

i) Duct plates shall be designed for one-way beam action over stiffeners and considered fully continuous over all supports.

j) Bidder to ensure proper draining facilities for the complete system including proper drainage of acidic fluids from the ducts so as to avoid any accumulation of acidic fluids.

k) The deflection of the plate, assumed continuous, shall be less than one-half the plate thickness.

1.8 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:

i) 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.

ii) 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 at suitable place shall be provided with erosion protection shields.

iii) The number of internal trusses shall be limited to the minimum required for structural integrity and shaped so as to offer least resistance to gas flow and to minimize the accumulation of fly ash in the bottom of duct.

iv) Conceptual data of internal stiffeners of the ducting shall be furnished along with the offer.

v) All the detailed design data shall be furnished to the Owner before the duct support column foundation data submission.

c) Corner angles shall be used on all inside corners of all ducts to provide adequate continuity.

d) Inside welds of corner angles to duct plate shall be continuous and seal welded. Where inside surface of ducts will be coated, welds shall be full throat.

e) 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.

f) The duct, plates, trusses, stiffeners, bracings and ductwork shall be designed as structures in accordance with relevant Indian Standards.

g) All openings in ducts shall be reinforced for all design loads.

h) Ductwork supports may be hangers or sliding bearing, guides and anchorages. A coefficient of sliding friction of 10% can be used with self-lubricated plates, a coefficient of sliding friction of not less than 35% shall be used for steel-on-steel contact. The allowable bearing stress for self-lubricated plates shall be 70 Kg/cm^2.

1.9 Fabrication Requirements

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

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

c) Ducts shall be strength welded and seal welded to produce a gas tight duct. Alignment holes shall be provided in mating flange sections.

d) Ducting shall be detailed and fabricated in a few pieces as practical, taking into account, shipping and erection considerations.

e) Materials improperly detailed or fabricated necessitating extra work during erection on field, shall be the responsibility of the Bidder.

1.10 DAMPERS

1.10.1 Types of Dampers

i) The arrangement of the flue gas system shall allow complete isolation of the absorber from the gas side, with the unit in operation. Following types of damper shall be provided by the Bidder:

a) One number gas tight motor operated Guillotine gate type damper shall be provided at inlet of Absorber.

b) One number gas tight motor operated Guillotine gate type damper at downstream duct of Absorber.

c) One number hydraulically operated multi louver/bi-plane damper shall be provided in FGD bypass duct.

d) One set of seal air fan skid for each damper shall be provided. Each set comprises of 2 X 100% pressurization fans, pressure switch, NRV, pneumatically operated outlet damper.

e) Bypass damper shall be capable of quick opening during emergency conditions within a time of 10-20 secs. Bidder should indicate the required opening time for bypass damper for emergency operating condition.

f) Equipment handling facilities shall be provided

g) Suitable hood or sloped roof on top for rain protection shall be provided for seal air fans and lube oil system.

1.10.2 Salient features of 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 100% with seal air fan.

b) Multi louver Dampers

i) The damper shall be of heavy duty construction.

ii) Shall operate without bind or fluttering under all operating conditions.

iii) The damper/louver shaft shall be rigidly constructed to prevent bending, vibrations and distortion.

iv) Shafts shall be balanced about the bearing shaft axis, suitably insulated to protect overheating.

v) The spindles shall be adequately sized and bearings suitably insulated to protect overheating.

vi) The shaft bearings shall be mounted outside the damper box channel and arranged for convenient inspection.

vii) Stuffing boxes shall be provided on all damper blade shafts.

viii) The damper shaft shall be rigid and shall have side bearing, plate.

ix) Horizontal shaft shall be provided wherever possible.

x) For preventing hot air or gases from escaping around damper shaft, double gland type stuffing boxes with graphite impregnated non asbestos packing material acceptable to the Owner shall be provided on all damper blade shafts.

xi) The dampers in flue gas paths shall be so located that the build-up of grit behind the damper blades is reduced to a minimum.

c) Weather hood to prevent rainwater entry & accumulation shall be provided at each damper top.

d) All dampers shall be designed to withstand the operating flue gas temperature without distortion.

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

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

g) Outlet dampers of seal air fans shall be pneumatically operated, suitable for remote manual operation.

h) All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves.

i) The blades and frames of the dampers provided at the outlet of ID fan in the untreated gas path shall be made of carbon steel. In the FGD outlet treated gas path the frame of the damper shall be made of STEN-1 or better material, the blades shall be made of STEN-1 or SS317LMN or superior proven material and the seals shall be made of Alloy C-276 or superior proven material.

j) The dampers shall be pneumatically operated and controlled from the control room. Provision shall be made for giving signal automatic bypass controls of the absorber in case of failure of the absorber spray system. The dampers shall have provision for manual operation, through a hand wheel. The force required for manual operation of the gate shall not exceed 35 kg (max.) at the rim of the hand wheel.

k) The isolating gates shall be provided with locking devices to permit locking in fully closed position.

l) If grease lubrication is required, grease connection shall be accessible. Further suitable approval & platforms etc. for greasing shall be provided.

m) Open and closed positions shall be clearly marked on the dampers.

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

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

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

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

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

s) Suitable all round approach and platform for manual operation of dampers and for carrying out maintenance on damper shall be provided.

t) Attachment of all louvers to the dampers spindles shall be by means of key fittings.

u) All bearings for spindles or damper operating gear shall be arranged for efficient grease lubrication.

v) Grease lines of copper/steel shall be run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.

w) Powered dampers shall have provision for manual operation during emergency/maintenance along with graduated local position indicator.

1.10.3 Damper Gas Tightness

All the gates shall be designed for tight shut off. Multi Louver gate type dampers mentioned in the tender specification shall have a guaranteed gas tightness efficiency (on flow) of not less than 99.5% 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. Sealing efficiency for multilouver /biplane damper shall be 100% with seal air fan.

For Guillotine gate type isolation dampers mentioned in the tender specification, the dampers shall be 100% leak tight with seal air fans under operation. The gas tightness shall be demonstrated at shop for minimum one type of damper of each type and size.

1.10.4 Pressurization Fans

a) Three sets of seal air fan skid, each set with 2 X 100% pressurization fans (one set for absorber inlet dampers, one set for absorber oulet dampers and one set for FGD bypass duct dampers)

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

1.10.5 All dampers shall be designed to withstand the operating flue gas temperature without distortion.

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

1.10.7 All regulating dampers/vanes/blade pitch controls coming under auto regulation shall be able to provide the desired relationship between percentage opening and the flow.

1.10.8 The auto regulating dampers shall be capable of being operated between 20% to 80% opening as per the optimal requirements of control systems to achieve stable, steady and smooth automatic control of the plant and processes under all operating conditions.

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

1.10.9 Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

1.10.10 All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves.

DUCTWORK

i)	Design internal pressure at 67% yield strength (mmwc)	+660,-150 mm of WC or maximum conceivable head of ID Fan, whichever is higher
ii)	Design Inlet Gas Temperature (deg.C)	150
iii)	Short temp excursion temperature of inlet gas for approx. fifteen (15) minutes at a time (deg. C	300 for upstream of absorber and 200 for downstream of absorber
iv)	Inlet Dust Burden in Gas (mg/Nm3)	100
v)	Maximum flue gas velocity through the Absorber (M/sec)	4.0-4.5 m/s at design Point Conditions.
vi)	Recirculation Slurry pH	Not less than 5.5 under all operating conditions

DAMPERS

S.No.	Description	Damper
1.	**FGD Inlet Damper (Absorber Inlet)**	
a.	Type of Damper	Biplane Damper
b.	No. of Dampers	Two
c.	Design Temperature	By Bidder
d.	Operating Temperature	By Bidder
e.	Duct Orientation	Horizontal
f.	Failsafe Position	Fail Fixed
g.	Sealing Efficiency	99.9% on CSA, 99.95% without Seal Air Fan & 100% with Seal Air Fan
h.	MOC	
•	Frame Assembly	IS 2062 E 250 BR
•	Blade Assembly	IS 2062 E 250 BR, Alloy C -276 min 2 mm thk
•	Shaft Assembly	ASTM A 276 Type 321
•	Stub Shaft	ASTM A 276 Type 321
•	Heavy Duty Lever	IS 2062 E 250 BR
•	SEAL AIR DAMPER ASSEMBLY	IS 2062 E 250 BR, ALLOY C-276 (UNS N10276), ASTM A276 TYPE 321
•	SEAL AIR DAMPER TRANSITION	IS 2062 E 250 BR
2.	**FGD Outlet Damper (Absorber Outlet)**	
a.	Type of Damper	Biplane Damper
b.	No. of Dampers	One
c.	Design Temperature	By Bidder

S.No.	Description	Damper
d.	Operating Temperature	By Bidder
e.	Duct Orientation	Horizontal
f.	Failsafe Position	Fail Fixed
g.	Sealing Efficiency	99.9% on CSA, 99.95% without Seal Air Fan & 100% with Seal Air Fan
h.	MOC	
•	Frame Assembly	STEN 1
•	Blade Assembly	S-TEN1, ALLOY C-276 (UNS N10276)
•	Shaft Assembly	SS 317LMN (UNS SS31726)
•	Stub Shaft	ASTM A 276 Type 321
•	Heavy Duty Lever	IS 2062 E 250 BR
•	SEAL AIR DAMPER ASSEMBLY	S-TEN1, ALLOY C-276 (UNS N10276), SS 317LMN (UNS SS31726)
•	SEAL AIR DAMPER TRANSITION	S-TEN1
3..	**FGD Bypass Damper**	
a.	Type of Damper	Biplane Damper
b.	No. of Dampers	One
c.	Design Temperature	By Bidder
d.	Operating Temperature	By Bidder
e.	Duct Orientation	Horizontal
f.	Failsafe Position	OPEN ON LOSS OF POWER OR AIR
g.	Sealing Efficiency	99.9% on CSA, 99.95% without Seal Air Fan & 100% with Seal Air Fan
h.	MOC	
•	Frame Assembly	STEN 1
•	Blade Assembly	STEN-1/ HASTELLOY C276
•	Shaft Assembly	STEN-1/ HASTELLOY C276
•	Stub Shaft	STEN-1/ HASTELLOY C276
•	Heavy Duty Lever	IS 2062 E 250 BR
•	SEAL AIR DAMPER ASSEMBLY	S-TEN1, ALLOY C-276 (UNS N10276), SS 317LMN (UNS SS31726)
•	SEAL AIR DAMPER TRANSITION	S-TEN1

SECTION – 5

ABSORBER SYSTEM

1.0 ABSORBER

The unit shall be provided with an independent/dedicated absorber.

The Bidder shall offer either spray type absorber with multiple levels of spray or an absorber with gas bubbling through the slurry, as per bidders/collaborators proven practice. Only proven system in successful operation in previous installations supplied by the Bidder shall be offered.

The first mist eliminator (bottom) shall be located at least 1.5 M above the last slurry recycle header (top) in the absorber module. For vertical mist eliminators, the spacing between the top of the first and bottom of the second mist eliminators should be at least 2 M. The mist eliminator outlet droplet content shall be guaranteed to be < 20 mg/Nm3 at absorber outlet measured over a period of 24 hrs continuous operation.

Provision shall be kept for addition of one more layer of mist eliminator for future use.

The mist eliminator shall be capable of meeting ASTM E84 flammability standards

A. Spray System (If offered)

1) The Bidder shall provide spray system and minimum spray levels required to meet the stipulated guarantee and design requirement.

   The spray system (including slurry recirculation pump & nozzles) shall be sized to achieve a desired L/G ratio required to meet the guarantees SO_2 emission level, with redundancies specified under this clause.

2) For this multilevel absorber, 1x100% slurry recirculation pump for each level of spray. One spray level zone at top with single side nozzle arrangement along with pump shall be provided by the Bidder as spare. The recirculation pump top sparest level shall be kept out of service (as standby) during performance guarantee test.

   The absorber multi-level spray arrangement from top/bottom shall be as per standard and proven practice of the bidder.

3) In case bidder offer single level of spray one no of standby pump of same capacity & head as the working slurry recirculation pump shall be provided. The bidder shall provide spray system/spray levels only as per proven practice which should be in successful operation elsewhere.

4) The slurry recirculation pumps shall have motor/ pneumatic driven knife gate valve at pump suction and discharge side.

5) The slurry recirculation pumps shall be wear resistant and equipped with flushing device to prevent sedimentation and shall be designed and installed in manner to allow easy replacement. The slurry recirculation pumps shall be

equipped with oil level indication, coupling guard and collecting equipment for leakage made of resistant material. Single mechanical seals with automatic flushing with a connection for additional manual flushing shall be provided.

6) The slurry recirculation pumps shall have a minimum margin of 15% frictional head, over the actual requirement for meeting the guarantee and design point conditions. All slurry recirculation pumps including motors shall be of the same size and type.

7) The absorber slurry tank/storage shall be designed for retention time based as per standard and proven practice of the bidder.

B. Jet Bubbling Absorber (If offered)

In case the bidder offers an absorber with gas bubbling through the slurry, the complete gas distribution system to the slurry shall be in bidder's scope. No re-circulating pump and spray header and nozzles shall be required in such case.

Further, 2x 100% Cooling Pumps instead of Slurry Recirculation shall be provided. The spray headers & piping for cooling pump discharge shall be made of Alloy 59 or C276 and nozzles shall be made of Silicon Carbide or ceramic or equivalent having a minimum guaranteed life of 20,000hrs. The Cooling Pumps shall be installed inside a building. The sparger and gas riser tubes shall be made proven material which shall have a minimum life of 5 years. Minimum 10% redundancy, shall be provided in the Sparger Tubes.

1.1 Agitator(s) for Absorber Recirculation Tank

Sufficient number of agitators, as per the proven practice of the bidder, shall be provided for thorough mixing of the recirculating slurry. In case the Bidder's Absorber includes side entry agitators, the bidder shall offer and demonstrate mixing arrangement such that n-1 number of agitators are sufficient to avoid the slurry settlement in the absorber tank in case of one agitator under breakdown (n- total no. of working agitators). In case vertical agitators in Absorber are offered, one complete mechanical assembly of agitator shall be supplied as warehouse spare for Absorber.

1.2 Absorber Oxidation Systems

1) The Bidder may offer either a grid type oxidation system or a sparge jet oxidation system or lance type or air rotary sparge system for oxidation of sulfite sludge to sulfates, as per his proven practice.

2) Compressors/Blowers shall be provided for the oxidation of the calcium sulphite salt to gypsum. The blowers will be used for supplying a variable volume of air to the absorber reaction tank and emergency quench seal.

3) The oxygen required for oxidation shall be supplied by 2x100% oxidation air blowers/ compressor for absorber. The compressor/ blower shall be sized to supply at least 2.5 times the stoichiometric air requirement for spray tower type & at least 4.0 times the stoichiometric air requirement for Bubbling Type or the actual requirement, whichever is higher, under the following condition, all occurring simultaneously. The natural oxidation of sulfite by residual oxygen in flue gas shall not be considered for this purpose.

Load	Design point Flow
Flow	Minimum 2.5 times for spray tower type & at least 4.0 times the stoichiometric air requirement for Bubbling Type the stoichiometric requirement
Head	**For spray tower** Actual requirement considering choking / blockage of minimum 10% of the oxidation nozzles / sprayers or minimum 8500 mmwc whichever is higher. **For Bubbling Type** Actual requirement considering choking/ blockage of minimum 10% of the oxidation nozzles / sprayers or minimum 3500 mmwc whichever is higher.
Margin on Head	10% under above conditions
Ambient Conditions	Maximum ambient as specified in project information chapter in tender specification

4) Oxidation nozzles / sparger shall have a minimum redundancy of 10% or as per the Bidder's proven practice whichever is maximum.

5) The oxidation system shall be complete with a quenching system to cool down heated oxidation air in order to prevent any scaling or buildup that could occur at the sparger tips due to localized evaporation of recycled slurry.

6) Blowers shall be equipped with air filter; safety valve; solenoid valve to open the drain when the blower is out of operation; and silencers on the intake and delivery sides. The output and discharge head of the air blowers shall be determined by the bidder. Anti-vibration mountings and cork insulation as well as flexible pipe joints on the suction and discharge sides and surge vessels etc. shall be provided as necessary. Suitable discharge pipes shall be provided for stuffing box leakage and shall be connected to a drainage system.

7) Necessary sparger, injectors, nozzles, gearbox, lube oil system, piping and valves, NRV, drain valves ,motorized outlet valve and instrumentation and accessories, etc as required for the complete operation of the system shall be envisaged.

8) The air intake filter area shall be at least twice that of the inlet pipe area. The filter shall be suitable for removing dust particles down to 5 microns size

1.3 Gypsum Bleed Pump

Absorber shall be provided with 2x100% Gypsum Bleed Pumps for supply of gypsum slurry to Gypsum Dewatering system. Each Gypsum bleed pump shall be sized to bleed-off the gypsum slurry from the absorber with slurry solid concentration not exceeding 30%, under the following conditions, all occurring simultaneously:

i)	Load	Design point
ii)	Flow	100% of gypsum produced at Design point condition
iii)	Head	As per system requirement
iv)	Margins	
a)	Flow	10%
b)	Head	15%

The pumps shall be designed to meet the stipulations of Section 7.

Provision shall also be provide in the Gypsum Bleed Pumping system by provision of tap off, valves etc. for pumping the gypsum bleed to alternate source.
100% of gypsum produced considering unit operating at BMCR with design Coal.

Margin on flow: 15% under above conditions

Margin on Head: 20% under above conditions.

All pumps in this FGD system, Pump Head calculation shall include detailed pressure drop calculation consists of line, strainers, valves and fittings losses.

1.4 Emergency Spray System

An emergency cooling system for automatic spray of quenching water for sufficient time(minimum 20 min) at the inlet to the absorber, in case the gas temperature exceeds the design temperature due to failure of upstream equipment's shall be provided to protect FGD & its auxiliaries against high flue gas temperature. The water shall be tapped up from emergency water tank installed near to absorber. The emergency water tank volume and the injection lances/nozzles shall be designed to protect the inlet duct and the lining of the absorber. The inlet duct shall be slopped towards the absorber**.**

One number emergency water tank shall be provided.

Adequate number of Man hole doors shall be provided in the absorber for absorber flue gas inlet inspection, spray maintenance, recirculation pump side, agitator maintenance, Mist eliminator, etc.,

Pumps drain, line drains, etc., shall be connected to trench and the trench shall be sloped to area drain sump.

2 x 100% drain pumps shall be provided in the absorber area sump to pump water to emergency absorber water tank.

1.5 Design

1) The design and arrangement of the absorber shall be field proven for successful long-term operation in conjunction with a coal fired power plant.

2) The design of the flue gas ducts and inlet and outlet hoods of the FGD as well as guide vanes and baffle plates shall ensure homogeneous flue gas flow with respect to disturbance of

    a) Temperature
    b) Velocity
    c) Dust content
    d) Slurry injection and distribution.

    The above shall be proven by two phase computational fluid dynamics simulations (liquid and gas). The scope of modelling shall include flue gas path inside the absorber vessel including inlet and outlet duct. Homogeneity shall be ensured, if the deviation from the average is less than ±10%. Further

in the absorber outlet hood no internals such as guide vanes and baffle plate shall be allowed.

3) The fabrication of the absorber vessel shall follow common practice as there shall be no longitudinal seams located behind any attachment or obstruction which would prevent inspection of the welds. Nozzles, access ways, and their reinforcements shall not be located in or on any seam. Inaccessible gaps or hollow beams shall be avoided.

4) The absorber shell shall be designed for pressure loads, piping forces and moments, wind and seismic loads and all other loads imposed on the absorber. Bracing and reinforcement shall be adequate to prevent deflection and vibration. Internal supports for mist eliminator sections, etc. shall be designed to withstand the flooded weight of the supported section. The absorber and its structural supports shall be designed for the maximum operating loads including design positive & negative internal pressure, static head, external attachment loads (such as exerted by piping) wind load using the allowable stresses permitted by the applied standards.

5) Bidder shall ensure the possibility of reaching the SO2 emission guarantees, at Guarantee point condition, with top spray level along with pump continuously out of service.

6) Three stage chevron type Mist Eliminators (ME) made of polysulfone or polypropylene or stainless steel or FRP shall be provided at the exit of the absorber. Provision shall be made for continuous washing of both ends of the first & second stage and the front section of the third stage of mist eliminators. Wash water arrangement shall also be provided at the back end of the second stage of mist eliminator. If the mist eliminator washing system is designed for cyclic washing of different sections, all the valves required for cycling shall be motorized or pneumatically operated. The automatic valve for the spray system shall be easily accessible on a platforms close to the mist eliminator. Entrained slurry shall be collected by mist eliminators downstream of the slurry spray system to avoid carry-over of slurry to the stack.

The ME system shall be equipped with washing and drain provisions, where drains are directed into the absorber. Washing provisions shall include external and internal piping systems with replaceable nozzles, water pressure pumps complete with all piping, valves, instrumentation and controls. The mist eliminator wash piping/header shall be constructed of glass fiber reinforced plastics. Bidder may offer Polypropylene or PVC for mist eliminator wash headers provided if it is their standard and proven practice of OEM/Bidder. Ease of replace ability and placement of the mist eliminator on maintenance platforms is an important requirement. The ME shall be designed to allow for efficient cleaning in process. Test ports shall be provided downstream of the mist eliminator to enable performance testing.

The mist eliminator system shall be capable of withstanding high velocity spray water jets typically employed during manual cleanings. The ME shall be constructed in individual cells. The design shall safely avoid ME vibration and/or humming. The individual cells shall be sized so that no more than two maintenance personnel are needed to handle them manually when they are fully scaled or plugged, and the cells shall be capable of passing through the access doors for the mist elimination section. Easy access for placement and

replacement of the mist eliminator shall be incorporated in the design of the mist eliminator arrangement and the absorber vessel.

Walkways shall be arranged and also measures shall be taken as appropriate to permit the internal components to be disassembled and reassembled during repairs without the necessity for time-consuming preparatory work. The headroom shall have a height of more than 2200 mm. The mist eliminator support beams shall be designed to act as maintenance walkways approximately 300 mm wide and shall allow for a minimum 500 Kg/m^2 load. The support beam/walkways shall provide personnel access to all mist eliminator modules, wash headers and wash nozzles.

Adequate number of viewing ports with flushing devices connected to automatically operating washing system shall be delivered at following locations:

a. upstream of 1st stage
b. between 1st and 2nd stage
c. Downstream of 2nd stage
d. Downstream of 3rd stage.

The regular flushing shall be done in a defined time sequence.

7) The absorber oxidation tank shall be provided with an over flow line (for spray tower type) complete with sealing pot, over flow and drain line. The absorber over flow shall be taken to a sump in the absorber region, from where the slurry shall be pumped back to the absorber by a sump pump.

8) Materials used shall be suitable for the chemistry of the absorber process and resist abrasion from any particulate contained in the incoming flue gas and from the particulate of desulphurization process.

9) All equipment located in the gas path or connected to such equipment shall be designed to withstand the maximum inlet gas temperature fluctuations. There shall be no damage whatsoever to any equipment as a result of these fluctuations.

10) The raw gas inlet duct of the absorber shall be equipped with a flushing device of the side walls and the ground, which shall operate continuously as well as intermittently.

11) The absorber vessel shall be made of minimum 7 mm thick carbon steel. The absorber oxidation tank, absorber tower & absorber outlet duct shall be provided with 2 mm (minimum) thickness lining / cladding / wall paper of Alloy C276 / Alloy 59 or better material with the exception of use of rubber material. Cladding/ wall paper shall be by explosion bonding or hot rolling.

12) The material of process equipment's of flue gas desulphurization system shall be appropriate for the chloride content and pH level at which the process is to operate.

13) All internal members shall be lined with minimum 2 mm Alloy 59/ C276. All metallic fasteners which are provided inside the absorber/absorber wet-dry interface ducting shall be of Alloy 59/ C276.

14) The absorber wet-dry interface shall be made of Alloy C276 / Alloy 59 of minimum 6 mm thickness.

15) The other bridges (supports) shall be lined with minimum 2 mm Alloy 59/ C276.

16) Lining material and technical application requirements shall be furnished by manufacturer experienced with similar FGD plants. Proof of such experience shall be provided by the Bidder.

17) The spray headers (if provided) and air supply headers shall be made of FRP or Carbon Steel material. For carbon steel material rubber lining of minimum 10 mm thick natural rubber (corrosion and erosion resistant) in the inner and outer side shall be provided. For FRP material Silicon carbide (SiC) lining of minimum 2.5 mm thickness in the inner and outer side shall be provided. If Silicon carbide (SiC) is mixed with FRP during manufacturing process, separate coating is not required.The slurry spraying system shall be made of material resistant to erosion and corrosion. During the lifetime of the plant, only the nozzles shall be replaced. The distribution system of the slurry shall be hydraulically optimized. The spray nozzles shall be of silicon carbide or ceramic or equivalent having a minimum guaranteed life of 20,000 hrs. The design of the spray nozzles shall be such that rapid wear, encrustation and plugging are avoided. Nozzle pipes and slurry spray nozzles shall be with bolted flanged connections. Nozzle pipes shall be installed easily to be removed partially through absorber modules.

18) The absorber several spray levels they shall be designed as follows.

    a) The last spray level upstream the mist eliminator shall be operated only in counter-flow.

    b) Depositions at downstream spray level and mist eliminator by co-flow injection of slurry shall be avoided.

    c) The spray lances shall be equipped with bars for installation of scaffolding without any offset. The spray levels shall be designed for load of min. 500kgf/m^2.

    d) A flushing device of the spray levels with water shall be installed. Flushing shall take place if spray levels are out of operation.

19) The absorber shall be self-supported from the bottom to suit site conditions. Absorbers which are externally supported from the structure are also acceptable provided bidder/OEM has proven experience of supplying such Absorbers which are operating for more than 5 years. The absorber shall have adequate stiffening arrangement on the external side. Internal stiffeners shall be used only where it is not possible to provide proper external stiffening.

20) It should be possible to build platforms inside the absorber for access to all parts of the absorber during maintenance. Minimum distance of 1.5 m shall be maintained between individual spray levels. Arrangement shall be properly designed to facilitate access for maintenance and replacement of spray nozzles.

21) The spray piping, mist eliminators and its supporting structure shall be designed to carry sufficient load during maintenance.

22) The bottom of the absorber sump shall be designed so that there will be an easy entrance for a man with wheelbarrow. Therefore arrangement and dimensions of the inspection doors of the absorber at the ground level shall be designed accordingly. The bottom of the absorber sump shall be designed in such a way that complete drainage of absorption liquid/slurry is possible and accessible without damage of lining/rubber.

23) In case of Spray Tower System, Suction screens shall be installed inside the Absorber vessel to protect the Slurry recirculation pumps. In case Bubbling type, suction strainers shall be installed at the suction line side of Gas Cooling Pumps. The suction screen shall be made of Alloy 59/C276. Abrasion resistant FRP/Polypropylene is also acceptable if bidder/ collaborator have proven experience of the same for similar applications. For the agitators a flushing system for start-ups shall be provided. Flushing system is not required as per OEM's standard practice for top entry agitators which are placed well above the slurry settling zone.

24) It should be possible to discharge the absorber retention tank into the emergency absorbent tank within 2 hrs with 1x 100% gypsum bleed pump running. Bidder may provide additional pumps to meet this requirement.

25) At the heads of the absorber two manholes shall be provided to reduce the draught of stack during outage.

26) Equipment required for internal & external inspection shall be furnished by the bidder in brand new condition. The bidder shall furnish list of all such item along with the bid. The formation of agglomeration, deposition and caking shall be avoided. The bidder shall furnish cleaning procedure including the safety measures for all such areas (like mist eliminators, spray levels) as a part of inspection concept.

27) Absorber sump shall be located above ground level so that its content can be completely discharged.

28) Absorber shall be designed to withstand the maximum pressure developed by the ID fans.

29) Absorber system shall be designed to maintain the required SO2 removal i.e 80 mg/ Nm^3.

30) Platform with a minimum clear width of 1000 mm shall be provided all around the absorber at various level and connectivity to elevator.

DATASHEET

S. No.	Description	Unit	Quantity
1.0	**WET LIMESTONE SPRAY OR TRAY ABSORBER**		
1	**SPRAY SYSTEM**		
1.1	NO OF SPRAY LEVELS		By Bidder
1.2	NO OF SPARE NOZZLES PER SPRAY LEVEL		MINIMUM 10%
1.3	ABSORBER OXIDATION SYSTEM		
1.4	OXIDATION AIR BLOWERS PER ABSORBER		2 (1W+1S)
1.5	MARGIN ON HEAD	%	10
1.6	QUENCHING SYSTEM FOR OXIDATION SYSTEM		AS PER THE BIDDER'S PROVEN PRACTICE
2	**MIST ELIMINATORS**		
2.1	NUMBER OF COARSE STAGE		Three stage chevron type Mist Eliminators
2.2	NUMBER OF FINE STAGE		BY BIDDER
2.3	MATERIAL		Polysulfone or polypropylene or stainless steel or FRP
2.4	TYPE		CHEVRON
2.5	VELOCITY OF FLUE GAS INSIDE THE ABSORBER	m/s	Max 4 m/s at design point conditions
2.6	SLURRY PH	-	shall be > 5.5 under all operating conditions
3	**ABSORBER VESSEL MATERIAL OF CONSTRUCTION**		
3.1	ABSORBER MATERIAL	-	Carbon steel
3.2	MINIMUM ABSORBER MATERIAL THICKNESS	mm	MINIMUM 7MM
3.3	INTERNAL LINING		Alloy C276 / Alloy 59 or better material
3.4	LINING THICKNESS	mm	MINIMUM 2 MM)
3.5	LINING THICKNESS IN SPRAY AREAS AND ABSORBER BOTTOM UPTO MINIMUM 4 M HEIGHT	mm	MINIMUM 2 MM
3.6	ABSORBER WET –DRY	-	Alloy C276 / Alloy 59 of

S. No.	Description	Unit	Quantity
	INTERFACE		minimum 6 mm thickness.
3.7	AREAS HIGHLY STRESSED BY SLURRY DUST FLUE GAS VELOCITY ETC	-	C276
3.8	SPRAY HEADERS/AIR SUPPLY HEADERS(INSIDE ABSORBER)	-	FRP/CARBON STEEL WITH RUBBER LINING(MIN 10 MM NATURAL RUBBER LINING) WITH SIC COATING ON SURFACES EXPOSED TO SLURRY
3.9	SPRAY NOZZLE	-	SILICON CARBIDE OR CERAMIC OR EQUIVALENT HAVING A MINIMUM GUARANTEED LIFE OF 20,000 hrs
310	MINIMUM OPERATING LIFE OF THE ABSORBER LINING	Years	25
4.0	**JET BUBBLING REACTOR TYPE ABSORBER**		
4.1	**GENERAL**		
4.1.1	NUMBER OF FLUE GAS SPARGER TUBE		BY BIDDER
4.1.2	NUMBER OF OXIDATION AIR NOZZLE		BY BIDDER
1.3	NUMBER OF LIMESTONE SLURRY NOZZLE		BY BIDDER
4.2	**ABSORBER OXIDATION SYSTEM**		
4.2.1	OXIDATION AIR BLOWERS PER ABSORBER		2x100%
4.2.2	LOAD		BY BIDDER
4.2.3	FLOW		BY BIDDER
4.2.4	HEAD		BY BIDDER
4.2.5	MARGIN ON HEAD	%	10
4.2.6	REDUNDANCY ON OXIDATION NOZZLES/SPARGERS		BY BIDDER
4.2.7	QUENCHING SYSTEM FOR OXIDATION SYSTEM		As per the BIDDER's proven practice
5.0	**MIST ELIMINATORS (IF REQUIRED)**		
5.1	NUMBER OF COARSE STAGE		BY BIDDER

S. No.	Description	Unit	Quantity
5.2	NUMBER OF FINE STAGE		BY BIDDER
5.3	MATERIAL		Polysulfone or polypropylene or stainless steel or FRP
5.4	TYPE		Chevron
5.5	VELOCITY OF FLUE GAS INSIDE THE ABSORBER	m/s	BY BIDDER
5.6	SLURRY PH	-	BY BIDDER
5.7	MINIMUM SUBMERGENCE DEPTH	m	BY BIDDER
6.0	**ABSORBER VESSEL MATERIAL OF CONSTRUCTION**		
6.1	ABSORBER MATERIAL	-	Carbon steel
6.2	FLUE GAS SPARGER TUBE MATERIAL		BY BIDDER
6.3	OXIDATION AIR NOZZLE MATERIAL		BY BIDDER
6.4	LIMESTONE SLURRY NOZZLE MATERIAL		Stainless steel
6.5	MINIMUM THICKNESS OF ABSORBER MATERIAL	mm	Minimum 7
6.6	INTERNAL LINING		C276
6.7	LINING THICKNESS	mm	Minimum 2 mm for C276
6.8	ABSORBER WET –DRY INTERFACE	-	Solid C276 of 6 mm thickness
6.9	AREAS HIGHLY STRESSED BY SLURRY DUST FLUE GAS VELOCITY ETC	-	C276
6.10	MINIMUM OPERATING LIFE OF THE ABSORBER LINING	year	25
6.11	GYPSUM RESIDENCE TIME	min	BY BIDDER
6.12	MASS AND WATER BALANCE OF FGD SYSTEM	-	TO BE ENCLOSED BY THE BIDDER
7.0	**RECIRCULATION PUMPS**		
7.1	**GENERAL**		
7.1.1	DESIGNATION :		LIMESTONE SLURRY PUMPS FOR SLURRY RECIRCULATION TO ABSORBER
7.1.2	NUMBER REQUIRED:	Nos(W+S)	As indicated in write up

S. No.	Description	Unit	Quantity
7.1.3	LOCATION :		Inside building
7.2	**DESIGN DATA**		
7.2.1	OPERATION :		CONTINUOUS
7.2.2	LIQUID PUMPED :		LIMESTONE SLURRY
7.2.3	TEMPERATURE :	°C	BY BIDDER
7.2.4	SPECIFIC GRAVITY :		1.0-1.15
7.2.5	MAXIMUM SPEED:	rpm	BY BIDDER
7.2.6	MAXIMUM SIZE OF SOLID IN SLURRY :		BY BIDDER
7.2.7	DESIGN CAPACITY :		1.5 times shut off head at maximum suction pressure
7.2.8	DIFFERENTIAL HEAD :	MLC	AS REQUIRED BY BIDDER + 10% MARGIN
7.2.9	NPSH AVAILABLE :	MLC	BY BIDDER
7.2.10	DESIGN CODE		AS PER IS 5120
7.3	**CONSTRUCTION FEATURES**		
7.3.1	TYPE OF PUMP :		HORIZONTAL CENTRIFUGAL PUMP
7.3.2	IMPELLER :		NON CLOG TYPE
7.3.3	VOLUTE :		SINGLE
7.3.4	SHAFT :		COUPLED
7.3.5	SEAL:		BY BIDDER
7.3.6	PUMP DRIVER :		MOTOR WITH FLEXIBLE COUPLING
7.3.7	NOZZLE ORIENTATION:		AS PER BIDDER'S STANDARD DESIGN.
7.3.8	FLANGE DRILLING STANDARD :		AS PER ASME B16.5
7.4	**MATERIAL OF CONSTRUCTION**		
7.4.1	OUTER CASING:		ASTM A 216 GR WCB
7.4.2	INNER CASING		HI-CHROME (ASTM A 532 CLASS III TYPE A, (550 BHN))
7.4.3	IMPELLER :		HI-CHROME (ASTM A 532 CLASS III TYPE A, (550 BHN))
7.4.4	SHAFT :		SS 410
7.4.5	SHAFT SLEEVE :		SS 410

S. No.	Description	Unit	Quantity
7.4.6	CASING RING :		SAME AS ITEM 4.3
7.4.7	IMPELLER RING :		SAME AS ITEM 4.3
7.4.8	BASE PLATE :		BY BIDDER
7.4.9	COMPANION FLANGES :		SG IRON
7.4.10	SUCTION SCREEN		AS PER ASME B16.5
7.5	**ACCESORIES**		
7.5.1	COMPANION FLANGES WITH NUTS, BOLTS, GASKETS :		YES
7.5.2	COMMON BASE PLATE :		YES
7.5.3	FOUNDATION BOLTS :		YES
7.5.4	COUPLING :		YES
7.5.5	COUPLING GUARD WITH BOLTS :		YES
7.5.6	DRIP TRAY :		YES
7.5.7	LANTERN RING :		YES
7.5.8	SUCTION PRESSURE GAUGE :		YES
7.5.9	DISCHARGE PRESSURE GAUGE:		YES
7.5.10	MOTOR STARTER :		YES
7.5.11	RECOMMENDED SPARES :		YES
7.5.12	PAINTING		YES
7.6	**MINIMUM GUARANTEED OPERATING LIFE**	Operating hr	20000
8.0	**AGITATORS**		
8.1	**GENERAL**		
8.1.1	DESIGNATION		AGITATOR FOR FGD SYSTEM
8.1.2	NUMBER		TO BE SPECIFIED BY THE BIDDER FOR DIFFERENT SYSTEMS
8.1.3	LOCATION		OUTDOOR/SEMI-OUTDOOR/INDOOR
8.1.4	TYPE		SIDE/TOP ENTRY
8.1.5	DESIGN PARAMETERS		
8.1.6	OPERATION		CONTINUOUS
8.1.7	DRIVE		BY BIDDER
8.2	**MATERIAL OF CONSTRUCTION**		

S. No.	Description	Unit	Quantity
8.2.1	SHAFT AND AGITATOR BLADE		ALLOY 926 OR CSRL BASED ON THE PROVEN EXPERIENCE OF SIMILAR SIZE AND CAPACITY OF THE BIDDER
	NOTE: 1. OUT OF TOTAL N NOS. OF AGITATORS REQUIRED FOR A SPECIFIC SYSTEM BASED ON BIDDER'S PROVEN EXPERIENCE, IF ANY ONE OF THE AGITATORS GOES OUT OF SERVICE FOR MAINTENANCE, THE REMAINING (N-1) NOS. OF AGITATORS SHALL BE CAPABLE OF MEETING THE PROCESS REQUIREMENTS AND AVOID ANY SETTLEMENT/ CRYSTALLIZATION.		
9.0	**EMERGENCY ABSORBER TANK**		
9.1	NUMBER REQUIRED		ONE (1) No. EMERGENCY ABSORBER TANK FOR QUENCHING
9.2	DESIGN AND FAB. CODE		IS 803/API 650
9.3	VENTING REQUIREMENT		AS PER API 2000
9.4	PLATE MATERIAL		IS:2062 GR B QUALITY MILD STEEL
9.5	CAPACITY NOM./TOTAL	m^3	BY BIDDER
9.6	TANK SHELL THICKNESS	mm	BY BIDDER
9.7	SP. GRAVITY OF CONTENT		BY BIDDER
9.8	TANK DIMENSION	LXBXH	BY BIDDER
9.9	OPERATING PRESSURE		BY BIDDER
9.10	DESIGN PR. INT./EXT.	kg/m^2	WATER FULL
9.11	HYDROTEST PRESSURE		WATER FILL TEST
9.12	OPERATING TEMP.	°C	AMBIENT
9.13	DESIGN TEMP.	°C	BY BIDDER
9.14	RADIOGRAPHY		SPOT
9.15	JOINT EFFICIENCY		0.85
9.16	STRESS RELIEF		NONE

S. No.	Description	Unit	Quantity
9.17	MINIMUM CORROSION ALLOWANCE	mm	HEAD (TOP) : 2
			SHELL & BOTTOM: 2
9.18	SEISMIC COEFFICIENT		AS PER IS 1893
9.19	WIND PRESSURE	kg/m^2	AS PER IS 875
9.20	LINING OF INTERIOR SURFACE	-	NOT REQUIRED
9.26	LINING MATERIAL/THICKNESS	-	N/A
9.27	WATER STORAGE CAPACITY	min	MINIMUM 20
9.28	PAINTING THE OUTSIDE SURFACE	-	YES
9.29	DRAIN	-	YES
9.30	MANHOLES	-	YES
9.31	OVERFLOW AND INLET LEVEL CONTROL VALVE	-	YES
10.0	**ABSORBER AREA SUMP PUMP**		
10.1	**GENERAL**		
10.1.1	DESIGNATION :		VERTICAL SUMP PUMP FOR ABSORBER AREA
10.1.2	NUMBER REQUIRED:	NOS	2(1W+1S)
10.1.3	LOCATION		SEMI OUTDOOR
10.2	**DESIGN DATA**		
10.2.1	OPERATION :		CONTINUOUS
10.2.2	LIQUID PUMPED :		LIMESTONE SLURRY
10.2.3	TEMPERATURE :	°C	BY BIDDER
10.2.4	SPECIFIC GRAVITY :		BY BIDDER
10.2.5	MAXIMUM SPEED:	RPM	BY BIDDER
10.2.6	MAXIMUM SIZE OF SOLID IN RAW WATER :		BY BIDDER
10.2.7	DESIGN CAPACITY :		AS REQUIRED BY BIDDER + 10% MARGIN
10.2.8	DIFFERENTIAL HEAD :	MLC	AS REQUIRED BY BIDDER + 10% MARGIN
10.2.9	NPSH AVAILABLE :	MLC	BY BIDDER
10.2.10	DESIGN CODE		AS PER IS 5120
10.3	**CONSTRUCTION FEATURES**		
10.3.1	TYPE OF PUMP :		VERTICAL CENTRIFUGAL

S. No.	Description	Unit	Quantity
			TYPE
10.3.2	IMPELLER :		NON CLOG TYPE
10.3.3	VOLUTE :		SINGLE
10.3.4	SHAFT :		COUPLED
10.3.5	SEAL:		BY BIDDER
10.3.6	PUMP DRIVER :		MOTOR WITH FLEXIBLE COUPLING
10.3.7	NOZZLE ORIENTATION:		AS PER BIDDER'S STANDARD DESIGN.
10.3.8	FLANGE DRILLING STANDARD :		AS PER ASME B16.5
10.4	**MATERIAL OF CONSTRUCTION**		
10.4.1	CASING		HI-CHROME (ASTM A 532 CLASS III TYPE A, (550 BHN))
104.2	IMPELLER :		HI-CHROME (ASTM A 532 CLASS III TYPE A, (550 BHN))
10.4.3	SHAFT :		SS 410
10.4.4	SHAFT SLEEVE :		SS 410
10.4.5	CASING RING :		SAME AS ITEM 4.3
10.4.6	IMPELLER RING :		SAME AS ITEM 4.3
10.4.7	STUFFING BOX PACKING :		BY BIDDER
10.4.8	BASE PLATE :		SG IRON
10.4.9	COMPANION FLANGES :		AS PER ASME B16.5
10.4.10	STRAINER		SS 2205
10.5	**ACCESORIES**		
10.5.1	COMPANION FLANGES WITH NUTS, BOLTS, GASKETS :		YES
10.5.2	COMMON BASE PLATE :		YES
10.5.3	FOUNDATION BOLTS :		YES
10.5.4	COUPLING :		YES
10.5.5	COUPLING GUARD WITH BOLTS :		YES
10.5.6	DRIP TRAY :		YES
10.5.7	LANTERN RING :		YES
10.5.8	BEARING TEMPERATURE GAUGES :		YES

S. No.	Description	Unit	Quantity
10.5.1	SUCTION PRESSURE GAUGE :		YES
10.5.11	DISCHARGE PRESSURE GAUGE:		YES
10.5.12	MOTOR STARTER :		YES
10.5.13	RECOMMENDED SPARES :		YES
10.5.14	PAINTING		YES
10.6	**MINIMUM GUARANTEED OPERATING LIFE**	OPERATING HR	20000
11.0	**Gypsum Bleed Pumps**		
11.1	Quantity		Two (1W + 1S)
11.2	Type		Horizontal Centrifugal
11.3	Capacity of each pump		By bidder
11.4	Material of Construction		
a	Body		Duplex Stainless Steel
b	Shaft		Duplex Stainless Steel
C	Impeller		Duplex Stainless Steel
D	Shaft Sleeve		Duplex Stainless Steel
e	All fasteners		Duplex Stainless Steel
12.0	**Emergency Water Tank**		
12.1	Quantity		One (1)
12.2	Material of Construction		
a	Shell		IS 2062
b	Roof		IS 2062
C	Bottom Plate		IS 2062
d	Flanges		IS 2062
E	All internal parts		IS 2062
123	Type of tank		Atmospheric
12.4	Capacity		20 min effective storage of quenching water
12.5	Joint Efficiency		0.85

SECTION – 6

LIMESTONE GRINDING AND SLURRY PREPARATION SYSTEM

1.0 General

A limestone and slurry preparation system is envisaged. Bidder shall supply wet limestone grinding and slurry preparation system complete with all auxiliaries and slurry storage tank of proven design.

2.0 Type of Limestone Silo

1) The Bidder shall provide two (2) number Limestone storage silos each having 24 hours effective storage capacity equivalent to the requirements of FGD system at Design point. The storage silo shall be complete with supporting steel structure, platforms, staircase, air canons power operated gates, gravimetric feeders, level switches, air relief devices, etc.

2) The storage silos and hopper cones shall be fabricated of minimum 10 mm thick carbon steel with a SS lining of SS304 (4 mm minimum) in the complete cones to ensure reliable discharge of material. The design of storage silos shall confirm to IS 9178. The storage silo shall be capable of feeding the limestone by means of gravimetric feeder to the wet ball mills. The top of unloading hopper shall be equipped with grate to protect the downstream equipment from gravel lumps or tramp waste.

3) For each silo, facilities shall be provided for unloading the silo, through feeder, to a truck at ground level, along with all necessary chutes and diversion chutes. The rod gate shall be provided above each rack and pinion gate to facilitate opening and closing of rack and pinion gates without any undesirable impact/load on the RPG with proper access and platform

4) Each Silo shall be provided with sufficient number of level transmitters.

5) Each silo shall be provided with minimum 3 nos. of air canons and mechanized hammering system at necessary location, capable of removing the jamming/clogging/blockage in the silos.

6) For dust free operation each silo should be provided with a self-cleaning bag filter system of suitably capacity containing blower, automatic/on-load cleaning system etc.

7) Limestone silo with hopper may be fabricated at factory in segments, transported and welded at site**.**

8) Rack and pinion gate shall be provided as per tender drawing with proper access and platform for maintenance and chain wheel arrangement to operate from feeder floor.

9) Maintenance Platform for silo outlet gates shall be a continuous operating platform for both silos and platforms shall be supported from column only and not support from feeder floor.

3.0 Bunker Shut-off Gates

1) A bunker outlet chute shall be provided for feeding limestone from bunker to the feeder. The size of the opening chute shall be sufficient to ensure proper flow of the limestone. There shall be no reduction of section in the bunker outlet chute from bunker to feeder. The inlet chute shall be provided with suitable poke doors/holes in order to remove jamming/blockage. A motorized bunker shut-off gate shall be provided at the inlet to each feeder.

2) All parts of the gate in contact with limestone shall be of stainless steel construction.

3) The shut-off gates and its actuator shall ensure 100% closing of the gate even with 'bunker full of limestone'.

4) Facility shall be provided to open/close the bunker outlet gate, through actuator, from remote as well as local.

5) In addition, a hand wheel with proper access shall also be provided for manual operation of the gate. The force at the rim of the hand wheel shall not exceed 35 kg with bunker full of coal.

6) For dust free operation each silo should be provided with a self-cleaning bag filter system of suitable capacity containing blower, automatic/on-load cleaning system etc.

4.0 Gravimetric Feeders

1) Gravimetric feeders shall be sized to meet atleast 120% of the maximum mill capacity.

2) The limestone feeder belt shall be of seamless rubber construction. It should be possible to adjust the belt tension from outside without opening the feeder body.

3) All parts in contact with limestone except belt shall be of stainless steel construction.

4) The feeder shall have adequate instrumentation to detect `loss of flow'.

5) The feeder shall have a motor/pneumatic operated gate at the outlet.

6) It should be possible to adjust the belt tension from outside without opening the feeder body.

5.0 Wet Ball Mill

1) One number tube mill for grinding of limestone dedicated to each limestone silo. Each mill shall be sized to meet atleast 120% of the maximum limestone requirement of the unit under the following conditions, all occurring together.

i)	Load	Design point flow
ii)	Flow	Atleast 120% of limestone requirement of the absorbers at design point for worse coal analysis
iii)	Input Limestone Size	1" (max.)
iv)	Output Fineness	90% or higher (as per the requirement of the absorber) through 325 mesh (for spray tower process) OR 90% or higher (as per the requirement of the absorber) through 200 mesh (for jet bubbling process).
v)	Mill Wear Part Conditions	Near Guaranteed Wear Part Life
vi)	Limestone bond index (kWh/sh.T)	13 (min)

2) All integral auxiliaries of the mills like hydro-cyclones, separator tank & mill circuit pumps shall be sized to meet the above conditions. A 100% stand-by pump shall be provided for the mill circuit pump.

3) The mill hydro-cyclone set shall have sufficient redundancy. A minimum 10% spare hydro-cyclone shall be provided in each set of hydrocyclone. The hydro-cyclone shall be designed to meet the requirements stipulated in relevant section. Hydro cyclone shall be of modular construction. It shall be possible to remove and replace individual hydro -cyclone with the set in service. Isolation shall be provided for each hydro cyclone to meet this requirement. The hydro cyclone shall be of proven design and shall be provided with rubber lining. The hydro cyclone shall be provided with replaceable rubber lining and thickness of 12 mm for the feed chamber and 12 mm for the overflow launder. The liner shall have minimum life of not less than 8000 hrs.

4) All parts of the mill including mill body, trunnion, hydro-cyclones, integral pipes, mill circuit pumps and other parts in contact with limestone slurry shall be provided with replaceable rubber wear liners. The wear liners or wear parts shall have a minimum guaranteed wear life of not less than 8000 hrs without reversal of the liners. The guaranteed capacity and fineness of the mill shall not be affected within the guaranteed life of the mil wear parts.

5) The material of the balls shall be chosen to ensure that the balls do not lose their original shape and to ensure minimum ball consumption. The Bidder shall also guarantee ball consumption per ton of limestone throughput. The Bidder shall furnish the minimum ball diameter below which the balls shall be replaced.

6) Facility shall be provided for on-load loading of steel balls to the mill. Two (2) nos. Ball charging devices including hopper and chute. Rejected ball collection facility shall be provided.

7) The ball mill shall be driven by a motor through a peripheral gear – shall be corrected as ball mill shall be driven by a motor through a clutch, peripheral gear and spray for gear.

8) The lube oil system shall have 100% stand-by arrangement for lube oil pumps and oil coolers of each circuit with independent pump / cooler. Wherever required duplex oil filters shall be provided.

9) The mill auxiliaries like separator tank, mill circuit pumps, mill hydro-cyclones and all connecting pipes handling limestone slurry shall have replaceable rubber linings. For mill circuit pumps, margin on Flow and head shall be 10% and 15% respectively.

The limestone after crushing shall be fed to the mill separator tank wherein it shall mix with filterate water. The mixing shall be achieved with the help of an agitator installed in the separator tank. 2 x 100% Mill circuit pumps installed at outlet of separator tank shall pump the limestone to the primary hydrocyclone.

10) Ball mill shall be provided with water washing facility along with complete piping and valves for cleaning of settled slurry in the system.

11) Mills shall have labyrinth and seals as required to prevent leakage.

12) Ball mill shall be statically and dynamically balanced. All inlet and Outlet Connections shall be Flanged connections. Mills shall have Suitable man Holes adequately sized and suitably located for the purpose of Maintenance and Inspection.

13) Bearings shall have proper lubrication arrangement. Necessary Pressure, Flow and Temperature Measurements shall be provided for the lubrication system. Bearings shall be AFBMA 60,000-hour minimum L10 life.

14) Maintenance space/platforms around mill, tanks, pumps, hydrocyclones and rooms for operator and maintenance shall be provided

6.0 Limestone Slurry Storage Tank

1) The Bidder shall provide two (2) numbers limestone slurry storage tanks and each tank shall be sized to meet 12 hours continuous limestone requirement of the unit operating at Design point of worst coal. For tank volume calculation, solid concentration (by weight) in the slurry shall be assumed not more than 25% or actual required whichever is lower.

2) The storage tanks shall be equipped with sufficient number of agitators, to avoid settling of limestone, as per the proven practice of the supplier. The agitators shall be designed to meet the requirements stipulated elsewhere in the tender specification.

3) The slurry storage tank shall be CS construction with replaceable chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness. Alternatively Glass Flake lining is also acceptable.

4) Coarse screen at suction side of these pumps shall be provided.

5) The mill separator tanks shall be installed indoor beneath the hydro cyclone stations. The limestone slurry storage tank shall be located outdoor.

7.0 Limestone Slurry Pumps

1) 2x100% (1W+1S) centrifugal type limestone slurry pumps shall be provided. Each limestone slurry pump shall be sized to supply the limestone requirement of the unit, under the following conditions all occurring together.

i)	Load	Design point
ii)	Flow	Atleast 110% of one absorber requirement with the limestone requirement at Design point
iii)	Head	As per system requirement
iv)	Margins	
	Flow	10% (minimum)
	Heads	15% (minimum)
v)	Solids Concentration	Max. 20% by weight or actual as per suppliers practice, whichever is minimum

2) The limestone slurry pumps shall be designed to meet the requirements stipulated elsewhere in the tender specification.

3) The limestone slurry pipes shall be sized to minimize erosion and avoid settling of the limestone at part load operation. The slurry pipes shall be lined with replaceable rubber lining of 10 mm thickness. Additional thickness of 2 mm rubber lining shall be provided at bends.

4) Automatic flushing equipment for all lime slurry pumps and pipes shall be supplied.

5) Coarse screen shall be provided at suction side of the Supply Distribution pumps

6) Ball mill, mill separator tank and pumps, Lime Slurry tank and pumps, etc., shall be located inside Limestone Slurry Preparation Building.

7) Manhole door at top and bottom for maintenance and vent shall be provided.

8.0 Mill Circuit Pumps

1) 2x100% 1W+1S) centrifugal type mill circuit pumps shall be provided for each mill. Each mill circuit pump shall be sized to supply the limestone requirement of the unit, under the following conditions all occurring together.

i)	Load	Design point
ii)	Flow	Atleast 110% of the absorber requirement with the limestone requirement at Design point
iii)	Head	As per system requirement
iv)	Margins	
	Flow	10% (minimum)
	Heads	15% (minimum)

v)	Solids Concentration	Max. 55% by weight or actual as per suppliers practice, whichever is minimum

2) All the slurry pumps shall be provided with motorized suction & discharge valves. In addition flushing water lines with motorized/ pneumatic valves shall be provided for each pump for automatic flushing after each shut down. The flushing water shall be taken from process water pumps.

8.1 Mill Separator Tank

1) The Bidder shall provide one (1 no.) mill separator tank for each mill. Each tank shall be sized to meet 12 hours continuous limestone requirement of the one mill operating at Design point. For tank volume calculation, solid concentration (by weight) in the slurry shall be assumed, not more than 25% or actual required whichever is lower.

2) The mill separator tanks shall be equipped with sufficient number of agitators, to avoid settling of limestone, as per the proven practice of the supplier. The agitators shall be designed to meet the requirements stipulated elsewhere in the tender specification.

3) The mill separator tank shall be CS construction with replaceable chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness. Alternatively Glass Flake lining is also acceptable.

4) Coarse screen shall be provided at suction side of the Supply Distribution pumps

8.2 Limestone Grinding Area Sump & Pumps

1) The Bidder shall provide one (1 no.) Limestone area grinding sump in mill area. The sump shall be of RCC construction and lined with replaceable chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness. Alternatively Glass Flake lining is also acceptable. Capacity of sump shall be as per standard practice of the bidder.

2) Agitator shall be provided in the limestone grinding area sump.

3) 2 x 100 % Sump pumps shall be provided in the limestone grinding area sump.

4) MOC of pumps shall be similar to slurry pumps.

DATASHEET LIMESTONE SLURRY STORAGE TANK

S.No.	Description	Data
1	Quantity	Two(2) nos.
2	Code	IS 803/ API 650
3	Type	Flat Roof Tank
4	Fluid Handled	Limestone
5	Agitator Type	Vertical Top Entering
6	Hydrotest Pressure	Full of Water
7	Specific Gravity	1.2
8	Joint Efficiency	0.85%
9	Capacity	Each tank shall be sized to meet 12 hours continuous limestone requirement of the unit operating at Design point of worst coal.
10	Corrosion Allowance	1.5mm
11	MOC	
A	Shell Plate	IS 2062 ER 250 (chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness/ Glass Flake Lining)
B	Roof Plate	IS 2062 ER 250 (chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness/ Glass Flake Lining)
C	Bottom Plate	IS 2062 ER 250 (chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness/ Glass Flake Lining)

DATASHEET MILL SEPARATOR TANK

S.No.	Description	Data
1	Quantity	Two (2) nos.
2	Code	IS 803/ API 650
3	Type	Flat Roof Tank
4	Fluid Handled	Limestone
5	Agitator Type	Vertical Top Entering
6	Hydrotest Pressure	Full of Water
7	Specific Gravity	1.2
8	Joint Efficiency	0.85%
9	Capacity	12 hours limestone storage requirement of one mill
10	Corrosion Allowance	1.5mm
11	MOC	
A	Shell Plate	IS 2062 ER 250 (chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness/ Glass Flake Lining)
B	Roof Plate	IS 2062 ER 250 (chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness/ Glass Flake Lining)
C	Bottom Plate	IS 2062 ER 250 (chlorobutyl /bromobutyl rubber lining of minimum 5 mm thickness/ Glass Flake Lining)

DATASHEET WET BALL MILL

S.No.	Description	Data
1	Load	Design point flow
2	Capacity	Atleast 120% of limestone requirement of the absorbers at design point for worse coal analysis
3	Input Limestone Size	1" (max.)
4	Output Fineness	90% or higher (as per the requirement of the absorber) through 325 mesh (for spray tower process) OR 90% or higher (as per the requirement of the absorber) through 200 mesh (for jet bubbling process).
5	Mill Wear Part Conditions	Near Guaranteed Wear Part Life
6	Limestone bond index (kWh/sh.T)	13 (min)
7	Quantity	Two (1W+1S)
8	MOC	
9	Balls	
	Material	Cast Hi Chrome
	Brinell Hardness	58-68 HRC
10	Shell/ Head	
	Material	Shell – ASTM A 36 Head – ASTM A27 Gr 70 40
11	Discharge Trommel	
	Material	ASTM A36 w/ Rubber lined
12	Shell/ Head Liner	Rubber
13	Main Gear	Cast Steel ASTM A 148
14	Pinion Gear	Forged Alloy Steel
15	Mill Efficiency	➢ 80%

DATASHEET MILL CIRCUIT PUMPS

S.No.	Description	Data
1	Quantity	Four (2W + 2S)
2	Capacity	Each pump shall cater to requirement of on mill.
3	Sealing	Mechanical Seal
4	MOC	
a	Casing	Ductuile SG Iron Grade 500-7
b	Impeller	Ultrachrome 27% or equivalent
c	Internal Lining	Natural Rubber
d	Shaft	CF 8M

DATASHEET LIMESTONE SLURRY PUMPS

S.No.	Description	Data
1	Quantity	Four (2W + 2S)
2	Capacity	Each pump shall cater to requirement of the unit
3	Sealing	Mechanical Seal
4	MOC	
a	Casing	Ductuile SG Iron Grade 500-7
b	Impeller	Ultrachrome 27% or equivalent
c	Internal Lining	Natural Rubber
d	Shaft	CF 8M

SECTION – 7

DESIGN CRITERIA FOR PUMPS, TANKS, SLURRY PIPE & AGITATORS

1.0 SLURRY PUMPS

1) This Section covers the design, manufacture and erection of all slurry pumps for the FGD system including the Absorber slurry recirculation pumps, Gypsum bleed pumps, Limestone slurry feed pumps, Mill recycle pumps and any other pump handling slurries.

2) The Bidder shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian / International (ASME / EN / Japanese) Standards.

3) The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type capable of delivering the rated flow at rated head with margins as specified in the respective clauses. The slurry concentration in the pump shall not exceed 30% by weight except for Mill recycle Pumps for which the slurry concentration in the pump shall not exceed 55% by weight.

4) All the slurry pumps shall be provided with motorized suction and discharge valves. In addition, flushing water lines with motorized valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken from the process water supply.

5) The pump casing should be radially/axially split to allow easy removal of impeller.

6) All the pump wear parts in contact with the slurry shall be provided with replaceable rubber/elastomer liners suitable for the fluid handled. The Bidder can also offer high chrome alloy line pump if he has previous experience of the same for similar applications. The material used by the Bidder shall be proven in previous installations.

7) For absorber recirculation service a Silicon carbide impeller and SiC lining for casing can also be accepted if the manufacturer has supplied a similar pump for a previous installation for similar service.

8) The material and thickness of the liners shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 14000 hrs.

9) The design of the shaft shall ensure that the operating speed is at least 20% above the critical speed of the shaft.

10) The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy duty ball/roller bearings.

11) All the slurry pumps shall be provided with water washing facility along with complete piping and valves for cleaning of settled slurry.

2.0 VERTICAL SUMP PUMPS

1) Bidder shall provide sumps of adequate capacity in the absorber area, limestone grinding area and gypsum dewatering area for containing the over flow from the respective systems. Bidder shall make arrangements for pumping the drainage water back to the respective system with vertical sump pumps. Agitators shall also be provided to avoid settling of solids in the sump. Adequate redundancy in line with the standard practice adopted by the bidder shall be provided. This Clause covers the design, manufacture and erection of all vertical sump pumps for the FGD system.

2) The Bidder shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian / International (ASME / EN / Japanese) Standards.

3) The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type with semi open or open impeller. The pump impeller shall be cantilever type and shall not be supported below the base plate for easy withdrawal.

4) The pump shall deliver the rated flow at rated head with margins as specified in the respective clauses. The pump shall be capable of pumping of reclaim water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.

5) The material chosen for the pump components shall be suitable for the fluid handled and shall be proven in similar application.

6) The pumps shall not be supported below the base plate level for easy withdrawal without entering the sump.

3.0 SLURRY & PROCESS WATER TANKS

All the slurry tanks (slurry tank, reclaim water tanks, secondary hydro cyclone feed tank, vacuum receiver tank, waste water tank, lime neutralization tank etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 3mm on the minimum tank shell thickness as calculated by IS: 803, latest edition shall be provided by the Bidder. Tanks shall be made from IS: 2062 quality mild steel plates of tested quality. The tanks shall be of welded construction. Interior surface of the tanks shall lined with replaceable rubber lining and the outside surface shall be coated with paint as approved by the Owner. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.

4.0 AGITATORS

1) Agitators shall be supplied in tanks and vessels to prevent caking and settlement of particles out of the slurry, e.g. in the absorber vessel, Primary hydrocyclone feed tank, Secondary hyrocyclone feed tank, Filterate water tank, Gypsum area dewatering sump, mill separator tanks, limestone slurry tanks, emergency absorber tank, and sumps (Gypsum are dewatering sump, limestone grinding area sump, Absorber area sump) etc.

2) All agitators shall be designed for continuous operation unless otherwise specified. Horizontal agitators shall be used for Absorber. Vertical agitators can also be used for Absorber, if it is only the standard & proven practice of the Bidder for the offered Absorber design. In other vessels and tanks vertical agitators are also acceptable if they are of proven make and the Bidders standard practice which can be proven by means of suitable references. The design of the agitators shall be of proven type.

3) Standard type agitators with suitable characteristics shall be used wherever practical. The agitators shall be complete with motor, gearbox, agitator shaft, coupling, safety guards, mechanical seal (for side entry agitators), impeller, support legs, agitator mounting flange including bolts nuts and gasket etc.

4) All agitator parts and accessories in contact with the stirred fluid shall be constructed of materials specifically designed for the conditions and nature of the stirred fluid and be resistant to erosion and corrosion.

5) The material for the shaft (which is continuously in contact with slurry) and agitator blades of the Absorber Agitators shall be made with Alloy 926 or better material. For Agitators in other tanks, agitator blades shall be made with Alloy 926 or better material & shaft can be rubber lined with separate rubber layer for corrosion & erosion protection. This does not release the Bidder of the responsibility for selecting the correct materials.

6) Each agitator and its associated equipment shall be arranged in such a manner as to permit easy access for operation, maintenance and agitator removal without interrupting plant operation. It shall be possible to remove the sealing devices of the Agitators of the absorber vessel without having to drain completely the absorber.

7) To prevent mechanical blocking and load start-up after standstill of pumps, piping and agitators for slurries shall be applied with C-hose connection.

8) Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the agitators and their components.

9) All agitator parts components shall be designed and calculated for fatigue life considering maximum bending loads induced by fluctuating hydraulic forces and torsional loads based on installed motor power. For side entry agitators the alternating bending moment resulting from impeller and shaft weight has to be considered additionally.

10) All exposed moving parts shall be covered by guards.

11) Side entry agitators shall be flange mounted.

12) The shape of the impeller blade of side entry agitators shall be designed to avoid wear on the impellers which will affect the agitator performance as specified for 2 years of continuous operation under the design condition for the range of coal and limestone specified in the specification. In order to avoid excessive wear impeller tip speed must not exceed 12 m/s.

13) Belt drive (if applicable) shall be properly designed to provide a minimum lifetime of two years under design conditions.

5.0 SLURRY PIPE LINE AND VALVES

1) Slurry pipes shall be designed to keep the velocity above the settling velocity under all operating conditions. The Bidder may provide a recirculation line with motorized isolation valve for the above purpose.

2) All the pipes handling slurry shall be provided with replaceable rubber lining of proven quality. The Bidder can provide slurry pipes of size lower than 3" made up of FRP material if it has previous experience of providing the same.

3) The isolation valves provided in all the slurry lines shall be of knife gate type/butterfly type. Motorized actuators shall be provided for valves requiring frequent operation as indicated in the relevant scheme.

4) The valves shall be of proven type and the Bidder shall submit a detailed valve schedule for Owner's approval. Reference list for previous installations for similar application shall also be furnished to the Owner.

5) The isolation valves shall be of knife gate type with rubber seats designed to prevent accumulation of solids on the valve seat.

6) Bidder shall provide all necessary arrangements for purging & flushing of all the process pipelines, equipment etc.

6.0 GENERAL CRITERIA FOR PUMPS

1) All pumps shall be designed to withstand 1.5 times the pump shut off pressure, under maximum suction pressure conditions.

2) Pumps shall be designed for 110% of nominal flow and shall be capable of at least 10% head increase at rated condition by installing new impeller. Best efficiency point for rated impeller diameter shall be on the right side of the rated capacity.

3) All pumps shafts shall be of ample size to transmit the full output from their drivers. The drivers shall be rated for the maximum power requirement of the pumps. For motor driven pumps, the rated flow and head shall be achieved with a variation of ±10% in voltage and ±5% in frequency of the power supply.

4) Impellers shall be fitted to the shaft in a suitable manner which will permit the transmission of the maximum torque developed under any operating conditions and removal without damage to either impeller or shaft.

5) All pumps shall be constructed of materials specifically designed for the conditions and nature of the pumped fluid and to resist cavitation's, erosion and corrosion.

6) Renewable wear rings shall be fitted to the casing and impeller

7) Mechanical seals shall be considered for all pumps.

SECTION – 8

GYPSUM DEWATERING SYSTEM

1.0 General

1) Gypsum dewatering system for the unit is envisaged. Bidder shall supply a two stage gypsum dewatering system, consisting of a primary stage of sets of hydro-cyclones and secondary stage of sets of hyrocyclones. Vacuum belt filters for dewatering of gypsum from absorber up to less than 10% moisture. All the equipments supplied shall be proven design with previous installations for similar capacities.

2) The Bidder shall provide 2 x100% gypsum dewatering system with each stream sized to dewater atleast 110% of the maximum gypsum produced operating at Design point of worst coal. All other stipulations with respect to sizing and design of the dewatering system, auxiliaries and other systems shall be in line with this specification.

2.0 Primary Hydro-cyclone Feed Tank & Pumps

1) One primary hydro-cyclone feed tank shall be provided to collect gypsum slurry from gypsum bleed pumps. The tank shall be sized to collect the total gypsum slurry from the unit plus 10% margin.

2) Two (1W +1S) Primary Hydro-cylcone Feed pumps shall be provided at outlet of primary hydrocyclone feed tank to pump water to the primary hydrocyclones. Each pump shall be sized to handle slurry from the unit. Pumps hall be sized to dewater the gypsum slurry produced by the unit operating at Design point with an additional 10% margin.

3.0 Primary Dewatering Hydro-cyclones

1) Primary stage consisting of two (2) interconnected hydro-cyclones.

2) Each set of primary dewatering hydro-cyclone shall be sized to dewater the gypsum slurry produced by the unit operating at Design point of worst coal and receiving feed from one (1) Primary hydro cyclone Feed tank through 2x100% Primary hydro-cyclone feed pumps. The outlet water content in the gypsum shall be as per the requirement of the vacuum belt filters.

3) The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Hydro-cyclone Waste Water tank via secondary hydro-cyclone feed tank and secondary waste water hydrocyclone as shown in the relevant tender drawing.

4) Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

5) The primary hydro cyclone shall be of proven design and shall be provided with replaceable rubber lining. The hydrocyclone shall be provided with replaceable rubber lining of thickness 12 mm for feed chamber and 12 mm for the overflow launder. The liners shall have a minimum wear life of not less

than 8000 hours. Alternatively, Polyurethane material shall also be used for hydro-cyclone construction.

4.0 Vacuum Belt Filters

1) 2 x 100% Vacuum belt filters, each suitable for handling / dewatering of the unit.

2) Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum:

   a) 110% of gypsum produced by Absorber for the unit at Design point.

   b) Outlet Moisture ≤10%.

   c) Gypsum Purity 90% (minimum).

   d) Chloride content < 100 ppm

3) One (1) number cake wash water tank with accessories and 2x100% cake wash pumps and each pump to be designed to handle requirement of the unit.

4) The vacuum belt filter shall be proven design in operation for similar capacities. The filter cloth shall be polyester or polypropylene as per the proven design of the supplier and shall be guaranteed for a minimum life of not less than 8000 hrs.

5) All parts in contact with gypsum shall be made of corrosion resistant material or shall be provided with corrosion resistant liners of proven design except frame for vacuum belt filter which shall be of MS with epoxy paint.

6) In case the bidder offers design with an underlying belt for carrying the filter cloth, the same shall be endless factory vulcanized rubber belts. The belts shrouds and sealing belts shall provide a leak arrangement to prevent overflow of gypsum slurry. The sealing shall have minimum life of not less than 8000 hrs.

7) The vacuum box shall ensure tight sealing with belt/cloth and shall be of proven design.

8) The belt filter shall have automatic cloth tracking mechanism and shall be provided with all required instrumentation as per supplier proven practice. The belt filter shall have an automatic cloth tensioning mechanism.

9) The filter shall be provided with minimum 2 stages of cake washing for removing impurities in gypsum. One stage of cloth washing arrangement shall also be provided.

10) The filtrate from gypsum slurry and cake washing shall be to separate vacuum receiver tank(s) as per proven practice of supplier. Each belt filter shall have independent vacuum pump.

11) Gypsum cake from each belt filter shall be discharged through belt conveyors to gypsum storage yard. The elevation of discharge point of vacuum belt filter shall be atleast 10.0 m above GL.

12) A 2 m (min.) wide platform shall be provided around each belt filter for easy approach & maintenance. Handling facilities for replacement of heavy components of the belt shall also be provided.

5.0 Vacuum System

1) Two (2) number vacuum pumps dedicated to individual receiver tank.

2) The filtrate from each belt filter, cake washing & cloth washing shall be taken to separate receiver tanks as per the supplier's proven practice.

3) Each vacuum pump shall be sized to meet the requirement of each belt filter operating at its maximum capacity. An additional margin of 10% (min.) over the above capacity shall be provided for each vacuum pump.

4) The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitations under all operating conditions. The seals shall be of proven design.

5) Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.

6) The vacuum receiver and pump internals shall be suitably lined/or without lining & shall be suitable for corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.

7) Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.

8) One (1) number receiver tanks dedicated to each vacuum belt filter.

9) Water separators shall be provided in the vacuum receiver tank.

6.0 Reclaim water System

1) Water from vacuum receiver tank(s) and the under flow from the secondary hydro-cyclones shall be taken to one number filtrate water tank provided with Agitator(s). 2 x100% horizontal centrifugal type Filterate Water pumps (1W+1S) shall be provided to recycle the water to the absorber, Limestone Mill & Mill Separator. Each pump sized to recycle the water to each absorber & Limestone Mill & Mill Separator.

2) The pump shall be capable of pumping of reclaim water with solid concentration of not less than 10% & particle lumps of 6-7mm. A 10% margin shall be provided in each of the pump.

3) 2 x 100 % (1W + 1S) Belt/ Wash Cloth Water pumps shall also be provided in the filtrate water tank for cleaning & washing of belt cloth in vacuum filter with Complete piping and valves for the system along with wash water line.

7.0 Waste Water System

1) The overflow from each primary set of hydro-cyclone shall be taken to one number secondary hydro-cyclone feed tank provided with Agitator(s) for feeding the secondary waste water hydro-cyclones.

2) Secondary hydrocyclone feed tank shall be sized to provide a minimum storage of minimum two (2) hour of primary hydro-cyclone overflow of the unit with unit operating at Design Point and no outflow from the tank.

3) 2 x 100% Secondary hydro- cyclones, each suitable for handling flow of the unit and receiving feed from one (1) Secondary hydro cyclone Feed tank through 2 x100% (1W+1S) secondary hydro-cyclone feed pumps.

   The over flow from the secondary hydro-cyclone shall be taken to Central Monitoring Basin.

4) Each set of hydro-cyclone shall be sized to process the maximum discharge from each secondary hydro-cyclone feed pump. A minimum 10% spare hydro-cyclones shall be provided in each set. Secondary Hydro-cyclones shall be of modular construction and of proven design. The secondary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

5) The secondary waste water underflow shall be taken to the adequately sized filtrate water tank, while the overflow shall be taken to over ground waste water tank.

8.0 Emergency absorber tank

1) The bidder shall provide one emergency absorber tank, sized to contain the complete slurry of one absorbent tank at its maximum level equipped to all necessary pumps, valves, piping and controls to transfer the contents back to the absorber to refill the absorber sump. It should be possible to discharge the absorber into emergency absorber tank within 2 hrs.

2) The bidder shall provide 2x 100% emergency absorber tank pumps for each tank to pump back the slurry from the sump back to absorber in maximum time of 8 hrs.

3) The bidder shall provide 2 x 100% emergency absorber drain pumps for each absorber to drain the absorber to emergency absorber tank.

4) Agitations shall be provided to prevent settlement of slurry by side entry agitators with emergency flush start system. Sufficient numbers of agitators shall be provided in the tank by the bidder to prevent the solid from settling down.

5) The emergency absorber tank shall be made of minimum 7 mm thick carbon steel with 4 mm thick rubber lining of best quality bromine butyl rubber and shall also be equipped with all necessary pumps, valves piping and controls to transfer the tank contents back to the absorber. Alternatively glass flake lining is also acceptable.

6) The emergency absorber tank shall be equipped with an opening to enable easy entry of a man with wheelbarrow.

7) Cross screen of suitable material at suction side of pumps shall be provided.

PRIMARY HYDROCYCLONE

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each Primary cyclone shall be sized for one unit
3	Material of Construction	
a	Cyclone	Polyurethane
b	Feed Pipe	Carbon Steel rubber lined/ FRP
c	Underflow Launder	Carbon Steel rubber lined/ FRP
d	Overflow Launder	Carbon Steel rubber lined/ FRP
4	Lining Material Thickness	Overflow Launder : Rubber (6 mm) Underflow Launder : Rubber (8 mm)
5	Solid contents of feed, %	20
6	Solid content leaving hydrocyclone (%)	
a	Underflow	4
b	Overflow	50

PRIMARY HYDROCYCLONE FEED PUMP

S.No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Material of Construction	
a	Body	Ductile Iron
b	Internal Lining	Rubber
C	Impeller	Ultrachrome 27%
d	Shaft	CF8M
e	Shaft Sleeve	CF 8M
4	Sealing	Mechanical Seal

SECONDARY HYDROCYCLONE FEED PUMP

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Material of Construction	
a	Body	Ductile Iron
b	Internal Lining	Rubber
c	Impeller	Ultrachrome 27%
d	Shaft	CF8M
e	Shaft Sleeve	CF 8M
4	Sealing	Mechanical Seal

GYPSUM DEWATERING AREA SUMP PUMP

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Material of Construction	
a	Body	Ultrachrome 27%
b	Internal Lining	Rubber
c	Impeller	Ultrachrome 27%
d	Shaft	CF8M
e	Shaft Sleeve	CF 8M
3	Sealing	Mechanical Seal

VACUUM BELT FILTER

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each vacuum belt filter pump shall be sized for one unit
3	Free Moisture of dewatered gypsum cake (%)	≤ 10
4	Type of Feed Distribution System	Fish tail feeder
5	Filter Cloth	Woven Type
6	Filter Cloth Mesh	50 – 60 Microns
7	Type of Pulley	Circular with diamond cutting on rubber lining
8	Discharge Blades	Knife Edge type
9	Vacuum Pump	
a	Type	Liquid Ring
b	Seal Type	Gland Packing
c	Material of Construction	Ultrachrome 27%
	Casing	Cast Iron Gr FG 260
	Rotor	SG Iron
	Shaft	EN 8

CAKE WASH PUMPS

S.No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Type of Pump	Horizontal
4	Suction	Flooded
5	Max Speed	1500 RPM
6	Material of Construction	
a	Body	IS 210 FG 260 (CI)
b	Wear Ring	CF 8M
c	Impeller	CF 8M
d	Shaft	SS 316
e	Shaft Sleeve	SS 316
7	Sealing	Mechanical Seal

BELT/ CLOTH WASH PUMPS

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Type of Pump	Horizontal
4	Suction	Flooded
5	Max Speed	1500 RPM
6	Material of Construction	
a	Body	IS 210 FG 260 (CI)
b	Wear Ring	CF 8M
c	Impeller	CF 8M
d	Shaft	SS 316
e	Shaft Sleeve	SS 316
7	Sealing	Mechanical Seal

RECIEVER TANK

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each Tank shall be sized for one vacuum belt filter
3	Material of Construction	
a	Shell	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
b	Bottom Plate	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
c	Top Plate	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
d	Lining	5 mm thk natural rubber(Alternatively Glass Flake Lining is also acceptable)

CAKE WASH TANK

S. No.	Description	Data
1	Quantity	One (1)
2	Capacity	Each Tank shall be sized for one unit
3	Material of Construction	
a	Shell	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
b	Bottom Plate	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
c	Top Plate	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
d	Lining	5 mm thk natural rubber(Alternatively Glass Flake Lining is also acceptable)

FILTERATE WATER TANK

S. No.	Description	Data
1	Quantity	One (1)
2	Capacity	Each Tank shall be sized for one unit
3	Material of Construction	
a	Shell	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
b	Bottom Plate	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
c	Top Plate	IS 2062 with internal rubber lining (Alternatively Glass Flake Lining is also acceptable)
d	Lining	5 mm thk natural rubber(Alternatively Glass Flake Lining is also acceptable)

EMERGENCY ABSORBER TANK

S. No.	Description	Data
1.0	**Emergency Absorber Tank**	
1.1	Quantity	One (1)
1.2	Material of Construction	
a	Shell	IS 2062 with Glass Flake Lining
b	Roof	IS 2062 with Glass Flake Lining
C	Bottom Plate	IS 2062 with Glass Flake Lining
d	Flanges	IS 2062 with Glass Flake Lining
e	All internal parts	IS 2062 with Glass Flake Lining
1.3	Type of tank	Atmospheric
1.4	Capacity	Sized to contain the complete slurry of one absorbent tank at its maximum level sized to contain the complete slurry of one absorbent tank at its maximum level
1.5	Joint Efficiency	0.85

FILTERATE WATER PUMP

S. No.	Description	Data
1	Quantity	Four (2W+2S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Material of Construction	
a	Body	Ductile Iron
b	Internal Lining	Rubber
c	Impeller	Ultrachrome 27%
d	Shaft	CF8M
e	Shaft Sleeve	CF 8M
f	Fasteners	Duplex Stainless Steel
4	Sealing	Mechanical Seal

EMERGENCY ABSORBER DRAIN PUMP

S. No.	Description	Data
1	Quantity	Four (2W+2S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Material of Construction	
a	Body	Duplex Stainless Steel
b	Impeller	Duplex Stainless Steel
c	Shaft	Duplex Stainless Steel
d	Shaft Sleeve	Duplex Stainless Steel
e	Sealing	Duplex Stainless Steel
f	Fasteners	Duplex Stainless Steel
4	Sealing	Mechanical Seal

EMERGENCY ABSORBER TANK PUMP

S. No.	Description	Data
1	Quantity	Two (1W+1S)
2	Capacity	Each pump shall be sized for one unit plus margin
3	Material of Construction	
a	Body	Duplex Stainless Steel
b	Impeller	Duplex Stainless Steel
c	Shaft	Duplex Stainless Steel
d	Shaft Sleeve	Duplex Stainless Steel
e	Sealing	Duplex Stainless Steel
f	Fasteners	Duplex Stainless Steel
4	Sealing	Mechanical Seal

SECTION – 9

GYPSUM STORAGE SYSTEM

1.0 General

Gypsum cake coming from the belt filter shall be discharged to a hopper. The belt conveyor will transport the gypsum to the closed gypsum storage shed.

The System shall also have Provision for Direct Unloading into the Commercial trucks.

Gypsum handling system shall be provided with 2x100% conveyor stream for conveying dewatered gypsum from gypsum vacuum belt filter to closed storage shed. The storage shed shall be sized for 15 days of gypsum production with unit in operation. Gypsum from storage shed shall be loaded to trucks using front end loader/ payloader

Gypsum shed of 15 days storage produced by the unit shall be considered. Shed shall be provided with side protection. Adequate space inside shed for truck movement shall be provided. Dozer (1 No.) and Pay loader (1 no.) required for gypsum storage and loading into the truck shall be included in the Bidder's scope. Maintenance area with arrangement required for the Dozer (1 No.) and Pay loader (1 no.) shall also be included in Bidder's scope.

1.1 Codes & Standard

The design, manufacture, inspection of Gypsum storage shall comply with all currently applicable regulation & safety codes. Other International applicable standards which equal or high performance than those specified shall be accepted.

1.2 Design & Constructional Features

Two Number individual Gypsum transfer conveyor (1W+1S) shall transfer the gypsum produced by the unit to Gypsum storage yard through Travelling tripper arrangement such that the gypsum can be discharged and spread across the length of the storage area.

The Gypsum transfer conveyor shall be provided with telescopic chute arrangement for unloading Gypsum directly to truck inside the gypsum storage shed.

4.0 M high RCC wall for stacking gypsum considering 15 days gypsum storage shall be provided.

Bidder to consider angle of repose less than 50 degree and stacking height less than 6 metres.

Gypsum storage shed shall be provided with a bay width of minimum 3 m on all side for movement of trucks, pay loaders and dozer.

Operator room, maintenance room with toilet, SW, PW facility shall be provided. Min 2 entry and 2 exit for truck movement shall be provided.

Sump pit and 2 x 100% pumps shall be located in the covered shed to prevent any rain water from entering and Discharge point of the sump pump shall be indicated.

Vehicle crush barrier shall be provided for all the structural columns inside the storage shed.

For conveyor discharge end, Maintenance hoist, canvas spout and safety rails shall be provided.

Plain water dust suppression system for Gypsum storage area shall be provided. All the associated system such as pumps (1w+1s), spray nozzles covering the entire storage area, including electrical, instrumentation and control system shall be provided.

1.3 Scope of Supply

The scope of supply is indicated below but shall not be limited to the following :

a) Gypsum shall be conveyed from the vacuum belt filter to the storage shed through a series of double stream conveyors and transfer points/junction towers.

b) One number of covered storage shed for gypsum. The storage shed shall be sufficient to store gypsum equivalent to gypsum generation of minimum 7 days at Design point.

c) Minimum four (4) Nos. sump pumps in gypsum storage shed complete with motors, local control panel, level switches, individual discharge piping with fittings and valves.

d) Complete dust extraction system for control of fugitive dust in gypsum storage shed.

e) Service water and potable water system for complete gypsum handling plant Water Pump houses & water tanks for service water, cooling water and potable water system. Common pump house for Limestone handling plant gypsum handling plant is also acceptable.

f) Suitable number of motorized travelling tripper / Flow diverter (as applicable) on each feeding conveyor for feeding the gypsum to the covered storage shed. Trippers shall be complete with all mechanical, electrical equipment, rails, chute work, rail supporting structure (along with structural stools, as required), cables with cable festooning arrangement, thruster brakes, rail clamps, electric hoist, actuator flap gates etc.

g) Complete ventilation system for gypsum storage shed.

h) Two (2) numbers of electronic type belt scales (One no. on each gypsum conveyor feeding to storage shed) for continuous weighing, complete with all mechanical, electrical, civil, structural works and accessories. Gypsum from storage shed shall be loaded to user's trucks using front end loader/pay loader.

i) Bidder to note that the above list is not exhaustive and any work required for integration of complete system and ensuring its satisfactory running shall be in the scope of work and supply for this package

DATASHEET FOR GYPSUM CONVEYORS

S. No.	Item description	Conveyor
A.1	Belt width, mm	Min 800 mm or Sized for unit (whichever is higher x 20°tr. x 3-eq. roll)
A.2	Guaranteed capacity, TPH	100
A.3	Material handled	Gypsum
A.4	Belt speed, m/s [max]	1.2
A.5	Length/ lift	To suit
A.6	Type of take up device	Gravity Take up
A.7	Belt sag	Not more than 2% of tr idler spaci
A.8	Wrap angle (approx.)	210^0
A.9	Minimum Motor, kW	Minimum kW rating = 1.2 x Power required by driven equipment at motor shaft. [use CEMA 5th Ed. For above calculation and belting selection calculation use ky value of not less than 0.023]. Also all conveyors & feeders shall be capable of starting fully loaded
A.10	Motor rpm [nominal]	100
A.11	Belting	Nylon/ Nylon Belting, Heavy Duty with minimum 3-ply Cover:6 mm Top/ 3mm bottom, Grade: M-24, Minimum Rating not less than 400/3, HD Identical belting shall be provided for all conveyors. Maximum operating tension in belt shall not exceed eighty (80) percent of maximum allowable working tension of the belt at the specified load
B.0	**Idlers**	
B.1	Roll construction	a) ERW tube to IS: 9295,Idler Construction to IS: 8598 b) Tube OD steel:88.9mmx4.05mmthk for all types of idlers except impact idler c) Tube OD steel:76.1mmx4.5mm,OD rubber disc:101mm for rubber disc impact idler, shore hardness min.50° on shore A scale d) Spindle:20mm ø, EN-8/equal
B.2	Idler Frame	MS plate/ structural section,IS:2062
B.3	Bearings	Sealed and lubricated for life' provided with double labyrinth seal and rain cap. 20ø Deep Groove ball bearing with C-3 clearance of SKF/ FAG make only.
B.4	**Type of Idler**	
a)	No. of Rolls	3 Equal rolls x 20 degree tr.
b)	Spacing, m	
c)	Transition idlers	These shall be identical in construction to carrying Idler except for troughing angle, Tr. Angle range : 5-10 Deg.

S. No.	Item description	Conveyor
d)	Deflector Roller	Suitable deflector roller of at least 101.4 mm OD x 4.5 thk shell on 20mm dia. [min.] lagged with 5mm thk natural rubber lagging shall be provided for each conveyor.
e)	Non Magnetic Idler	Non-magnetic idlers made of aluminum/equal tube lagged with 5mm natural rubber lagging shall be provided in conveyor portion over which magnetic separator (Suspended Electromagnet) is mounted.
C.0		
C.1	Type of Construction	Welded Steel Construction & shall conform to the requirement of IS: 1891/ IS: 8531, Face Width:750mm Shell thickness [finished]: 8mm [minimum] for drive pulley and 6mm[minimum] for non-drive pulley
C.2	Pulley Dia., mm, (min.)	a) Drive pulley/ HT bend pulley: 400mm b) Non Drive pulley/ LT bend pulley: 315mm c) Snub pulley: 200mm
C.3	Bearing centers, mm, (minimum)	1200
C.4	MOC of shell / end discs	Mild Steel (IS:2062 / Equal) for all pulley except non-magnetic pulley. For Non-magnetic pulley, SS-304 shell & end discs shall be provided
C.5	MOC of Shaft & hub	EN-8 / equal & C-20/ equal
C.6	Shaft Diameter	As per design requirements. Shaft deflection shall not exceed six (6) minute for any pulley. Pulley assemblies shall be statically balanced and run concentric when mounted on shaft. T1/T2 shall be based on rubber lagging only
C.7	Lagging	For Drive Pulley: Min.12 mm (4mm ceramic + 8mm rubber) thick Ceramic rubber lagging For Non Drive Pulley: Min. 12 mm thick (plain) natural rubber lagging having 50 to 60 degree hardness on shore "A" scale.
C.8	Type of Bearing	Heavy duty antifriction - double row self-aligning spherical roller bearings with double labyrinth seals and grease nipples. L10 Life of bearing shall be 60000 hrs minimum
C.9	Type of Plummer Block	Bearings shall be housed in horizontally split type Plummer block and complete with side covers. Plummer blocks shall be of cast iron construction. Adjustable screw and lock nut shall be provided on one side of Plummer block for alignment purpose

DATASHEET FOR TRAVELLING TRIPPER

a)	Type	Motor operated travelling tripper
b)	Qty	One for Each Conveyor
c)	Type of drive unit for tripper Travel.	Motor (reversible) coupled to gearbox & gear box coupled to drive axle complete with flexible couplings or with shaft mounted gear box. No chain drive
d)	Rail size	90 lb/yard (Minimum)
e)	Rail Gauge	To suit.
f)	Tripper capacity	To suit
g)	Travel speed of Tripper (approx.)	12 m/min.
h)	Type of discharge chute	Two-way with flap gate having Linear actuator
i)	**Travel Wheels**	
i.	Type & material of wheel	Flanged, Cast Steel, quenched and Tempered wheels
ii.	Type & life of Bearings	Spherical roller bearing having **60000 hr**. (L-10) life. Method of lubrication through grease nipple
iii.	Axle material	C-45/EN-8
j)	Rail clamps	Manually operated rail clamps, two (2) set per Tripper
k)	**Head, Bend & Hold down Pulley**	
i.	Type	M.S. welded construction (IS:2062)
ii.	Material & Thickness of lagging	14 thk, plain natural rubber lagging on Head pulley and **12 thk** plain natural rubber lagging on Bend pulley.
iii.	Hold down pulley	Shall be provided to suit layout.
iv.	**Limit Switches**	To be provided as required.
l)	Mechanical End Stopper / Buffer Post provided	Yes
m)	Type of operation	Only Local operation to be provided

Datasheet for Gypsum Storage Area Sump Pumps

S. No.	Description	Data
1	Quantity	Four (2W+2S)
2	Material of Construction	
a	Body	Ultrachrome 27%
b	Internal Lining	Rubber
c	Impeller	Ultrachrome 27%
d	Shaft	CF8M
e	Shaft Sleeve	CF 8M
4	Sealing	Mechanical Seal

SECTION – 10

PROCESS WATER SYSTEM

1.0 INTRODUCTION

This section presents the system description, basic design criteria and performance requirements, broad scope of supply and operation and control philosophy of the Filtered Water System.

1.1 SYSTEM DESCRIPTION

The process water system shall convey process water make up from process water tank to various areas in FGD plant by means of horizontal pumps.

1.2 SCOPE OF SUPPLY

The pumps shall be installed in the filtered water pumphouse located above the filtered water reservoir.

a) Two (2) (1W+1S) vertical FGD process water pumps.

b) Two (2) (1W+1S) vertical Mist Eliminator Wash pumps. Alternatively, Bidder may use process water pumps for mist eliminator washing if it is the standard & proven practice of the OEM / Bidder.

c) One (1) number overhead Emergency Quenching Water Tank.

d) One (1) Cake wash tank along with Two no's cake wash water pumps (1W+1S) shall be provided.

e) The tank shall be provided with drain, manholes, over flow, level gauge, level transmitters & inlet level control valves etc.

f) The capacity of the pumps shall be such that it shall meet the maximum process water requirement of unit. A further 10% margin shall be provided over the above capacity for all the above pumps.

g) Flow distribution shall be indicated as per tender drawings.

h) Piping and instrumentation as indicated in the P & ID for Process water system.

1.3 GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMNETS

1.3.1 The process water system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Volume III, Chapter 27.

1.3.2 The total dynamic head of the pumps shall be selected by conducting detailed system resistance calculations. Bidder shall furnish these calculations and system resistance curves superimposed on pump characteristic curves. However the actual TDH shall be finalized by the bidder and following general guidelines shall be adhered to by the bidder towards computation of the same.

- Static head in each pumping system from minimum suction level to

highest discharge point. It shall also take into account highest level encountered on the route.

- Frictional losses shall be calculated based on pumping capacity as specified assuming C=100 on Hazen & Williams formula for design purpose. A minimum margin of 10% shall be provided over and above the calculated frictional losses.

1.3.4 All piping and related accessories shall be designed to withstand a pressure not less than the shut off head of respective pumps. Bidder shall also conduct water hammer analysis of the piping system in different transient conditions such as closure of valves, tripping of pumps etc. Bidder shall also consider such transient pressure surges in designing of the piping systems. The procedure and results of water hammer analysis shall be furnished to purchaser for his information and approval.

Following valves, fittings and appurtenances shall be provided by the bidder as minimum requirement.

1. Motorized discharge butterfly valves. Gate valves/ check valves as required.
2. Isolating valves shall be provided at suitable intervals and at suitable locations to isolate a particular section of pipeline for maintenance which will be mutually decided by Owner/ Consultant and bidder during detailed engineering stage.
3. Scour or drain valves at suitable locations for adequate drainage of pipelines.
4. Pipe supports/ racks complete with all accessories as required.
5. Any other accessories as required for safe and reliable operation of respective pumping system.

2.0 OPERATIONAL & CONTROL PHILOSOPHY

2.1 Refer Volume V Instrumentation and Control works.

DATA SHEET FOR FGD PROCESS WATER PUMPS

S. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	By Bidder (Capacity shall be fixed after taking 10% margin over required flow)
3.	Pump total head excluding losses in the pump	MWC	By bidder
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Vertical Pumps
6.	Location		Indoor
7.	Liquid handled		Filtered Water
8.	Type of line bearing lubrication		Self
9.	Liquid for lubrication		Pumped liquid
10.	Type of pump motor coupling		Flexible
11.	Thrust bearing location		In pump and motor
12.	Pump operating range		70% to 130% of rated capacity
13.	Materials of construction		
a.	Casing		2 % Ni CI
b.	Impeller		CF 8M
c.	Shaft		CF 8M
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 316
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 2062 epoxy painted

DATA SHEET FOR MIST ELIMINATOR WASH PUMPS

S. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	By Bidder (Capacity shall be fixed after taking 10% margin over required flow)
3.	Pump total head excluding losses in the pump	MWC	By bidder
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Vertical Pumps
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Filtered Water
9.	Type of line bearing lubrication		Self
10.	Liquid for lubrication		Pumped liquid
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		70% to 130% of rated capacity
14.	Materials of construction		
a.	Casing		2 % Ni CI
b.	Impeller		CF 8M
c.	Shaft		CF 8M
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 316
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 2062 epoxy painted

DATA SHEET FOR GYPSUM CAKE WASH PUMPS

S. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	By Bidder (Capacity shall be fixed after taking 10% margin over required flow)
3.	Pump total head excluding losses in the pump	MWC	By bidder
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Horizontal Split Casing
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Filtered Water
9.	Type of line bearing lubrication		Self
10.	Liquid for lubrication		Pumped liquid
11.	Type of pump motor coupling		Flexible
12.	Thrust bearing location		In pump and motor
13.	Pump operating range		70% to 130% of rated capacity
14.	Materials of construction		
a.	Casing		SS 316
b.	Impeller		SS 316
c.	Shaft		SS 316
d.	Shaft Sleeve		SS 316
e.	All hardware under water		SS 316
f.	Stuffing Box Packing		Asbestos Free
h.	Base Plate		MS IS 20

SECTION – 11

THERMAL INSULATION AND CLADDING

1.0 General

Thermal Insulation along with aluminum cladding shall be provided for all the equipments/surfaces having skin temperature more than 60 degree Celsius. The specification of the insulation including type, density, thickness, heat conductivity and finish shall be designed based on criteria specified below. The insulation thickness shall be designed based on following criteria.

S. No.	Criteria	Requirement
a)	Ambient Temperature	40°C
b)	Surface velocity	0.25 m/sec.
c)	Emissivity of Aluminum	0.2
d)	Insulation surface temperature	60 °C (max.)
e)	Thermal conductivity of insulation material	Not less than maximum values as per IS: 8183.
f)	Pipe/Equipment/Wall Temperature	Maximum fluid design temperature
g)	Overall heat transfer coefficient and insulation thickness	To be calculated as per ASTM-C-680-89. However, the minimum insulation thickness, however, shall not be less than 75 mm

1.1 Material and application of insulation material, protective cladding, wire mesh etc. shall be conforming to latest edition of following codes:

a) IS:8183
b) IS:3677
c) IS:3144
d) IS: 14164
e) IS:280
f) ASTM-B 209

1.2 Insulation material for all equipment, ducting, etc. shall conform to following requirements:

S.No.	Parameters	Requirement
1)	Material	
a)	Lightly resin bonded mineral wool of best grade conforming to IS:8183 (Handmade mattresses are not acceptable).	
b)	Material shall be rock wool only. Slag wool or slag wool inclusion shall not be accepted.	
c)	Lightly resin bonded glass wool mattress, having density 64 Kg/m³	

S.No.	Parameters	Requirement
	(min.), self-stitched in shop can also be accepted for temperature less than 400°C.	
2)	Bulk density of lightly resin bonded mineral wool mattresses	
a)	For use upto 400°C	100 Kg/m³
b)	For use above 400°C	150 Kg/m³
3)	**Physical requirements -** Following shall be met by testing as per relevant clauses of IS: 3144.	
a)	Shot content	5% by weight (max.), size of any shot not to exceed 5 mm in diameter
b)	Bulk density	To comply with 18.3 (1) & (2) above
c)	Weight gain by moisture absorption	2% (max.)
d)	Sulphur Content	Not exceeding 0.6%
e)	Alkalinity as percentage of Na2O	Not exceeding 0.6%
f)	Maximum oil content	Not exceeding 0.3% by weight
g)	Total carbon content	Not exceeding 0.3% by weight
h)	Settlement	Nil (When tested as per Cl. 21.1 & 21.2 of IS:3144)
i)	Handability	Fully handable, without any lump formation and disintegration of material
j)	Loss of weight after combustibility test	Not exceeding 5% by weight

1.3 The Insulation mattress shall be rated incombustible when tested by the method prescribed in clause 15 of IS:3144.

1.4 In addition to requirements as mentioned above, insulation material (and protective covering) shall:

a) Be fresh, incombustible, rust proof, non-hygroscopic.

b) Be capable of withstanding continuously and without deterioration the maximum temperature to which they will be subjected.

c) Not react chemically, either to itself or with other components.

d) Not sustain any fungi, or vermin and must not pose health hazards.

1.5 The Mineral wool shall:

a) Pass standard combustibility test both immediately after application and after subjected to maximum operating temperature for not less than 100 hours.

b) Not suffer permanent deterioration as a result of contact with moisture due to condensation and shall be free from objectionable odor.

c) Not cause corrosion of the surface being insulated or of cladding on it under normal site conditions.

d) Not suffer any quality deterioration under specified service conditions (both cold/hot face temperature) of use.

1.6 The use of insulation of finishing materials containing asbestos in any form is not permitted.

1.7 Insulation mattress/section shall be supplied in thickness of 25,40,50 and 75 mm. Insulation of higher thickness shall be made up in multiple layers using mattress/slabs of thickness specified above. However, if the required thickness is such that by using above mattress/slabs the calculated thickness is not achieved, the mattress/slabs in increment of 5 mm shall be acceptable for outer layers. The min. thickness however, shall not be less than 25 mm and number of layers shall be minimum and innermost layer shall be thickest.

2.0 Sheathing Material

Sheathing material for all insulated surfaces, equipments, piping etc. confirming to ASTM B-209-1060 temper H-14 or IS:737 Gr 19000/H2, shall be provided. The thickness of aluminium sheathing to be used shall be 22 SWG (0.71mm).

2.1 Binding and lacing wires shall be 20 SWG Galvanised Steel wire.

2.2 All Straps and bands shall be Galvanized Steel. Bands shall be 20 mm wide and 0.6 mm thick. For securing Aluminum sheathing material, stainless steel or anodized aluminum bends shall be used.

2.3 Screws shall be of galvanized steel, check headed, self-tapping type. Above 400 degree Celsius temperature, screws shall be stainless steel.

2.4 Hexagonal wire mesh netting shall be 10-13 mm aperture and atleast 0.56mm diameter conforming to following Galvanized Steel wire.

2.5 Non-metallic components like 3 mm thick mill board, aluminum pigment sealant, white glass cloth, insulating cement, neoprene washer shall be provided.

3.0 INSULATION MATERIALS

	Type#1	**Type#2**	**Type#3**	**Type#4**	**Type#5**	**Type#6**
Type	Lightly resin bonded mineral (rock) wool	Lightly resin bonded mineral (rock) wool	Bonded glass wool	Resin bonded mineral (rock) wool performed pipe section	Resin bonded glass mineral wool performed pipe section	Calcium silicate performed block type
Apparent density	120-150 Kg/m^3	100 Kg/m^3	64Kg/m^3	140-150Kg/m^3	60-80 Kg/m^3	20-25 Kg/m^3

Mtl. standards	IS: 8183	IS: 8183	IS: 8183	IS: 9842	IS: 9842	IS: 8154
Applicable service	Piping system & equipment with operating temp. above 400^0C	Piping system & equipment with operating temp. in range of 60-400^0C	Piping system & equipment with operating temp. in range of 60-400^0C	Piping system of 350 NB and below with operating temp. in range of 60-650^0C	Piping system of 350 NB and below with operating temp. in range of 60-400^0C	Piping system & equipment with operating temp. in range of 400-600^0C
Testing requirement	As per IS:8183	8183	8183	8183	IS:9842	IS:8154

4.0 CLADDING MATERIAL & ACCESSORIES SHALL BE AS SPECIFIED HERE UNDER:

S. No.	Item	Basic specification	Description
1.	cladding	Aluminium ASTM B-209-1060 temper H14 or IS:737 Gr.19000/H2	Thickness of sheathing (a) 18SWG (1.219) for diameter for insulated surface 450mm and above and for flat surfaces. (b) 20 SWG (0.91mm) for diameter of insulated surface 150mm and above upto 450mm. (c) 22 SWG (0.71mm) for diameter of insulated surface 150mm and below.
2.	Binding & lacing wire	Galvanized steel wire to IS: 280 for temp. below 400^0C and stainless to IS:6528 for temp above 400^0C	20 SAWG for all insulation interface temperature.
3.	Straps & brands	(i) Aluminium where interface temperature are below 400^0C (ii) Stainless steel	Band shall be 20 mm wide & 0.6 mm for securing aluminium sheathing anodized aluminium bends shall be used.

S. No.	Item	Basic specification	Description
		where temperature are above 400^{0}C	
4.	screws	Stainless steel	Self tapping, chese headed
5.	Hexagonal wire mesh	(i) Galvanized wire to IS :280 mesh for interface temperature upto 400^{0}C (ii) Stainless steel wire for temperature above 400^{0}C	Wire mesh netting shall be 10 to 13mm aperture at least 0.56 mm diameter wire

5.0 Application of Insulation

5.1 General

a) All surfaces to be insulated shall be cleaned of all foreign materials such as dirt, grease, rust etc. and shall be dry before the application of insulation.

b) Before applying the insulation the Bidder shall check that all instrument tapping, clamps, lugs and other connections on the surface to be insulated have been properly installed as per the relevant erection drawing.

c) All flanged joints shall be insulated only after the final tightening and testing.

d) The insulation shall be applied to all surfaces when they are at ambient temp. Ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied so as to avoid breaking/telescoping due to alternate periods of expansion and contraction.

e) All cracks voids and depressions shall be filled with finishing cement, suitable for the equipment operating temperature so as to form a smooth base for the application of cladding.

5.1.1 All the refractory and insulation materials required for complete field application of insulation, cladding etc. covered under these documents and specifications shall be furnished with the equipment. They shall conform to the requirements of the various relevant ISI standards or other approved equivalents. All items such as insulating cement, sealing material, insulation material, screws, washers, etc., needed to complete the work in the course of the application of insulation and refractory shall be furnished. All insulating materials shall be chemically inert in both the dry and wet state and shall withstand the full working temperature conditions to which they are exposed without any deterioration. The gas ducts shall be insulated with mineral wool block or mineral wool blanket and all other equipment operating at elevated

temperature not enclosed in the boiler casing shall be insulated with calcium silicate blocks, mineral wool blocks or mineral wool blanket insulation.

5.2 Application on Piping

a) All vertical pipes shall be provided with the suitable insulation supports to prevent collapsing/crushing of insulation due to its self-weight. Support rings shall be provided on all vertical piping with a difference in elevation of 4 meter or above, and there shall not be more than 3 m straight length between support rings.

b) Longitudinal joints of insulation mattress sections of horizontal piping shall be on the bottom or at the sides of the pipe.

c) When more than one layer of insulation mattress/section is required on piping the circumferential joints on adjacent layers shall be staggered by at least 150 mm and longitudinal joints shall be staggered by at least 50 mm.

d) The mattress type insulation shall be formed to fit the pipe and applied with the mattress edges drawn together at the longitudinal joints and secured by lacing wire. Pipe section insulation shall be fitted on pipe using binding wires.

e) Where insulation is applied in two or more layers each layer of mattress shall be backed with hexagonal wire mesh. For the first layer of insulation and in case of single layer insulation, hexagonal wire mesh shall be provided on both the surface of the mattress. For pipe sections, the sections shall be held in place by binding wires without any wire mesh.

f) The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of the insulation. Any gap in the insulation shall be filled with loose mineral wool or finishing cement.

g) Insulation mattress/section ends shall be terminated at a sufficient distance from the flanges to facilitate removal of bolts.

h) The insulation shall be held in place by fastening over with binding wire for insulation surface with diameter upto and including 550 mm and with metal bends for insulation surfaces with diameter over 550 mm. The fastening shall be done at intervals of 250 mm except where specified otherwise. The ends of the binding wires shall be hooked and embedded in the insulation. The straps shall be mechanically stretched and fastened with metallic clamping seals of the same materials as the strap.

i) Insulation for application on bends and elbows shall be cut into mitred segments, sufficiently short to form a reasonably smooth internal surface. After the application of insulation material place, insulating cement shall be applied as required to obtain a smooth surface.

j) Weather hoods shall be provided for insulated piping passing through floors/walls.

k) All pipe attachments coming on horizontal pipes, inclined pipes and bends shall be insulated along with pipe such that there will be no insulation applied to hanger rod and the component connecting hanger rod to pipe attachment.

All pipe attachments exposed to weather shall be provided with weather proof covering.

l) Upstream of all drain lines and the lines connected to steam traps, shall be insulated upto and including first isolating valve for heat conservation. Rest of such lines such as downstream of the drain valves, traps etc. and other lines such as safety valve discharges, vents, etc. shall be insulated for personnel protection.

5.3 Application on Valves and Fittings

a) All valves fittings and specialties shall be insulated with the same type and thickness of insulation as specified for the connected piping with the special provisions and or exceptions as given below.

b) All valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminium sheets of thickness same as the connected pipe cladding. Adjoining pipe insulation shall be bevelled back to permit removal bolts and nuts or bands. The portion of the valve which cannot be covered by box type insulation shall be filled by loose insulating material of packing density at least equal to that of the insulating material of adjoining pipe. The insulation for valves/flanges shall be applied after the finishing has been applied over the connected piping. The cladding shall be applied in such a manner that the bonnet flange can be exposed easily without disturbing the complete insulation and cladding.

Flanges on lines having temperature upto and including 150 deg.C shall not be insulated.

c) Union shall not be insulated.

d) Expansion joints, metallic or rubber, shall not be insulated unless otherwise specifically indicated.

e) Safety valves shall be insulated.

5.3.1 While applying mineral wool blanket insulation:

a) Provide expended metal or hexagonal wire mesh on both sides for single layer mattress and on first layer in case of multilayer insulation. Subsequent layers of multilayer insulation to have only one side wire netting.

b) The edges of adjacent blankets to be leased together, by appropriate lacing wire as specified in the tender specification.

c) Any gap between joints between insulation layers shall be filled by loose mineral wool confirming to IS:3677.

d) All insulation to be secured by 1.63 mm diameter wire netting over blankets with ends of wire tightly twisted, and pressed in to insulation surface.

e) Impelling pins shall be placed on centers not exceeding 300 mm.

5.3.2 Flue Gas ducts with external stiffeners shall have first layer of insulation between the stiffeners and a second layer of insulation over stiffeners so that stiffeners are also insulated and a level surface is achieved.

6.0 Application of Metal Cladding

All insulated surfaces of the FGD shall be provided with metal cladding in accordance with the following requirements.

a) All insulation procedure of metal cladding shall have prior approval of the Owner.

b) All insulated surfaces of FGD shall be covered with aluminium cladding.

c) Cladding for FGD components are to be finished with plain aluminium sheeting of thickness not less than the values specified. Wherever an inner casing plate is necessary to effect a gas tight enclosure, the plate shall be of mild steel of required thickness, but not less than four (4) mm suitably stiffened and supported.

d) Cladding on straight surfaces shall be finished with aluminium sheeting of at least 20 SWG thicknesses suitably pressed along diagonals to form diamond shape or otherwise formed.

e) Cladding for insulated circular surfaces will be constructed from aluminium sheets of thickness not less than 20 SWG.

f) Weather proof flashings shall be installed where the panels intersect with columns and at other similar joints.

7.0 Application

All metal cladding shall be fabricated and installed to ensure a neat appearance and no open ended sections of cladding shall be left uncovered. The following provisions shall also be complied with:

a) All closures, flashings and seals required shall be provided and installed.

b) An asphalt and craft paper moisture barrier shall be provided to the aluminium cladding for all out door applications. Such moisture barriers shall be fixed to the inner surface of the cladding or shall be cemented to the outside surface of the insulation before application of cladding.

c) All the used in the outdoor cladding shall be provided with Neoprene washers.

d) All openings and joints in outdoor cladding for piping connections, supports or access shall be suitably flashed and weather-proofed. Where such flashings or weather-proofing cannot effectively control the entry of moisture, then such openings and joints shall be weather-proofed by application of aluminium pigmented sealer.

e) Cladding on the top surfaces of the FGD, duct work and equipment shall be suitably reinforced to prevent damage by personnel walking thereon.

8.0 Protection of Equipment during insulation application

All equipment and structure shall be suitably protected from damage while applying insulation. After completion all equipment and structures shall be thoroughly cleaned of insulating materials which might have fallen on them.

CHAPTER – 31

WEIGH BRIDGE

CONTENTS

31.0 WEIGH BRIDGE

31.1 One (1) Electronic Weigh Bridge of 100 Tonnes capacity suitable for weighing loaded road trucks/trailers/Bulkers shall be provided in the Fly ash silo area. The system shall have an accuracy of ±0.25% of actual weight. The scope shall include supply of 2 PCs, printer, UPS with 2 hour backup, software capable of providing details like net weight, tare weight, total weight etc. Stamping by relevant authorities shall also be included in the scope.

31.2 One (1) Electronic Weigh Bridge of 100 Tonnes capacity suitable for weighing loaded road trucks/trailers/Bulkers shall be provided for handling Limestone and gypsum trucks/trailers/bulkers and Stores. The system shall have an accuracy of ±0.25% of actual weight. The scope shall include supply of 2 PCs, printer, UPS with 2 hour backup, software capable of providing details like net weight, tare weight, total weight etc. Stamping by relevant authorities shall also be included in the scope.

DATA SHEET

S. No.	Item	Units	Description
1.0	**DESIGN DATA**		
a	Type		Pit less
b	Capacity		Min 5T & Max 100T
c	Size of Platform		To accomodate standard trucks and bulkers
d	Minimum Gradutaion		5
e	Accuracy		0.025% of maximum capacity
f	Method of Weighing		Electronic
g	Load Cell Capacity		Minimum capacity of each load cell shall be (2 x capacity of weigh scale) / number of load cells
2.0	**MATERIAL OF CONSTRUCTION**		
a	Platform supporting structure		CI IS 210 Gr FG 150 A/ CA IS 2062 Gr A
b	Platform		CI IS 210 Gr FG 150 A/ CA IS 2062 Gr A
c	Knife Edge		Steel with 66 RC hardness
d	Levers		CI IS 210 Gr FG 150
e	Load Cell		Alloy Steel
3.0	**DISPLAY UNIT**		
a	Mechnical		Dial/ Steel Yard
b	Electronic		

S. No.	Item	Units	Description
	Digital Indicator		Yes
	Digital Indicator+ Recorder+Printer + Keyboard		Yes
	PC with Keyboard		Yes
c	Provision for RS 232 C/ 485 for MMI		Yes
d	Display Unit/ Local/ Remote		M Away
e	Weighing software shall have the facility to print the following details on continuous basis		
			Date & Time
			Party Name
			Material to be weighed
			Truck/ Vehicle Number
			Batch Number & S No
			Gross weight, date & time
			Tare Weight, date & time
			Net weight
f	PC Configuration	2 (1 for weighing & 1 for invoicing)	Each shall be provided with the following:
			22" TFT Monitor
			8 GB Ram
			Intel Core I 7 Processor
			1 TB HDD
			DVD R/W Combo
			4 USB Ports
			2 Serial & 1 Parellel Port
			Windows 11 OS
			Standard Weighing Software
			MS Office
g	Printer		Laser Printer – A3 and A4
4.0	**CALIBRATION & STAMPING**		
a	Test Weight for Calibration		By Bidder

S. No.	Item	Units	Description
b	Stamping at site as per weights & measures act		By Bidder
5.0	**ACCESSORIES**		
a	Auto Zero Tracking		Yes
b	Provision of Tare Facility		Yes
c	Arrestors		Weigh Bridge shall be supplied with arrangement to avoid vibration & distortion and arrestors to restrict the platform motion in longitudinal & lateral motions.
d	Furniture in control room		Yes to be supplied by the bidder
e	UPS		Yes
6.0	**TESTS & INSPECTION**		
a	Overload test with 150% of specified load		Yes
b	Performance test at site		Yes

CHAPTER – 32

MISCELLANEOUS PUMPSETS

CONTENTS

32.0 MISCELLANEOUS PUMPSETS

32.1 GENERAL INFORMATION

32.1.1 Sump pumps specified hereinafter shall be used to dewater various sump pits in various plant areas like BTG area, Plant Water System, Ash Handling plant etc. where gravity draining is not be envisaged and to ensure general housekeeping

32.1.2 Pumps under this specification have been divided into following three (3) groups according to different duty envisaged and location of sumps/pits.

32.1.2.1 Group - A

The Group - A pumps shall be electric motor driven permanently installed vertical wet pit bottom suction volute type and shall handle drainage water, containing solid particles with sludges, polluted liquid, oils etc. from the area where they are installed. These pumps shall run intermittently by the use of high and low level switches in the sump. Particle size in the water shall not normally exceed 20 mm.

Group-A pumps shall also be provided to all indoor sumps of the plant and outdoor sumps of capacity 5 M^3 and above and underground cable vaults (if any) under the scope of this specification.

32.1.2.2 Group - B

These pumps shall be horizontal centrifugal electric motor/diesel engine driven portable type. Each pump set along with control panel etc. shall be mounted on a trolley for ease of transportation. These pumps shall be suitable for dewatering of pipelines of large diameter, if required and alike jobs and handling of liquids containing hard solid particles, sludge, polluted liquid, significant amount of fuel oil/LDO etc., and particle size shall not normally exceed 20 mm. These types of pumps shall be used in different plant areas.

32.1.2.3 Group - C

The Group - C pumps shall be vertical submersible portable type pump motor sets with suitable arrangement for carrying to any place and for lowering to and raising from various water reservoirs and pits. The pump motor set shall be suitable for handling water containing mud/sludge, solid particles, cotton waste, silica, ash particles, coal particles, polluted liquid etc. The particle size in water shall not exceed 20 mm. These pumps shall be utilised to dewater various deep sumps/pits (e.g. C.W pump house) in case of any eventuality.

32.2 CODES AND STANDARDS

32.2.1 The design, manufacture and performance of the sump pumps and drives specified, hereinafter, shall comply with the requirements of all applicable codes, the latest applicable Indian/British/American/DIN Standards, in particular the following:

32.2.2 IS-1710 : Vertical Turbine Pumps for clear cold and fresh water.

32.2.3 IS-5120 : Technical Requirements – Roto-dynamic special purpose pumps.

32.2.4 IS-5600 : Sewage and drainage pumps.

32.2.5 Hydraulic Institute Standards of USA.

32.2.6 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

32.3 GENERAL PERFORMANCE REQUIREMENT

32.3.1 The pumps shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated by the manufacturer.

32.3.2 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum head being at shut off.

32.3.3 Permanently installed vertical pumps shall be suitable for parallel operation. The head vs capacity, the bhp. vs capacity characteristics etc. shall match to ensure equal load sharing and trouble free operation throughout the range. Drive Motor shall not be overloaded when pump discharge is more than rated condition.

32.3.5 The static head requirement of portable submersible type sump pump may have a considerably wide range of variation depending upon the depth of pit being dewatered. While the pump shall have adequate capacity at the maximum head, the motor shall be sufficiently rated to cater for any overloading during the pump operation at its minimum possible head, i.e., maximum discharge.

32.3.6 Pump motor set shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards (latest edition).

32.4 SCOPE OF WORK

32.4.1 Pumps under groups A, B and C as listed in the Annexure- I along with drive units, couplings and other accessories mentioned below, as also those needed to make the pump-motor sets complete in all respect, for proper operation and maintenance. All motors in outdoor duty shall be provided with IP-55 enclosure and canopy. In addition to the accessories listed in Annexure-I, each pump set shall also include the following:

32.4.2 For the vertical Group - A sump pump motor sets

Three (3) capacitance level switches per sump; one for low level, the second for high level and the third for very high level, along with necessary junction box, local control panel, control cables etc. to achieve automatic starting/stopping of the sump pumps, and also ON/OFF indication for sump pump shall be monitored at DDC system. The entire assembly being mounted on the same base frame as mentioned above (item "b"). The control panel shall also be equipped with start/stop push button for starting/

stopping individual sump pumps manually. Local control panel and cable shall be as per requirements described else where in the specification.

32.4.3 For each of the trolley mounted horizontal Group-B sump pump motor sets/pump-Diesel Engine sets

a) One (1) no. 7.5 M long hose for the pump suction and one (1) 30M long hose for the pump discharge, either ends of each hose being provided with female hose coupling.

b) One (1) 500 mm long straight pipe piece, with both ends flanged, one end matching with the pump suction nozzle.

c) Two (2) male type hose couplings, one of which is suitable for coupling with the above mentioned 500 mm pipe piece on one side and the 7.5 M long suction hose on the other side, whereas the other is suitable for coupling with the pump discharge nozzle on one side and the 30 M long hose on the other side. The pump suctions pipe-piece and discharge nozzle shall be of flanged type. As such each coupling end that is to match with the pipe/pump nozzle shall also be flanged and shall be equipped with necessary bolts, nuts & gaskets.

d) A foot valve (of Bidder's recommended size) with suction strainer, necessary coupling and matching piece/reducer (if necessary) to couple with the 7.5 meter long suction hose end.

e) A starter panel complete with incoming switch/contactor, fuse, overload relays, start-stop push button, O/L reset push button, cable gland, wiring terminals, red and green indication lamps (LED type), necessary control cables etc., and also 50 metres length of flexible power cable with power plug at one end and arrangement to connect the other end with the starter panel.

f) The pump motor set with a baseframe along with the starter panel, power cable, suction & discharge hoses etc., as mentioned above, shall be mounted on a suitable trolley with swivelling front wheel and having adequate fixing arrangement for all equipment, for operation without any undue vibration and with facility for being handled by a single operator.

32.4.5 For each of the portable submersible Group-C sump pump motor sets.

a) Two (2) nos. 30 M long discharge hose, having female hose coupling at both ends.

b) One (1) no. 500 mm long pipe piece with both ends flanged, one end connected by necessary bolts, nuts & gaskets with the flanged discharge nozzle of the sump pump.

c) One (1) male type hose coupling, one end of which is suitable to couple with the discharge hose and the other end is flanged, matching with the above mentioned 500 mm long pipe end and connected therewith by necessary bolts, nuts & gaskets.

d) Suitable attachment for temporary seat of the pump motor set on the

floor at sump bottom.

e) One (1) no. 25 M long submersible type power cable having a power plug at one end and a hermetically sealed (waterproof) cable gland for connection with the pump drive- motor at the other end.

f) Suitable lugs and other attachments on the pump motor assembly frame, for hoisting and lowering of the pump motor set from and to the sump.

g) One starter panel, having a plug socket as receptacle of the above mentioned power plug (item "e"), a 25 metre long incoming power cable with switch/contactor and fuse, start- stop push buttons, red and green LED type indication lamps, over load relays, O/L reset push button, cable gland etc., and also a suitable arrangement for temporarily mounting the starter panel, near the sump, where the portable sump pump-motor set is to work. The incoming 25 M long power cable shall also be provided with a suitable power plug at one end.

32.4.6 Lubrication of one (1) initial fill and one additional fill after commissioning.

32.4.7 Rust inhibiter paint at Manufacturer's works.

32.5 DESIGN AND CONSTRUCTION

32.5.1 The design, construction testing and other details of the sump pumps and related accessories shall be in line with the stipulations and data in this chapter.

32.5.2 Each sump pump shall be equipped and coupled with a drive motor, with rating so selected as to have at least 15% margin over the maximum power required by the pump, throughout its range of operation. All other requirements of the drive motors shall be as stipulated in the Electrical Specification Vol III, Part B.

The discharge rate of sump pump is uncontrolled. As such pump should be capable to operate even under a condition of as low as 25% of specified total head. Motors of group-B pumps should be designed to cater such eventuality.

32.5.3 All electrical items shall conform to the stipulations of Electrical Specification Vol IV as applicable.

32.5.4 All piping shall be as per IS-1239 of medium or heavy grade (as suited for the maximum operating pressure) and shall be either galvanised or painted with approved rust inhibiting paint. Pipe size shall be as per Appendix-II. Any matching piece/reducer required to match the pipe with pump nozzle, hose, etc. shall be provided.

32.5.5 All valves shall be steel body type as per applicable IS/BS/ANSI standard,with pressure class compatible with the maximum working pressure.

32.5.6 All hoses shall be of steel wire reinforced type. Pump suction hose shall be suitable for working under vacuum. Pump discharge hose shall be suitable to withstand the maximum pressure that it may be subjected to in all

working conditions, including hydrostatic testing of the sump pump discharge line.

32.5.7 Pump suctions strainer shall have openings large enough just to permit the entry of solids having maximum size as stipulated under clause no. 1.02.00.

32.6 Pumps

32.6.1 Pumps under Group-A shall be wet pit type, vertical shaft, centrifugal, vertical submerged suction, non-clog volute type complete with enclosed shaft, discharge pipe, head assembly thrust bearing and drive assembly, cover plates etc.

32.6.2 Pumps under Group-B shall be of horizontal shaft, single stage, end suction, radially split casing, centrifugal, non-clog design complete with common base plate, drive assembly etc. These pumps shall be trolley mounted portable type.

32.6.3 Pumps under Group-C shall be submersible pump-motor type, single stage and non-clog design and shall be portable type.

32.7 Casing

a) Casing shall be so designed to allow free passage of specified maximum size of solid.

b) Casing shall be designed to withstand the maximum shut-off pressure developed by the pump.

c) The casings shall be cast, free from blowholes, sand holes, other detrimental defects. The casing shall be complete with suction and discharge connections.

d) For pumps under Group-A adequate seal arrangement shall be made to keep leakage of liquid from casing to column assembly to minimum and adequate drain shall be provided in column assembly to permit escape of the leakage flow. The casing shall also include the bearing housing of the bottom pump shaft bearing.

e) Casing of pumps under Group-B shall be provided with vent connections and drain connections with valves. These pumps shall be manually primed.

32.8 Impeller

a) The impeller shall be open/semi-open non clog type, cast in one piece and specially designed to pass large solids or unscreened liquids. The clearance between stationary and moving parts should be such as to allow sustained performance without exclusive maintenance.

b) Impellers of pumps under Group-A shall have provision for adjustment from an accessible location and for pumps under Group-C shall be capable of passing fibrous material like cotton waste, jutes, etc.

32.9 Pump Shaft

a) Shaft size selected shall be such that critical speed is at least 20% away from the operating speed and the runway speed.

b) The shaft shall be ground and polished to final dimension and of ample size to withstand all stresses resulting from rotor weight, hydraulic loads and across the line starting. Shaft shall be provided with renewable sleeves particularly under stuffing boxes and other locations as recommended by pump manufacturers.

c) The coupling between shafts shall be so designed that they become tight during pump operation.

32.10 Column Pipe (for pumps under Group-A)

The discharge pipe shaft assembly shall be flanged or screwed as per manufacturer's standard and standard length of each piece of column pipe shall be in conformity to the shaft piece lengths from consideration of easy handling.

32.11 Bearings

a) Adequate nos. of properly designed bearings shall be furnished. Bearings for pumps shall be antifriction type and lubricated by grease. Line shaft bearings of vertical pumps shall also be grease lubricated. All necessary grease gun, grease cup and tubing shall be included.

b) Thurst bearing of adequate design shall be furnished for taking the entire pump thurst arising from all probable conditions of continuous operation through out its "range of operation" and also the shut-off condition. The life of thurst bearing shall be 20,000 working hour minimum for the load corresponding to the duty point. The bearings shall be lubricated by grease from a location conveniently accessible. Design shall be such that the lubricant cannot contaminate the handling liquid.

32.12 Wearing Ring/Liner Plate

Renewable wearing rings/liner plates shall be provided either on impeller or on the casing or on both impeller and casing.

32.13 Stuffing Box

Stuffing Box of pumps under Group-A shall be of mechanical packing type. For pumps under Group-B and Group-C mechanical seal of reliable design shall be provided.

32.14 Coupling

Pump and motor shall be connected with a suitable flexible coupling. Coupling shall be provided with coupling guard.

32.15 Mounting Plate for Group-A Pumps and Base Plate for pumps under Group-B.

Each pump under Group-A shall be provided with a suitable mounting plate. The mounting plate shall be adequately sized to accommodate the level switches, discharge pipe, grease cups etc. if any. Pumps and motor under Group-B shall be mounted in one base plate. Base plate shall be of rigid construction properly ribbed as needed. Suitable drain with valve and drain funnel shall be furnished by the Bidder.

The necessary supporting plate, mounting frame, base plate etc. as required shall be supplied under this specification, along with anchor bolts, foundation bolts, pipe, sleeves etc. Lifting lug, eyebolts, etc. as required for the proper handling of each pump set shall be furnished.

32.16 Suction Bell

The pumps under Group-A, C shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

32.17 Material of Construction

For material of construction of various parts of data specification sheet shall be referred to.

32.18 INSPECTION AND TESTING

32.18.1 All pumps shall be tested at the shop for capacity, head, efficiency and brake horse power. These tests are to be done according to the requirements of "Hydraulic Institute Standard".

32.18.2 The pump integral accessories like thrust bearing, pump motor coupling etc. shall be subject to tests as per manufacturer's standard.

32.18.3 Test on motors, control panels, starter panels, cables shall be conducted as per the requirement of Vol.II-F of this specification and as per Quality Assurance Plan to be approved by Owner during detail engineering.

32.18.4 After delivery/erection at site, pumps shall be operated to prove satisfactory and trouble free performance.

DATA SHEET – MISCELLANEOUS PUMPSETS

S. No.	Description	Group A	Group B	Group C
1	Pumps			
1.1	Rated Capacity	Capacity of each pump should be so selected to empty sump pit in 10 to 15 minutes	Twenty (20)	Fifty (50)
1.2	Total Dynamic Head at rated Capacity (MLC)	To be calculated with 10% margin on frictional drop	15	20
1.3	Minimum suction lift	-	6	-
1.4	Nos. required	These pumps shall be provided in all indoor sumps and outdoor sumps of 5 cum & above and underground cable vaults and CW pumphouse. Pumps shall be of 2 x 100% capacity for each sump.	Four (4) (2 electric motor driven and 2 diesel engine)	Four (4)
1.5	Duty	Intermittent		
1.6	Pump design standard	IS 5120/ IS 1710/ HIS		
1.7	Parallel operation	Yes	No	No
1.8	Material of Construction			
a)	Base Plate/ Cover Plate	MS – IS 2062	MS – IS 2062	MS – IS 2062
b)	Column Pipe	MS – IS 2062	MS – IS 2062	MS – IS 2062
c)	Casing	2% NiCi	2% NiCi	2% NiCi
d)	Impeller	2% NiCi	2% NiCi	2% NiCi
e)	Pump/ Impeller Shaft	SS 410	SS 410	SS 410
f)	Shaft Sleeve	SS 316	SS 316	SS 316
g)	Shaft Coupling	SS 410	SS 410	SS 410
h)	Shaft Bearing	BUSH GM as per IS 306	BUSH GM as per IS 306	BUSH GM as per IS 306
i)	Gland	CI IS 210 FG 260	CI IS 210 FG 260	CI IS 210 FG 260
j	Fasteners	SS 304	SS 304	SS 304

CHAPTER – 33

LAYOUT REQUIREMENTS

CONTENTS

33.0 LAYOUT REQUIREMENTS

33.1 Broad Guidelines for Layout Plan

33.1.1 General layout plan indicating the available spaces for proposed project is as shown in the tender drawing. It shall form the basis for further elaboration by the bidder for the plant facilities.

33.1.2 While preparing the detailed layout, planning the facilities in the Bidder's scope and deciding upon the transportation and construction/ erection strategy and functional requirements, the Bidder shall ensure the following aspects:

a) Face of the buildings and facilities shall be located in such a way so as to have an offset of minimum 20 m with respect to centre line of double lane road and 15 meter with respect to centre line of single lane road. The spacing between various buildings and facilities shall be suitably decided so as to avoid interference with the foundations.

b) The entire construction activity shall take into account the commissioning of the unit.

c) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores is to be managed by the bidder within the areas available in General Layout Plan.

d) The finished floor level at ground level of the TG building shall be designated at EL. 0.0M and shall be 500mm above the finished ground level (FGL) of that area.

The finished floor level for various areas/facilities shall be as follows:-

i)	FFL of Main Plant Building	: EL. 0.0 M
ii)	Top of paving for boiler/ESP & Chimney area	: EL. 0.0 M
iii)	Top of paving for Transformer Yard	: (-) 0.1 M
iv)	FFL of offsite buildings	: 500 mm above FGL or respective area.
iv)	Top of roads	: (-) 0.2 M

e) Fuel storage tanks, hydrogen storage complex, etc., shall be designed in accordance with statutory agency guidelines.

g) All the buildings and facilities shall be approachable by the fire tenders.

h) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

33.2 Control Room for Offsite facilities

Independent Control room for each of the following off-site facilities shall be provided:

- Water system
- Makeup water system
- Coal handling system
- Ash handling system
- FGD System
- Other systes as required

However panels for above offsite facilities to be placed in respective off-site control rooms. Further Remote I/O (RIO) rooms shall be provided as required basis for offsite areas. The exact RIO locations shall be finalised during detailed engineering stage.

Control Rooms/Control Equipment Rooms/RIO rooms shall be air-conditioned. Batteries for power supply systems as required for RIO rooms shall be placed in a separate ventilated area within RIO rooms.

33.3 Main Plant Layout

Introduction

The proposed location of main plant block is indicated in the Plot Plan enclosed with the bid documents. However bidder has an option to develop his own layout keeping the location/orientation of the main power block, power evacuation corridor, make-up water corridor, Ash dyke same as indicated in bid document. Bidder shall develop his own layout for the equipment offered and the same to be clearly brought out in the bid. However, while developing the layout the bidder must give due considerations for the following requirements:

33.3.1 The unit control room shall be located in the centre of TG building towards boiler side at operating floor level.

33.3.2 The unit control room shall be multi-level and shall essentially house but not be limited to the followings:

i) Unit control panels in control equipment rooms, operator's consoles etc. for all modules. CCR shall not have any internal column inside the room. Large span roof beams for control room to be adopted and designed.

ii) Computer room with programmer station & associated consoles and PADO room etc.

iii) Electrical control panels, protection panels etc., shall be suitably located.

iv) Conference room and C&I engineer's room.

v) Shift supervisor room.

vi) 24V charger, UPS & batteries on unit basis in the control room below unit & common control room & control equipment room at mezzanine floor level.

vi) Cabling and all other facilities associated with the above system.

vii) SWAS room at 0.0M in TG building.

33.3.3 The unit control room, computer room with programmer station, PADO room, 24V charger & UPS room, SWAS room shall be located in Air conditioned areas. Washroom/Toilet facilities for ladies & gents separately shall be provided. Further, no vertical bracings, pipes, cable shafts etc. shall be routed through control room or control equipment room area.

33.3.4 The following clearances to be maintained for C&I DDCMIS cabinets:

i)	Inter panel spacing	-	1200mm
ii)	Clearance from back	-	1000mm
iii)	Clearance from front	-	1000mm
iv)	Clearance from side wall	-	1000mm

The above clearances are minimum requirement and may increase with increase in door swing of the cabinets.

33.3.5 The cable vault space below the HT / LT switchgear room and Control Room shall have 800 mm wide and 2.1 m high movement passage all around the cable trays in the cable vault/ cable spreader room for easy laying/maintenance of cables.

33.3.6 Operating floor inside the main plant building shall match with top level of TG deck.

33.3.7 Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to:

1) Unit and generator transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher.

Oil capacity of individual transformer (in Litres)	Clear separating distance (in M)
5,000 to 10,000	8.0
10,001 to 20,000	10.0
20,001 to 30,000	12.5
Over 30,001	15.0

2) In case of auxiliary transformers having an aggregate oil capacity in excess of 2300 litres but individual oil capacity of less than 5000 liters, the maximum separating distance between transformers and surrounding building shall be at least 6M unless they are separated by fire separating walls or are protected by high velocity spray system.

33.3.8 Layout requirements for Electrical MCC/switchgear rooms

1. The following clearances shall be maintained for HT Switchboard.

a.) Front Clearance

i) For one Row of Switchgear - 2.0 M (Min)

ii) For two Rows of Switchgear - 2.5 M (Min)

b.) Back Clearance - 1.5 M (Min.)

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800+width of panel.

2. The following clearances shall be maintained for LT Switchboard.

a. Front Clearance

i For one Row of Switchgear - 1.5 M (Min)
ii For two Rows of Switchgear - 1.5 M

b. Back Clearance

i. For single front - 1.0 M (Min)
ii. For double front - 1.5 M (Min)

c. Side Clearance

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800 mm + width of panel.

HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same MCC room.

3. Height of HT/LT Switchgear Room

i) With Bus Duct – 4.5 m (min)
ii) Without Bus Duct – 4.0 m (min)

33.4 Equipment layout

While developing the layout, the bidder shall ensure the following major layout requirements:

1.	Area of unloading bays	Minimum Tone (1) nos. (on either end) of maintenance bay for TG building
2.	Passage way between TG hall & first row of boiler column	12 M
3.	Arrangement of TG set	Longitudinal
4.	Basement, Pits & Trenches	Basement floors are not acceptable in Main plant Building/Mill Bunker building
5.	Clear walkways along A-row & B-row of Power House.	a) 1.5 M at all the levels of AB bay b) 3 M along B-row at

		operating floor level for interconnection with service building & in front of control room.
6.	Control Room	Unit control room shall be provided at operating at operating floor level in B-C bay
7.	Control Equipment Room	Location of Control equipment Room shall be in B-C bay at operating floor level & in at mezzanine floor level
8.	Minimum clear working space Around the equipment	1200 mm
9.	Minimum clear working space	1500 mm around the Coal mills
10.	Minimum width of all staircase	1200 mm
11.	Clear approach width between Boiler & ESP	12 M minimum (Height=8M)
12.	Clear approach width between ESP & ID fan	10M minimum (Height=8M)
13.	Clear Head room within Main Plant Building for pipes, ducts, structures & cable trays etc.	2.5 M (Minimum)
14.	Clear head room in passage bay between TG hall And first row of boiler column i.e. CD bay	8 M
15.	Shape of Coal Bunkers	Circular
16.	No. of Fire Escape staircases in the main plant with fire doors at each landing.	Min-4 Nos. However the number shall meet the requirement of insurance companies.
17.	Minimum straight length in flue Gas duct at ESP outlet for Opacity meters	As required for accurate dust measurement within the battery limits.

18. Coal Mills shall be located on the side of the boiler.

19. Adequate space and provision for handling/removal of pumps, motors, heaters, heat- exchanger, fans, Mills, Switchgear Panels, and Transformers during maintenance shall be provided.

20 Independent floor drains with separate down comers shall be provided where fire protection system are provided.

21 In TG bay at crane rail level, chequered plate walkway of minimum 600 mm clear width from face of the column to the hand rail on crane side to be provided for entire A-row & B-row column sectional depth for full length of the building. Necessary staircase shall be provided for the access to this walkway from operating floor.

22. Interconnecting walkways (minimum 2.0 M clear width) between main plant building and boiler (on either side of boiler) at mezzanine, Operating, PRDS and Deaerator floor level shall be provided. Also interconnecting platform (min. 1.5 M clear width) between Boiler and Coal Bunker Building at mill maintenance floor level, Feeder floor level and Tripper floor levels shall be provided by the bidder. Number of interconnecting platforms between boiler and coal bunker building for each level/floor specified above shall be two numbers on each side of boiler, i.e. four numbers per floor if the mills are located on the side of the boiler and two numbers per floor if the mills are located on rear side of the boiler.

23. Layout of facilities and equipment shall allow removal of Generator Stator, Generator transformers, Station & Unit transformers without disturbing equipment, piping, cabling, ducts routed in the area.

24. Valves including actuators and instrument tapings shall be located in accessible positions and operating/maintenance platform for the same shall be provided. All piping shall be routed at a clear height of 2500 mm (min.) from the nearest access level to clear man movement.

25. Steam turbine and Generator and other equipment located in the turbine hall shall be accessible by the EOT crane for handling during erection and maintenance. Wherever special handling procedures are to be followed such as for the generator stator, rotor withdrawal of Generator etc, the same shall be described in written out document and attached with the bid. The offered layout of TG Hall shall be such that it shall be feasible to remove the Generator Stator and send it for repair without removal of any equipment located in TG Hall. Further the complete set up including all tools required for removal, assembly & handling of Generator stator shall be provided by the bidder. A separate EOT crane with proper maintenance area shall be provided along with all tools required for removal, assembly & handling of Boiler Feed Pumps.

26. FD, ID and PA fans handling arrangement complete with crane and handling facilities along with removal space shall be provided. A continuous platform shall be provided between fan and motor end for ID/PA/FD fans in order to facilitate movement of personnel.

27. Mill handling arrangement complete with crane and handling facilities along with removal space shall be provided. For each mill bay, bidder shall provide adequate maintenance area for safely handling the mill equipment/parts.

28. Fuel oil (F.O) piping shall be routed over trestles. The headroom for F.O. Trestle in Boiler/ESP area shall be 8 M till the road behind chimney as per the layout requirement. The headroom for all pipe/cable racks

in outlying areas shall be 5 M except at rail/road crossing where the headroom shall be 8 M.

29. Routing of cable trays & piping including F.O piping & ducting-

i. Trestle height in outlying area shall be 5 M (BOS)

ii. Trestle height from TG hall to road behind chimney/in front of TFMR yard/ Boiler/ESP area shall be 8 M (BOS).

iii. Cable/Pipe trestles height at rail/road crossings shall be 8M (BOS)

iv. The pipes including fire water pipes shall be routed over ground either on pedestals or on trestle in plant area. No trenches for pipes shall be envisaged as far as possible. Wherever fuel oil pipes and steam pipes are running over the trestle, fire water pipes shall not be routed on the same trestle.

v. Head room below cable/ pipe rack in transformer yard area for movement of spare GT shall be such that the same can be moved with bushing installed. A clear gap of 500mm between top of bushing and BOS of the trestle shall be ensured.

vi. A walkway of 600mm (minimum width) with pipe hand rails & toe guards shall be provided all along length of the trestle for maintenance of cables & pipes. Ladders for approach to these platforms shall be provided near roads, passage ways and turning points. Wherever ash handling pipes are routed on the trestle, grating platform all along the length and width of the trestle shall be provided. Further, one walkway of 600mm width shall be ensured on the tier meant for routing the ash handling pipes.

vii. Wherever, dry ash pipes are routed on the top most portion of the pipe/cable trestles, a clear head room of 2.1 M over the walkways of dry ash pipe rack shall be ensured.

viii. Head room for man movement shall be minimum 2.5 M at ground floor in TG and boiler area and 2.1 M over all platforms.

ix. Height of trestles at approach roads to various buildings/ facilities shall be 8 M. In case building are located in off site area and are adjacent to each other, then as a good engineering practice, the height of trestle shall be maintained all over as 8 M.

x. Separate cable tray for optical fiber cable/UTP cable shall be provided.

xi. The layout shall be developed so as to meet the requirements of the Cabling philosophy indicated separately (Cabling, Earthing & Lightning Protection).

30. Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC.

31. All cranes shall be provided with approach rung ladders at least at two places. Where ever cranes can't be maintained in situ on the carriage, facility to draw them to maintenance platforms as well as provision of suitable platforms shall be considered by the bidder.

32. For Ventilation requirement from A-row side of TG building, space for installation of Air washer units along with pumps shall be considered in AB bay at suitable elevation. No separate room outside A-row for locating Air Washer equipment and no trestle outside A-row for routing Ventilation duct shall be considered. Further, for Ventilation requirement in BC bay, adequate space for installation of Air washer units along with pumps in BC bay for each unit shall be considered. All fresh air ventilation louvers shall be 1000 mm from floor level and directed downward at an angle.

33. Separate A/C systems shall be provided for Main plant, ESP Control Room, Service building, CHP control room, (including buildings housing weigh bridge, PLC Control Panels at remote site, stacker Reclaimer PLC panels etc) & mill rejects control etc. For further details, Chapter 25.0 Voulme – III shall be referred.

34. Minimum one (1) staircase shall be provided between two adjacent passes of ESP. These staircases shall be equally distributed on the inlet and outlet side of ESP.

35. All equipment operating/maintenance platforms at Mill Hoist Level, Mill Discharge Valve level, Bunker/Feeder Outlet Level, Cold and Hot air damper level, scanner approach level, oil gun approach level, approach to bottom of hopper for ash handling and for other equipment shall be provided.

36. All equipment operating maintenance platforms including supporting structures such as grating platforms in the oil equipment room, control fluid equipment room, valve room, Deaerator, Gland Steam Condenser, Flash tank and for other equipment shall be supplied and erected by the Bidder.

37. Suitable rolling shutters shall be considered in the equipment layout to be developed by the bidder on `A'-row to facilitate the movement of Generator Transformers, Station & Unit transformers to the maintenance bay. Rolling shutter shall be provided for removal of Condenser tubes. Further rolling shutters at different location shall be provided in TG hall for the movement of material.

38. Ash slurry pipe lines shall be routed on pedestals except at road/rail crossings where pipe culverts shall be provided. Drainage pits shall be provided at an interval of 750M for ash slurry pipes maintenance.

39. A suitable rail track and associated facilities like Jacking pads, mooring posts etc., shall be provided to facilitate the movement of Generator transformers. Station and Unit transformers to the maintenance bay. These rail tracks shall be accessible from the equipment unloading area of TG bay by a rail track.

40. Approach platform shall be provided from ESP outlet to ID fan suction gate.

41. Passenger cum good elevator shall be provided for approach for steam generator, TG building (BC Bay), service building, coal handling TPs in Boiler area, crusher house etc., chimney for Operation and maintenance.

33.5 Lay down area for maintenance and overhauling

1. The layout of the steam turbine shall permit sufficient lay down area for all the parts/components to enable carrying out maintenance and overhauling operations without any restrictions and without any hindrance to the operating personnel.

2. In case any special arrangement for rotor maintenance is required, the same should be provided.

3. All handling arrangement including any special arrangements like trolley, drive, pedestals etc. for carrying out maintenance and overhauling for steam turbine generator and its auxiliaries shall be provided by the bidder.

4. The bidder shall furnish general arrangement drawings indicating the equipment lay down area with details such as blocks indicating orientation of dismantled items, travel path etc.

5. The bidder shall also furnish general arrangement drawings indicating the lay down arrangement of major unit assemblies (provided as spares) in the TG hall with access from EOT crane. If the area provided inside TG building is not sufficient to accommodate these unit assemblies then a separate building shall be provided. The layout and arrangement shall be furnished along with the bids submitted by the bidders.

33.6 Local Pits/trenches in Main Plant building shall be avoided. However pits/sumps which are unavoidable such as CW (Circulating Water System) pits etc. shall be provided with required dewatering arrangements by means of drainage pumps and piping up to the nearest drainage network. Bidder shall provide required sump pumps/drainage pumps/submersible pumps & Piping etc.

Only vertical top mounted sump pumps (2x100%) shall be provided in condenser Pit/sump in TG Building so that the entire pit is evacuated within 15 minutes and the operation of the pumps shall be interlocked through level measurement devices to be installed in the pit/sump so that the pumps shall start automatically and empty the pit. Sump level shall be displayed in DCS system for monitoring and Sump pumps shall have also start/stop provision from control room.

Pumps shall be permanently fixed in the pits/sumps. If the pit depth is shallow, vertical top mounted sump pumps shall be provided and in deep pits, self priming drainage pumps (horizontal type) at floor level or alternatively submersible type pumps shall be provided.

Each pit/sump shall be provided with two numbers (2x100% Capacity) of respective type pumps so that the entire pit is evacuated within 15 minutes

and the operation of the pumps shall be interlocked through level measurement devices to be installed in the pit/sump so that the pumps shall start automatically and empty the pit.

The general design and construction features of Vertical sump pumps and Submersible pumps are furnished elsewhere.

33.7 Bidder shall furnish the detailed erection strategy along with the bid for major equipment located in TG hall, boiler area and ESP area.

33.8 Bidder's shall prepare the detailed layout of main power block area indicating the location of all major equipment. The layout shall be furnished along with the bids submitted by the bidder.

33.9 In addition to above, layout requirements regarding Coal Handling Plant, Ash Handling Plant and Fuel Oil Handling area buildings, specified elsewhere in the specification shall also be followed.

CHAPTER – 34

GENERAL REQUIREMENTS HORIZONTAL AND VERTICAL WATER SERVICE PUMPS

CONTENTS

34.0 GENERAL REQUIREMENTS HORIZONTAL AND VERTICAL WATER SERVICE PUMPS

34.1 SCOPE

General requirements in respect of design, material, constructional features, manufacture, inspection, testing the performance at the Vendor's/ Sub-Vendor's works and delivery to site erection, field testing and commissioning of Horizontal Centrifugal Pumps.

34.2 CODES AND STANDARDS

Design, material, construction manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment supplied shall comply with the latest applicable Indian standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

34.2.1 List of Applicable Standards

i) IS : 1520 - Horizontal Centrifugal Pumps for clear cold fresh water.

ii) IS : 5120 - Technical requirements of roto-dynamic special purpose pumps

iii) API - 610 - Centrifugal pumps for general refinery service.

iv) IS : 5639 - Pumps Handling Chemicals & corrosion liquids.

v) IS : 5659 - Pumps for process water

vi) HIS - Hydraulic Institute Standards; USA

vii) ASTM-I-165-65 -Standards Methods for Liquid Penetration Inspection.

ix) IS-1710/1989 -Vertical Turbine Pumps for Clear, Cold and Fresh Water.

In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

34.3 DESIGN REQUIREMENTS

The maximum efficiency of pumps shall be preferably within + 10% of the rated design flow indicated in data sheets.

Total head capacity curve shall be continuously rising from the operating point towards shut - off without any zone of instability and with a minimum shut off head of 15% more than design head.

Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation.

Speed	Antifriction bearing	Sleeve bearing
1500 rpm and below	75.0 micron	75.0 micron
3000 rpm	50.0 micron	65.0 micron

The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1M from the equipment surface.

The pumps shall be capable of starting with discharge valve fully open and close condition.

34.4 DESIGN CONSTRUCTION

34.4.1 Horizontal Pumps

Pump casing shall have radially/axially split type construction. The casing shall be designed to withstand the maximum shut - off pressure developed by the pump at the pumping temperature.

Pump casing shall be provided with a vent connection and piping with fittings & valves Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pr. Gauge as standard feature.

Impeller

Impeller shall be closed or semi-closed as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled. The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying pinning or lock rings.

Impeller/ Casing Wearing Rings

Replaceable type wearing rings shall be provided at suitable locations pumps. Suitable method of locking the wearing ring shall be used.

Shaft

The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

Shaft Sleeves

Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening shaft and shaft sleeve assembly should ensure concentric rotation.

Bearings

Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble - free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Anti-friction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hours of continuous operation at maximum axial and a radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided such that lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

Stuffing Boxes

Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standard. If external gland sealing is required, it shall be done from the pump connection.

Mechanical Seals:

Wherever specified in pump data sheet, mechanical seals shall be provided The sealing face should be highly lapped surfaces of material known for their low frictional co-efficient & resistance to corrosion against the liquid being pumped.

Pump Shaft Motor Shaft Coupling

The Pump and motor shaft shall be connected with a adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor.

Base Plate

A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, suitable ribbed and reinforced.

Assembly and Dismantling

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

34.4.2 For Vertical Pumps

Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories, as applicable. General design and constructional features of the pumps shall be as follows:

Bowl Assembly

This will be either a single or multi-stage centrifugal, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of the handling fluid.

Pump(s) shall have provision for adjustment of impellers in vertical direction from an accessible location, preferably at the housing (where separate thrust bearing for the pump is provided). The adjustment mechanism must take into consideration the extension of the line shaft due to hydraulic down thrust, weight of the shaft and impeller.

Discharge Head

Pump(s) shall be either above floor or below floor discharge type, as specified in the specification, attached to this section.

In case, expansion joint is to be used at the pump discharge, pump base plate shall either be adequately designed to take the unbalanced forces and moments from the use of such expansion joint or a separate thrust block at the pump discharge head shall be provided to transmit these forces to the external supporting structure. Calculation of thrust load shall be done considering the highest pressure seen by the pump and internal diameter of the arch of the expansion bellow.

Column pipe

Column pipe shall be flanged and of bolted connection. Column pipes shall be designed for full internal vacuum.

In case the specification asks for the pump with below floor discharge, and the water level is at or above the discharge valve level, the column pipe piece located at the intermediate floor level shall be provided with suitable floor sealing device.

In case of multi-piece column pipe and shaft assembly, the design shall permit raising/lowering of the pump assembly piece by piece without any difficulty. Any fixtures, clamps, etc. necessary for such purpose shall be supplied by the Contractor under this section. The Contractor shall also submit a write-up describing clearly the procedure of handling the pump.

Impeller shaft, line shaft and head shaft

Shaft size shall be selected on the basis of maximum torque to be applied on the pump shaft.

Critical speed of the shaft shall be sufficiently away from the pump operating speed and in no case shall lie between 90% and 110% of the rated speed.

Impeller shaft shall be guided by bearings provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall be chamfered at the edges.

Line shaft may be of single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the standard practice of the manufacturer.

For screwed coupling, screw directions shall permit tightening of the joint during pump operation.

Replaceable shaft sleeves shall be furnished at applicable locations, particularly under stuffing box and at other locations, as considered necessary.

Shaft enclosing tube

Shaft enclosing tube shall be required, unless self lubricated (and cooled) type of shaft bearings is asked for. Length of the shaft enclosing tube shall be in conformity with the shaft piece lengths.

Seal rings

Replaceable seal/wear rings both on impeller and on casing shall be provided in case it is asked for.

Shaft bearings

Adequate number of properly designed bearings shall be provided for smooth and trouble-free operation of the pump. Number of bearings shall consider the number of shaft pieces used and the critical speed of the shaft. Bearings shall be either lubricated by external clear water/oil/grease or self lubricated as specified in the Specification.

In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump. If the specification calls for prelubrication of the shaft bearings, prelubrication tank and other accessories shall be within the scope of supply of the Bidder/Contractor.

Thrust Bearings

Thrust bearing of adequate size and capacity shall be provided to take the vertical thrust of the impeller arising out of the pump operation and dead weight of the rotating components. Life of the thrust bearing shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load.

Thrust bearings shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the bearing, while the pump coast down to stop in case of power failure of the station. Pre-lubrication of the thrust bearing, if recommended by the pump manufacturer, shall be taken care of in designing the lubrication system.

Cooling of the thrust bearing, if necessary, shall be done by the handling fluid / external water, depending on the fluid handled.

Location of the thrust bearing may be at the pump body or at the driver, or at both depending on the requirement of specificationoras per the recommendation of the pump manufacturer (and approved by Purchaser).

Reverse Rotation

If the specification calls for, the pump impeller and other rotating components shall be designed for reverse rotation, when subject to reverse flow at rated pump discharge head.

34.5 Drive Motor (Prime Mover)

The KW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps is specified, the actual motor rating is to be selected considering overloading of the pump in the event of tripping of operating pumps. Continuous motor rating (at 50 deg. Cent, ambient) for pump shall be at least 10% above the maximum load demand of the driven equipment in the complete range.

Annexure - A

SUBMERSIBLE PUMPS

SCOPE

This specification covers general requirements in respect of design, material, manufacture, construction, testing & inspection at Vendor's / sub-vendor's delivery to side, of submersible pumps.

CODES AND STANDARD

The design manufacture and performance of submersible pumps shall be comply with all currently applicable statues, regulation, and safely codes in the locality where the Equipment will be installed. The Equipment shall also conform to the latest applicable Indian standards listed below/equivalent standards.

List of Applicable Indian Standards

IS: 8034 - Submersible pumps for clear cold fresh water
IS: 5120 - Technical requirement of Rotodynamic Special Purpose pumps.

In case of any contradiction with aforesaid standards and the technical specification requirements, the stipulation of the technical specification shall prevail.

DESIGN AND PERFORMANCE REQUIREMENTS

a) The pump shall be of single stage mono - block type with non-clog esign.
b) Components of Identical pumps shall be interchangeable.
c) Pumps shall have continuously rising head characteristics.

MOTOR RATING

Continuous motor rating (at 50 deg. C ambient) for pumps shall be at least ten percent (10%) above the maximum load demand of the driven equipment in the complete operating range to take care of the system frequency variations.

CONSTRUCTION FEATURES

a) Pumps shall be of Submersible, wet pit type.

b) Pumps shall be able to pass through solids upto 100 mm and capable of handling waste water which may contain, sludge, plastic solids etc.

c) Coupling device shall ensure leak proof joint between the pump and discharge elbow. This shall also enable pump to be removed from the sumps without the necessity of dismantling any nuts, bolts etc.

d) Pumps shall be portable type and capable of using in any sump as and when required. Pump shall be provided with required stool, flexible, hose chain connection etc. for easy installation, removal and maintenance. Adequate length of chain required for lowering the pump into the sump and flexible type discharge pipe shall be provided.

e) Impeller: The Impeller shall be as indicated in Data Sheets in this Sub-section. Enclosed impellers shall be equipped with seal rings on their hubs. In case of open impeller, the pump shall be design to take care of the additional thrust produced.

CHAPTER – 35

GENERAL REQUIREMENT FOR MISCELLANEOUS TANKS

CONTENTS

35.1 **General**

35.1.1 This section covers the design, supply of steel pipes and plates, structural steel and all accessories as required, paints and protective paintings as specified and as required, fabrication, erection, painting, testing of Fabricated & Miscellaneous Tanks with accessories as specified and associated civil works.

35.2 **Codes & Standards**

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

35.2.1 IS-805: Code of practice for use of steel in gravity water tank.

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

35.2.3 IS-9595: Metal arc welding of carbon and carbon manganese steels – Recommendations.

35.2.4 BS EN 12285-1&2: Workshop fabricated horizontal cylindrical steel tank.

35.2.5 IS-10987: Horizontal Cylindrical storage tank for Petroleum products.

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

35.2.7 IS-804: Code of practice for material, design, fabrication and erection of rectangular pressed steel tanks.

35.2.8 API-650: Welded Steel Tanks for Oil Storage

35.3 **Miscellaneous Steel Tanks: General Requirements**

35.3.1 The connections, accessories and fittings to be supplied with each tank shall be as specified and as required. The piping material required inside or outside up to the flanged terminal shall be supplied by the Contractor.

Tank connections shall be provided with suitable counterflanges with necessary bolts, nuts & gaskets by the Contractor.

35.3.2 The tank, where applicable, shall be complete with supporting structure, legs or pedestals, base plate, anchor bolts, nuts & sleeves etc. as required.

35.3.3 The special fittings, e.g. conservation vent valves, level indicators etc. shall also be supplied by the Contractor.

35.3.4 Preparation of detailed design, fabrication drawings, bill of materials, tag and piece numbers, welding procedure, etc.

Stiffeners where not specified and other structural framing for supporting tank shell shall be designed by the Contractor including supply of materials for the same.

35.3.5 This specification covers supply of steel plates, structural steel, pipes etc. as required.

35.3.6 The scope of work under this specification includes excavation and backfilling work required for installation of pipes running underground.

35.3.7 All pipe supports, thrust blocks, etc. as required will be properly designed and constructed by the Contractor in accordance with approved drawings. Necessary steel work at supports shall also be supplied, fabricated and erected by the Contractor.

35.3.8 The final fixing grout over the concrete support or through the opening left in the concrete work shall also be done by the Contractor.

35.3.9 The designer and manufacturer of storage tanks shall comply with and obtain approval of all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The tanks shall conform to IS 803 / IS 804 / IS 805 / IS 2825 / API 650 / IS 4049 / IS 4682 (part-I) and IS 4864 to 4870 / ASME B& PV code Sec.-VIII as the case may be

35.4 **DESIGN AND CONSTRUCTION**

(a) Design of all vertical atmospheric storage tanks containing water, acid, alkali and other chemical shall conform to IS: 803 & API 650.

(b) Design of all horizontal atmospheric storage tanks containing water, acid, alkali and other chemicals shall generally conform to IS:2825 as regards to fabrication and general construction taking care of combined bending, shear & hoop stresses developed due to supporting arrangement.

(c) Design temperature of vessels shall be 10 deg. C higher than the maximum temperature that any part of the vessel is likely to attain during the course of operation.

(d) Tank shall be made from mild steel plates to BS 4350/IS-2062 Gr. B (or equivalent).

(e) The joint efficiency factors to be adopted for design calculations shall be in accordance with the specified design code.

(f) Tank shall be provided with suitable supporting joints. All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection.

(g) The material for flanges shall be of ASTM A 105/IS-2062 Gr. B.

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

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

(j) Tanks shall be provided with float operated level indicators/level gauges/level transmitters and level switches, as required, with compete assembly. Suitable flanged pads for level switches mounting shall also be provided. The level indicator can be top or side mounted as the case may be.

(k) In addition to inlet and outlet nozzles, the tanks shall be provided with vents, overflow, drain nozzles complete for various connections on tanks. Overflow lines from storage tanks is to be routed to the nearest surface drains. For tanks containing dm water, alkaline water or power cycle water the vent to atmosphere shall be through carbon-di-oxide absorber vessel suitably mounted on the tank. CO_2 absorber vessel shall be provided with the initial fill of chemicals. Similarly for equipment cooling water overhead tank, the overflow & drain from tank shall be combined together and shall be led to nearest drain (at zero level) via. a seal-trough so as not to come directly in contact with atmosphere.

(l) Tanks shall have suitable stairs/ladders walking arrangement on inside and outside of the tanks, manholes/inspection covers as required and also platform suitably located.

(m) Tank supporting arrangement as approved by Employer shall be provided with all plates/angles/joints/flats and supporting attachment including lugs, saddles, legs etc.

(n) Piercing nozzles/pipes from tank body/dish ends shall be adequately compensated as per relevant code.

(o) Tank fabrication drawings and design calculations shall be approved by Owner/consultant.

35.5 Technical Requirements

35.5.1 Tanks shall be suitably constructed for safe, proper and continuous storage of liquid described. The design code, material standard, minimum plate thickness, size and other details shall be as per the specified Codes and Standards as applicable.

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

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

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

35.5.5 Due consideration for wind load and/or earthquake effect shall be given by the Contractor in the design of tanks. Data for wind load and earthquake shall be taken as indicated in the Project Information of this specification. Maximum allowable stresses for design loadings combined with wind or earthquake shall not exceed 133% of stress permitted for the design loading condition but in no case shall exceed 80% of specified minimum yield strength of the material.

35.5.6 Except where otherwise indicated in the Purchaser's drawings/ specifications, if the stiffening of the shell and/or roof is necessary the same shall be stiffened from outside.

35.5.7 Reinforcement pads in tank connections shall be provided as per applicable code & the reinforced connection shall be completely preassembled into a shell plate. The completed assembly including the connection shall be thermally stress-relieved as per API Standard 620 if specified.

35.5.8 All welding shall be done as per IS-816, IS-817 and IS-9595, latest revision as applicable. All welds are to be continuous welds. Bidder shall clearly state in his offer the make and type of welding rods proposed by him for fabrication. Inspection of welding shall be carried out in accordance to IS-822 and IS-9595. Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage, Contractor shall indicate in his Drawing the sequence of welding proposed by him which should meet prior approval of the Purchaser/Consultant.

35.6 **Tank Connections**

(a) Bidder shall furnish all piping material required for the tank connections.

(b) Unless otherwise specified, for all flanged connections Bidder shall furnish suitable counterflanges and the necessary nuts, bolts, gaskets etc.

(c) Flange faces of all nozzles shall be machined and square with the vessel centrelines.

(d) Unless otherwise stated, bolts and nuts shall be of hexagonal head conforming to IS-1357, latest revision.

(e) The material and thickness of gaskets shall be suitable for the specified service. On completion of hydraulic test, Contractor shall replace the gaskets used during testing at his own cost.

(f) All tanks shall be provided with connections for drains, vents and overflow.

35.7 **Accessories**

The tanks shall be provided with following minimum accessories as indicated in the Specification. All the accessories shall conform to relevant Indian Standards.

a) Level transmitter

SMART (HART) type D.P. level transmitters shall be provided for continuous level measurement as well as for alarm/Interlock (wherever applicable).

b) Level gauge

Reflex type Gauge Glass shall be provided at each tank.

c) Where the tank height exceeds 2 M, vertical ladder is to be provided with cage.

d) Top Manhole shall be provided in all tanks. Manhole size shall be 600 mm NB (minimum).

35.7.1 When installation of tank is specified the recommendation regarding installation in BS EN 12285-1 & 2 shall be followed in general. In addition to those recommendations, the following shall also be taken care of.

35.7.2 The finished tank grade for cylindrical tank shall be crowned from the outer periphery to the centre with a slope. The sloping factor shall be taken as 1:35 unless otherwise specified.

35.7.3 Welding shall be done in accordance with IS-816, IS-817, IS-822 & IS-9595.

35.7.4 Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the Engineer.

35.8 **Corrosion Protection**

(a) A corrosion allowance, applicable to surface in contact with corrosive media, when required, shall be taken into consideration.

(b) Manholes shall be provided for easy access into the vessels. The size shall be minimum 500 mm and will be with cover plate, nuts bolts, etc. to ensure leak tightness at the test pressure.

(c) Each tank shall be provided with drilled cleats welded to the tank for electrical grounding. Material of cleats shall be same as that of the shell.

(d) Epoxy-coating shall be provided on the inside of vessel in three coats (minimum) resulting in total thickness of not less than 150 micron in which ever case required, such as equipment cooling water overhead tank, sodium hydroxide tank, condensate storage tank, condensate surge tank etc.

35.9 **Cleaning & Painting**

(a) Inside surface of all tanks shall be protected by anti-corrosive paints as required.

(b) For tanks/vessel requiring epoxy painting, all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

(c) Outside surfaces of all vessels shall be provided with two coats of primer with three (3) coats of epoxy resin based paint of approved color.