2X660 MW ENNORE SEZ STPP, AT ASH DYKE OF NCTPS, CHENNAI

COVERED SHED

FOR COAL STOCK YARD

VOLUME – II B

TECHNICAL SPEFICATIONS

COVER SHED

FOR COAL STOCK YARD

SPECIFICATION NO.
IS-4-TS-688-108-C280A R0

SECTION – DI

Bharat Heavy Electricals Limited
Industrial Systems Group
IISc,Post
Malleswaram
Bangalore-560012

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION

2 x 660 MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS, CHENNAI – 120

SPECIFICATION

FOR

EPC CUM DEBT FINANCING CONTRACT

BID SPECIFICATION NO: CE/C/ P & E/ EE/ E/OT No.3 /2013-14.

VOLUME – III

MECHANICAL WORKS

Job No	4027	Name / Sign	Date		DESEIN PRIVATE LIMITED DESEIN HOUSE, GREATER KAILASH – II. NEW DELHI – 110 048
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SPECIFICATION
FOR
EPC CUM DEBT FINANCING CONTRACT

VOLUME III – MECHANICAL WORKS

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SPECIFICATION

FOR

EPC CUM DEBT FINANCING CONTRACT

VOLUME III – MECHANICAL WORKS

CHAPTER - 1

SECTION – 1

SCOPE OF WORK

1.0. STEAM GENERATOR AND AUXILIARIES

The Contractor's scope of supply & services for Steam Generator(s) (SG) Package shall include all equipment required for two (2) numbers of 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 (preferably tangential fired) 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 of Contractor. The scope of supply and services for each steam generating unit shall include all items indicated but will not be limited to the following:

1.1 Furnace/Evaporator

a) Water cooled 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) numbers of retractable type temperature probes with duplex type elements at the furnace outlet, complete with all accessories like guiding supports, cooling arrangement, motor with position indicator etc.

1.2 Separator(s) & Drain collection vessel

Minimum Two (2) numbers of 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 etc.

1.5 Economizer

In line, bare tube economizer, including vents, drains and sampling connections etc.

1.6 Start-up Recirculation & Drain system

The scope for above 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.

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 Contractor has proven experience on satisfactory performance of such system(s) in sub critical/supercritical units of similar capacity which are designed for variable pressure operation. In case Bidder offers startup circulation system without mixing box, the Bidder in his bid proposal shall furnish necessary data / information in support.

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. 2x100% pumps to transfer condensate from the receiving vessel to the main condenser shall also be provided. All necessary valves and discharge piping up to the condenser / flash tank in TG area will be in the Contractor's scope.

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 kicker stage of BFP or upstream side of HPH. However, for Reheater

desuperheating, the spray water shall be tapped off from the intermediate stage of Boiler Feed Pumps.

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

a) Two (2) no's of pneumatically/motor operated spray control valves, each rated for the full duty.

b) Two (2) no's pneumatically/motor operated isolating valves upstream of the spray control valves

c) Two (2) no's Motor 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) no's of pneumatically operated spray control valves each rated for full duty.

b) Two (2) no's pneumatically operated isolating valves upstream of the spray control valve.

c) Two (2) no's of Motor 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

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 in SG Package scope. 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 degree Celsius. 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 SG C&I system.

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

i) Start-up drain and vent isolating valves with motor drives with control from SG 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°C.

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 Contractor 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 Contractor 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. Location of steam tapping for soot blowing shall be from inter stage of any SH links after primary SH

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. These valves shall be designed for full flow and shall be tight shut off type.

Complete soot blower control system 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.

Necessary provision shall be provided for future interconnection with proposed third unit.

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 number electro-hydraulically/electro pneumatically operated pressure reducing valve with separate desuperheater rated for full duty.

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

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

4. One number of temperature control valve electro hydraulically / electro pneumatically operated on the desuperheating spray water line along with an identical 100% capacity bypass arrangement.

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

6. One number 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.

1.10.2 Low capacity PRDS

a) One number electro-hydraulically/electro-pneumatically operated pressure reducing valve rated for full duty.

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

c) One number 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.

d) One number 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.

e) A non-return valve on downstream side of low capacity PRDS.

f) One number desuperheater in between the interconnection of high and low temperature unit headers.

g) One number each of pressure and temperature control valve, electrohydraulically/electro-pneumatically operated on the desuperheating spray water line along with an identical 100% capacity bypass arrangement.

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

i) One number motorised isolation valve on the upstream of motorised control valves on the bypass line of desuperheating spray water line.

j) One number 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.

k) One number 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

1.10.3. One 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 number electro-hydraulic / electro-pneumatic operated pressure reducing valve rated for full duty.

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

c) One number 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 number 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 will be arranged by the bidder based on the steam requirement and can be taken back after commissioning. The details of startup boiler is furnished elsewhere in this specification.

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 fuel oil atomization, mill fire fighting etc. 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 Employer's 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 isolation valves and a blank flange for interconnection between the units and for future interconnection with other units.

17. Interconnecting auxiliary steam piping from auxiliary steam station header(s).

18. Interconnecting auxiliary steam piping from auxiliary boiler to auxiliary steam station headers(s). The complete engineering, routing, hanger, support and auxiliary structure shall be in the contractor's scope.

1.12. Blow Down and Flash Tanks

One (1) number atmospheric flash tank (located in the SG area) as indicated in clause 1.6 of this chapter, One (1) no. of condensate receiving vessel (located in SG area), including level gauges, redundant level transmitters for remote level control through SG 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) nos. of 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.

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 will also be 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 installation on spring supported RCC foundation.

Adequate nos. of duplex thermo couples or duplex platinum RTD's (100 ohms at 0°C) and temperature indicators shall be provided for bearing metal temperature measurement, control & monitoring shall be included in the scope.

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

b) Induced Draft Fans

Two (2) nos. ID fans (Axial type, constant speed, variable pitch controlled or Radial type with variable speed, 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.

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.

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.

ID fans shall be suitable for installation on spring supported RCC foundation.

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

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

a) Regenerative Air Pre-heater (RAPH) (Tri-sector)

Two (2) numbers Tri-sector air preheater for primary and secondary air system

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

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.

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. Off load water-washing facility alongwith 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.

11. 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.

12. 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 etc.

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

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

Provision shall be provided in bypass duct of each SA fan

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 clause no (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/contractor. Storage capacity of the bunkers shall correspond to 12 hours requirement of the unit under BMCR condition with worst coal firing or 14 hours requirement of the unit under BMCR condition with performance coal firing, whichever is higher.

1.15.2. **Raw Coal Feeders**

Gravimetric type raw coal feeders with microprocessor based precision weighing and calibration devices, one for each mill. 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) no's of coal pulverisers shall be provided for each 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 and any other equipment necessary for safe and efficient operation of pulveriser. The Pulveriser shall also include rotary classifier 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 Contractor. Independent purge meters, air filter cum regulator sets, local pressure indicators, instruments and sensing device for milling system including the instrument requirements. 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.

c) 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.

d) The contractor will provide spring supported vibration isolation system. Foundation for mills.

1.15.4. **Primary Air Fans**

a) Two (2) numbers of two stage axial PA fans for each 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.

c) PA fans shall be suitable for installation Spring supported RCC foundation.

d) Adequate numbers of duplex thermocouples or duplex platinum RTDs (100 Ohm at 0 Deg. 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 Contractor on the bearing housing in such a way, so that welding/screwing of the pads shall be possible.

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 take suction from either cold primary air header or the Contractor may take suction from atmosphere also.

1.15.6. **Coal Burners**

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**

1.15.8. **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.

1.15.9. **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 1 meter downstream of the bends as per the specifications.

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

1.15.10. 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 & shall be equal to at least the number of PF pipe outlets from one coal pulveriser.

i. Each of 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.

1.15.11. Contractor 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 to the Employer. The number of dirty pitot tubes provided for each Steam Generator shall be equal to at least the number of PF pipe outlets from one coal pulveriser.

1.15.12. On line fuel measurement facility for accurate measurement of coal mass flow rate/ air fuel ratio in each pulverized fuel (PF) pipe for each coal pulveriser. The equipment shall comprise of sensors working on micro wave technology. The error in measuring system shall not be more than 5%, which shall be demonstrated by comparisons with isokinetic measurements.

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.

1.15.13. 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 APH, bypass ducting for locating SCAPH downstream of FD fan.

2. Cold air inlet duct to PA fan suction, from PA fan discharge to APH.

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

4. Hot air duct from each APH to burner wind box to coal mills.

5. Flue gas duct from economizer outlet to APHs inlet ducts and from APHs outlet to ESP inlets. Economizer dust hoppers, (if applicable) shall be provided with high & low 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 Contractor. Contractor 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 Contractor'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, APH outlets and common flue gas ducts at ESP inlet and outlet.

13. Provision of wear resistance plates of special material such as BORON & TITANIUM ALLOYS in flue gas ducts at corners and direction changing areas (min 5 mm thick)

14. Any other ducting required for the completeness of the system.

15. Matching flanges on the flue gas duct after ID fan discharge and before chimney to be connected with flue gas desulphurization system ducts to be installed in future by Employer (if required).

1.17. **Scanner air Fan**

Two (2) numbers AC (2x100%) scanner air fans (one working and one standby) for each unit.

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.

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

1.18. **Damper**

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 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 each air preheater outlet on flue gas path and wherever required.

5. Fully gas tight, motor operated, dampers at each hot air duct to the mills, before and after each ESP stream, before and after each ID fan, at inlet to each of APH on

flue gas side, before and after of each APH on air side, at discharge of each PA fans, FD fans and at each economiser bypass duct.

6. Supporting structure for all dampers & drives.

7. Access and platforms for all dampers and drives including gratings, toe plates and hand rails.

8. 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.

9. All dampers shall be of BI plane type.

1.19. **Fuel Oil System**

Fuel oil system shall cater to Heavy Fuel Oils (HFO/LSHS/HPS) and Light Diesel oil firing requirements for two (2) steam generators:

I. **Heavy Fuel Oil System**

HFO preparation and firing system shall be provided having a firing capacity equivalent to 30% BMCR requirements of two (2) Steam Generators.

HFO firing system shall also have provision to cater the requirement for the third unit to be installed in future. For this purpose, civil foundation for fourth pump and motor should be ready within the pump house.

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

1. Three (3) electrically traced rotary positive displacement type heavy fuel oil pumps with motor, coupling, coupling guards etc.

2. Three (3) steam oil heaters, each heater with individual oil temperature control valve, bypass control valves, isolating valves and relief valves to relieve excess oil pressure.

3. Three (3) electrically traced duplex coarse filters at heavy fuel oil pumps suction, three (3) duplex fine filters at fuel oil heater(s) discharge and one duplex fine filter in the supply line to each boiler.

4. All Base plates, foundation bolts, nuts and bolts.

5. Fuel oil burners complete with diffusers, tips extension pipes, atomizers, burner shut of valves, flexible hoses and all other ancillaries.

6. Oil connections to each burner from ring main.

7. HEA igniters for each burner.

8. Complete Piping along with suitable hangers, support etc, including following

   i. Interconnecting fuel oil piping integral to the system to make it complete.
   ii. Auxiliary steam piping if applicable. However electric tracing for all lines shall be provided.

iii. 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
iv. Vent piping along with local collection bucket for collecting of leak off oil from vents/relief valves.
v. Electrical tracing for heavy fuel oil piping complete with all accessories.
vi. Blow off piping.
vii. Recirculation piping around firing aisle.
viii. The heavy fuel oil piping and steam heating units 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.
ix. All condensate piping upto the flash tank and from flash tank to the drain pit including all valves and fittings.

9. Main oil tanks shall be provided with complete steam tracing facility.

10. One (1) drain oil tank of 6 m^3 capacity with steam coil heaters and with one oil transfer pump with motor, duplex filter at suction and other accessories for each steam generator to transfer drain oil from boiler area to HFO storage tank(s). Control of the same shall be implemented in SG C&I system.

11. One (1) drain oil tank common for two (2) steam generator units in pressurizing pump house area having 10 m^3 capacity with steam coil heater and one oil transfer pump with motor, duplex filter at suction and other accessories to transfer drain oil from pump house to HFO storage tank(s). Control of the same shall be implemented in FOPH control system.

12. One condensate flash tank of 6 m^3 capacity complete with all accessories.

13. Two (2) no's HFO cooler on common fuel oil return line along with 100% bypass line to each cooler, located in FOPH area with necessary automatic oil temperature control system to cool the return oil from the Steam Generators to the temperature of HFO in the storage tank with necessary cooling water piping with complete with all necessary valves, control valves & fittings, etc.

14. Control of the same shall be implemented in FOPH control system.

15. The hot water piping from HFO cooler to a oil/water separator pit to be provided by the Bidder. The separator bit shall be provided by the Bidder

16. 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.

17. Distribution header at boiler front along with filter,Trip valves on common fuel oil line to each 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.

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

19. Facilities shall be provided for flushing of complete heavy fuel oil system, transportation, recirculation & firing system (piping, pumps, heaters, filter, valves, etc) using light diesel oil during long shut down of unit(s). Contractor's scope shall include all piping, valves, fittings, pumps hoses etc. needed for this purpose. The facility shall cover flushing of heavy fuel oil system of unit, as well as flushing of common systems.

20. Complete insulation and cladding of heavy fuel oil piping drain/flash tanks, steam and condensate piping and accessories with outer finish.

21. Supply of one (1) no. flow meter of positive displacement type including all its accessories.

22. Two (2x100%) no's sump pumps with motors along with steam jacketing.

23. All local instrumentation (gauges, switches, transmitters etc.) and associated control devices for HFO system in Contractor's scope.

II. **High Speed Diesel (HSD) System**

a) A HSD preparation and firing system shall be provided having a firing capacity equivalent to 7.5% BMCR requirements of two (2) Steam Generators.
HSD firing system shall also have provision to cater the requirement for the third unit to be installed in future. For this purpose, civil foundation for fourth pump and motor should be ready within the pump house.
The HSD burners (preferably same burners as for HFO firing) of required capacity shall be installed at the lowest oil elevation for Main Steam Generator.

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

b) The system shall include three (3) nos. of pressurizing pumps, piping, valves including control valves, strainers, burners, flow meter with control & instrumentation etc., with equipment redundancy and flexibility of operation similar to those for HFO firing system for Main Steam Generators. Control for HSD pressurizing system including controls for unloading/Storage System shall be from the control system of FOPH.

c) Approval is required from statutory authorities for the entire F.O. pumping installation. Contractor 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 dia and made from minimum 10 mm thick mild steel pipe shall be provided for each Steam Generator, from pent house level to ground level for disposal of debris & scrap generated during erection, operation and maintenance. The chute shall be provided with branch connections with doors & approach platforms at all platform levels. Garbage collection trolleys shall also be provided at the ground level.

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 four (4) 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
   - 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. Platforms for removal, handling & storage of Economiser and Reheater / Superheater sections (all horizontal heating surfaces)

3. Provision shall be made by the Contractor, for adequate space in various platforms, galleries etc. for locating local instrument enclosures under contractor'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 the Bidder shall include in his proposal of adequate platform area (inclusive of platforms, structures & supports) (clear of all intervening pipes, columns, actuators, instrument enclosures, racks etc. and excluding area covered by stairways & landings).

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

1.22. **Elevators**

Two (2) no. passengers cum goods elevator having a capacity of 3000 kg (each) for each steam generator will be provided. The scope for each elevator shall include all items/accessories including all electrical equipment, services etc. required to meet all

design, installation, operation, safety, protection and other requirements of IS:14665 (all parts). "Electrical Traction Lifts" (Latest Edition). The scope shall also include items/services needed to comply with requirements of IS: 14665 and requirements. The scope shall also include provision of a Fireman's switch for each Elevator. Two nos., adequately sized, Air conditioners each having minimum cooling capacity of 2.5 Ton shall be provided for each elevator machine room to make it dust proof.

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 in the scope of this specification so as to ensure skin casing temperature of any surface in Contractor's scope is not more than 60 deg.C with ambient temperature of 45 deg.C and air velocity of surface air being 0.25 m/s when the boiler is operating at 100% BMCR.

1.24. **Field Control & Instrumentation Equipments**

Refer C&I Section

1.25. **Pre-commissioning and Commissioning Activities**

Contractor'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 Contractor'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 Contractor solely for the precommissioning and commissioning work shall on completion of these activities, remain the property of the Contractor. However, the nitrogen blanketing equipment including nitrogen cylinders shall get included in the Contractor's permanent scope of supply and become property of the Employer.
   c) The selection of material of all the temporary equipments/ instruments shall be compatible with the service conditions expected during pre-commissioning/ commissioning activities.
   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 each 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:

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

b) 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 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) nos. of 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 Pneumatic operated platform or 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 of a steam generator and shall be complete with all slings etc. Steam generators shall have suitable provisions for suspending this cradle from the top.

C. Complete lifting tools and tackles. Contractor 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 Contractor'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 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. Contractor's scope shall include Instrument for Tube Thickness Measurement as follows:

The scope shall include 12 nos. 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) number 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.

I. One pump suitable for hydraulic testing of boiler with permanent connection and with necessary isolation. The pressure rating is to be 1.5 times of design pressure of boiler.

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)

2.0. LP DOSING & OXYGENATED TREATMENT SYSTEM

Complete Boiler Feed water chemical dosing (both AVT & Oxygenated treatment) system complete with dosing pumps, tanks, associated pipings, supports, fittings, valves, instrumentation and controls etc. as specified elsewhere in the specification.

3.0. POWER CYCLE PIPING & LOW PRESSURE PIPING

3.1. GENERAL

3.2. Scope of supply and works for Power Cycle piping system shall include the piping systems as listed below.

a) Complete mainsteam, hot reheat & cold reheat piping between boiler and turbine nozzles, HP bypass valve upstream & downstream piping and LP bypass valve upstream & LP bypass valve downstream piping up to the condenser inlet nozzles– as per P&ID finalized during the detailed engineering.

b) Complete auxiliary PRDS & Aux. Steam piping system.

c) Complete Spray piping system for the following:
   1. Reheater attemperation,
   2. Superheater attemperation
   3. Auxiliary PRDS system

d) Steam drains from piping /equipment(s) in the scope of bidder to flash Tank(s) / flash tank manifold(s).

e) Miscellaneous line drains and vents.

f) Complete safety valve exhaust piping for SVs / SRVs on piping/equipment in Bidder's scope.

g) Complete steam blowing piping system (Temporary).

h) Any interconnection required for MS stop valve, MS control valve, HRH stop valve, HRH control valve, MS piping, HRH piping, CRH piping as per the requirement of TG supplier.

i) Any drain required from the piping supplied by the SG contractor, to meet the TG supplier's requirements.

j) Any other piping system required to make the power cycle piping, in the bidder's scope, complete.

3.3. Design, manufacture, supply, erection, testing and commissioning of complete piping/fittings/accessories, valves and specialties, strainers, expansion joints, snubbers, restraints, hangers/ supports with all components, thermal insulation and auxiliary structures including structure in C-D Bay, , etc., for the above piping systems.

3.4. For the above piping system scope shall include complete design and engineering including but not limited to pipe sizing, flexibility and dynamic analysis, hanger /

snubber support engineering, engineering of thermal insulation etc. and shall be to Employer's review and approval.

3.5. Steam blowing of piping systems, as specified elsewhere in the specification, after complete erection is to be carried out, which includes supply, erection and dismantling of temporary piping, valves and fittings, etc.

3.6. Providing other necessary services for making the piping systems in bidder's scope complete.

3.7. All paints and primers as required and suitable for environment / conditions prevailing at site.

3.8. All supplies, works, services shall comply with the detailed scope given in the subsequent clauses of this section.

4.1. **Pipes and fittings**

a) Piping, fittings, stubs, plugs, flanges, steam traps, caps, break-down orifice, drip pan and other accessories for the piping systems identified above and as per approved schemes.

b) The contractor shall supply all standard and non-standard matching pieces as may be needed within the piping systems.

c) Pipe stubs for mounting thermowells and other instrumentation, including for the instruments supplied by others, along with necessary root valves, reducers / matching pieces and instrument tubing

d) Thermal insulation and cladding along with all necessary accessories for all piping systems, etc. in bidders scope

e) The contractor shall also design and provide for additional guides/ stops/restraints/snubbers/ dampers, etc. along with auxiliary steel for control of pipe line vibration within allowable/ acceptable limits

f) Provision for creep measurement on the piping operating in creep region viz. Main steam and Hot Reheat.

4.2. Valves and Specialties

Valves, actuators and specialties including orifice plate assemblies, steam traps, strainers, instrument root valves, etc. for the systems specified The Contractor shall also supply special accessories like floor stands, chain operator, extended spindle etc. as required. Valve, especially for which approach from existing floors are not possible for O&M, bidder shall provide appropriate platforms with the access ladders for the same.

4.3. **Hangers and Supports**

All pipe supporting elements such as constant load spring hangers, variable spring hangers, supports, guides, restraints, stops, etc. and all associated auxiliary steel and hardware such as beams, channels, insert plates section attachments to pipe supports, pipe and beam clamps, straps, slings, stools, shoes, saddles, devices, rods, turn buckles, graphite/steel plate / Teflon sheet etc. for all the systems specified.

4.4. **Snubbers**

Snubbers or shock absorbers as required on the main steam, hot reheat, cold reheat, HP/LP bypass piping etc. to take up forces due to impact and surge forces arising from sudden closure of turbine stop valves and blowing of safety valves. The requirement of snubbers will be decided by the Contractor while undertaking dynamic analysis of the piping systems. The snubbers shall be hydraulic type. It will be responsibility of the contractor to do the static/dynamic analysis for complete piping systems as required. Also it will be the responsibility of the contractor to engineer and supply snubbers required for the above piping systems

4.5. **Miscellaneous Erection, Testing and cleaning Materials**

a) All erection material such as bolts, nuts, washers, gaskets, electrodes, filler materials, welding gas, consumable inserts and backing rings, accessories and miscellaneous specialties required for the proper installation of piping systems.

b) All temporary piping, supports, valves, blanking plates, caps, pumps, pressure gauges, plugs, gaskets, bolts & nuts, spool pieces for valves/control valves, flow nozzles & specialties,, tools & tackles and other accessories required to complete the Hydrostatic testing of piping systems in SG contractor's scope.

c) All temporary piping, supports, valves, blanking plates, caps, pressure gauges, temperature gauges, plugs, gaskets, bolts & nuts, spool pieces for valves/control valves, flow nozzles & specialties, tools & tackles, target plates and other accessories required to complete steam blowing operation of piping systems as specified.

5. SCOPE OF OTHER SERVICES

5.0. Complete design, engineering, etc. for the power cycle piping systems and other piping systems included in this specification shall be the responsibility of the Contractor. Employer's responsibility/ function in this connection shall be limited to review and approval of Bidder's design/ calculation, engineering, drawings, documents. Bidder's scope of services for complete engineering of the power cycle piping systems shall include but not be limited to the following :

a) Preparation of engineering piping diagram indicating flow schematic, flow parameter, pipe sizes, line designations and tag nos. of various components etc. and submission of same to Employer for review.

b) Design parameter selection, pipe sizing calculation, pipe schedule, valve schedule, insulation schedule, specialties schedule and hanger schedule for the systems included in the Bidder's scope.

c) Preparation of preliminary as well as final composite piping layout drawings and isometric drawing of pipe size 65mm NB & above and submission of same to Employer for review and approval.

d) Preparation of fabrication and erection isometric (with material take off) drawings for shop fabricated piping which are of size 65 mm NB and above and submission of the same to the Employer for review and approval .

e) Preparation of layout drawings for site routed piping and submission of the same to the Employer for records.

f) AS BUILT" drawing of the piping layout shall also be prepared by the Contractor based on any layout modifications made at site and submitted to Employer for records.

g) Approval from Statutory Authorities

1. It is the sole responsibility of the contractor to identify and obtain all necessary approvals from various Government agencies/board/statutory authorities/IBR etc., as applicable for the design, manufacture and testing of pipes, valves, fittings, specialties etc.

2. The contractor shall also identify and obtain all necessary approvals from the IBR authority in the state where the plant is being installed, for the erection/testing/commissioning/ registration and any other requirement as required by IBR.

3. In order to obtain the above approvals, all necessary documentation etc. required shall be arranged and furnished by the Contractor to the statutory authorities.

5.1. The Contractor shall design in detail all piping supports including restraints, guides, stops, snubbers etc., after deciding the final location of hangers and supports and based on final stress analysis/ dynamic analysis and hanger/ support load data originated by him. Bidder shall submit to Employer for review his hanger design document in the form of hanger GA drawings and hanger schedule.

5.2. The Contractor shall furnish separate sketches for each hanger/ support, restraint, anchor, etc. These sketches shall include the location with reference to column co-ordinates, identification number, bills of material, design loads, operating load, spring stiffness, amount of spring pre-compression etc., the method of attachment to the pipe and steel structure. Additionally the sketches shall show a key plan referenced to plant north and centre line elevation of the pipe at the point of attachment for cold and hot conditions.

5.3. In order to ensure that all supporting elements, anchor and restraints have been installed and adjusted in accordance with design documentation, the Contractor shall inspect and log the hanger readings for the hangers associated with the power cycle piping system as follows:

a) After hydrostatic test with the piping in the cold position, with all travel stops removed, with the pipe completely insulated and in all respect ready for startup.
b) Piping in hot position, with the unit operating at rated parameters
c) Piping in hot position (rated parameter condition) after six (6) months of operation
d) Piping in cold position during the first complete shutdown after at least six (6) months of operation.
e) After steam blowing, in case steam blowing is applicable for the line.

5.4. At the time of each inspection, the Contractor will determine the necessity for revision, adjustment or replacement of pipe supporting elements, restraints and anchors. Any changes proposed shall be subject to the concurrence of the Employer. The changes shall be incorporated by the Bidder after Employer's concurrence. A written record shall be furnished to the Employer.

5.5. Design and engineering of all temporary piping that are required for the commissioning activities of power cycle piping system shall be as specified herein.

5.6. All shop tests as required by the applicable codes, ANSI Standards, IBR and other standards enumerated or specified.

a) Obtaining approval from Chief Inspector of Boiler as per Indian Boiler Regulations (IBR - 1950). This shall include furnishing all necessary certificates for design, manufacture and testing for pipe, valves, fittings, specialties, certificate of manufacture and test for each erected piping in the relevant formats to the Chief Inspector of Boilers, obtaining his approval and furnishing the same to the Employer.

b) The Contractor shall also identify and satisfy all other statutory code requirements as may be required for the piping systems covered in this specification.

5.7. Certified copies of test reports for all tests and examinations specified in the specification and for the mandatory test and analysis required by ASME/ ASTM material specification, for the materials used for piping, shall be furnished to Employer.

5.8. Drawings, data and design calculations as specified in this Sub-section and elsewhere in the specification shall be furnished by the Contractor to the Employer for review.

5.9. Cleaning including steam blowing of all systems as specified herein and installation of temporary pipe work including making temporary closures on piping systems etc. for the same.

5.10. Making temporary closures on piping system as required for hydrostatic testing and performing hydrostatic test on all piping

5.11. Interface Connections (if applicable)

5.12. Installation/mounting of pipe mounted items on the piping system.

5.13. Providing complete interface engineering with the suppliers of other equipment and piping with which the piping systems in the contractor's scope is to be connected or have interface in any other way.

5.14. Performing all tests and implementing all quality control procedures as specified herein including provision of testing equipment, stress relieving equipment, radiography equipment and any other equipment necessary to meet the requirements of the specification.

5.15. Apart from carrying out steam blowing, the work shall include disposal of water, clean up, reinstatement of the cleaned piping system, dismantling and removal all temporary piping, equipment and materials from site.

5.16. Final painting of piping system in accordance with the stipulations laid down elsewhere in this specification.

5.17. Weather hood for pipes crossing ceilings and walls.

5.18. **Stress / Dynamic Analysis**

The Contractor shall carryout stress analysis of piping system and submits for Employer's approval. Contractor shall also carryout the dynamic analysis of piping systems as required and submitted for employer's approval:

a) A write up on the stress analysis /dynamic analysis including codes used and design conditions considered.

b) A copy of the computer print out for input data for the various design conditions considered for stress analysis along with the stress diagram (piping isometric marked with node points marked).

c) Analysis results in tabular form giving calculated and allowable reactions/forces/moments on equipment nozzles / terminals for the various design conditions considered for analysis.

d) Allowable and calculated code stresses at various node points in the piping for the design conditions considered based on code requirements for analysis.

e) Analysis results giving calculated forces and moments and movements at various hanger / support / restraint / anchor points from dynamic analysis as well as from the static analysis corresponding to various thermal /operating conditions, sustained load case, hydro load case (other than water lines) and occasional loads ,as applicable, for each piping system analysed .

5.19. **LOW PRESSURE PIPING**

The Scope of Low Pressure (LP) piping systems for the following services are as follows:

a) Boiler fill system.

b) Equipment Cooling Water (ECW) system including its chemical dosing system for primary circuit.

c) Service water system

d) Instrument Air System.

e) Service (plant) Air System.

f) Air pre heater wash water system

g) Tanks as described elsewhere in the specification for the above systems.

h) Drain and vent piping system for the piping\equipment etc. under the bidder's scope.

i) Re-circulation pipes along with valves, breakdown orifices etc., wherever required/specified elsewhere in Technical Specification.

j) Any other piping system required to make the Low Pressure (LP) piping systems in the bidder's scope complete.

For other details please refer respective chapters in Volume III.

5.20. The scope also covers the following:

a) Complete assemblies of hangers, supports anchor, guides, restraints, etc. including welded attachments, clamps, devices tie-rods, turn-buckles, springs and spring cages, shoes, rollers, trapezes etc.

b) Weather hoods for pipes crossing ceilings and walls.

c) Instrument tapping and stub connections, root valves, 3-way valves (where applicable) with test connections, drains and vent valves & expanders / reducers as required and instruments as indicated elsewhere for instruments supplied by the Contractor.

d) Drain funnels, drip pans, moisture traps etc. where ever required shall be provided.

e) Instrument tapping, stub connections, root valves and instrument tubing up to root valves for instruments supplied by the Employer for onward connections by the Employer. Contractor shall furnish the list of all such tapping with their X, Y, Z coordinates.

f) All supporting attachments like plates, saddles, stools, shoes, base plate, saddle plates, angles, channels, I-beams, trapeze, cantilevers, brackets, sways, braces, nuts, bolts, cleats, clamps, needed to complete the erection of piping system covered under this specification.

g) Anchor bolts, bed & foundation plates, pipe sleeves and Nuts to be embedded in concrete for piping where ever indicated in the drawing. All grouting and chipping work (including supply of cement, sand and stone chips) for equipment foundations, pipe supporting etc.

h) Reinforced concrete valve chambers wherever required for underground piping.

i) Excavation, preparation of bed, backfilling with compaction of soil and removal of extra-earth to designated places in case of pipes to be buried.

j) Bidder shall also design, supply, fabricate, erect, set and commission all hangers, tie-rods, turn-buckles, supports, guides, restraints, anchors, etc. as required for the, piping system. This includes the provision of all associated steel work including brackets, cradle supports, duck foots, channels, angles, etc. It is Bidder's responsibility to estimate these requirements and include them in their offer price. Whenever, straight run of the yard pipes are more than 300 meters, flexibility analysis shall be conducted by the contractor to identify the requirement of loops, type of supports etc.

k) In covered concrete trenches bidder shall supply necessary supporting materials such as stools, saddles, base plates, clamps, U-bolts, angles, clips etc.

l) Bidder shall supply all necessary drains and vents with drain & vent valves including anti-flash funnels and moisture traps for compressed air system as required for the safe and effective draining-venting of the piping systems based on the approved flow scheme / single line diagram. It is bidder's responsibility to identify the requirements of drains, vents, and supply the necessary pipe work, fittings, hangers and supports etc. for the same.

m) Bidder shall supply and install necessary matching pieces as may be needed for connection of piping systems with equipment terminals, valves and specialties.

n) Bidder shall erect all instrument impulse piping and fittings from the tap-off point of the last root valve including the root valve and instruments.

o) Bidder shall perform necessary internal machining of pipe for installing orifices, flow nozzles, straightening vanes etc.

p) The Bidder shall prepare the flow diagrams, detailed dimensional piping layout/ Isometric/ fabrication/ As built drawings of all the systems along with Cross sectional drawings, showing all supports and equipment as required.

q) Bidder's scope of supply for fabrication, erection, cleaning, testing and commissioning of the piping systems installed by him shall include the following:-

All welding consumables like welding electrodes, filler rods and wires; gases like oxygen, acetylenes, argon, carbon-dioxide, propane, backing rings etc.
Films for radiographic examination of welds.

X-ray and Gamma -ray equipment including isotopes, dye penetrants, and other required non-destructive testing materials and equipment (all to be taken back by the Bidder after completion of work).

All heating and stress relieving equipment, thermocouples asbestos blankets, cables, temperature recorders, charts heat sensitive chalks and crayons etc. (All to be taken back by bidder after completion of work).

All machinery, equipment tools and tackles as required for transportation handling, fabrication and erection (All to be taken back by Bidder after completion of work).

All equipment/ materials as required for cleaning, flushing, blowing out and hydro testing of the piping systems; these shall include but not be limited to pumps and compressors with prime movers, instruments, pipe work with supports, valves, strainers and other specialities, blanks, plugs, spool pieces, dummy plates, electrical accessories, etc. (All to be taken back by Bidder after completion of work).

All scaffolding materials and false work (To be taken back by Bidder after completion of work)

5.22. The contractor shall provide Services of erection superintendent and foremen, fitters and riggers, welders, transport and crane operators and other skilled and unskilled labour.

The design engineering and providing all temporary pipe work as required for erection, cleaning, flushing, blowing out, testing and commissioning of the piping system is the responsibility of the Bidder.

The Bidder's scope shall include design, supply of required structural steel (except those which are specifically excluded), their fabrication and erection where ever required.

The Bidder shall include in his offer a complete set of special tools and tackles required for handling the various equipment / piping system during maintenance.

Bidder scope of services shall include the following also:

i. Obtaining approval from Chief Inspector of Boiler as per Indian Boiler Regulation, (IBR-1950) for design / fabrication / erection / testing of piping / fittings / valves and specialties coming under the purview of IBR, if any.

ii. The bidder shall also identify and satisfy all other statutory code requirement as may be necessary for the piping systems covered in this specification.

Certified copies of test reports for all tests and examinations specified in the specification shall be furnished to the Project Manager. Cost of meeting all statutory requirements and furnishing the required certificates shall be deemed included in the proposal price.

CHAPTER - 1

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

The 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

The Steam Generator shall be direct pulverized coal fired, 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:

a) 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 1.02 times the steam flow at turbine VWO condition plus continuous auxiliary steam requirement of unit at TMCR, rounded to next integer divisible by 5	
2.	Steam flow at superheater outlet	BMCR will be calculated by bidder based on above (1) but not less than 2100TPH
3.	Pressure at HP Turbine inlet (at inlet to mainsteam strainer)	Atleast 247 kg/cm^2(a)
4.	Pressure at superheater outlet header	At least 256 kg/cm^2(a)
5.	Steam temperature at superheater outlet	At least 568°C
6.	Steam temperature at reheater outlet	At least 596°C
7.	Feed water temperature at economiser inlet	Not less than 296°C (To be optimized by bidder)

Note:
BMCR flow will alter with increase in steam parameters, Bidder to furnish the value according to steam parameters selected.

1.4. FUELS

1. Coal

For coal analysis, refer subsequent chapter.

2. Fuel Oil

i. Description of Fuel Oil Unloading & Storage System

The fuel oil requirements for steam generator package shall be drawn from the heavy fuel oil and HSD tanks being provided and covered in subsequent chapter. The fuel oil pressurizing, heating (as required) and firing system shall be in the scope of contractor. Bidder shall include all required piping (for HFO, steam condensate, heat tracing, HSD etc), valves, fittings, instrumentation etc.

ii. Fuel Oil Firing System

The fuel oils (HPS/LSHS/Heavy Furnace oils), having characteristics as given in subsequent chapter shall be used for start-up, coal flame stabilization and low load operation of the main Steam Generator. In addition, the light diesel oil (HSD) firing facilities shall also be provided for cold start up of the steam generator, black start of units and for generation of auxiliary steam from Auxiliary Boiler HSD characteristics are given in subsequent chapter.

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 in the specification

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 Contractor.

In all above cases specific approval of concerned Chief Inspector of Boilers shall be obtained by the Contractor 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 Contractor to obtain the necessary approvals of Inspection Authority/Chief Inspector of Boilers Registration Authority etc. on behalf of the Employer, as may be required for designing and design calculations, manufacturing and erection procedure, testing, registration etc. as called for under the IBR. All such documentation submitted to statutory authorities shall also be submitted to the Employer for his review.

1.7. 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 72% relative humidity:

Excess air at economizer outlet at Turbine Maximum Continuous Rating (TMCR) (660 MW) load: 20% (minimum)

Flue gas temperature at air-heater outlet (corrected) at TMCR (660 MW) load: 125 deg. C (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 at clause no 1.7 of this section above 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 30% BMCR load when firing any coal from the range specified, with any combination of mills/ adjacent mills (to Employer's choice) in service. This shall be guaranteed and demonstrated by the Contractor.

1.9. The Employer envisages to have following major operating capabilities for the unit/plant:

i. The maximum continuous rating of the unit is 660 MW (TMCR) with peak output of approx. 105% TMCR.

ii. Sliding Pressure Operation from rated pressure down to 30% 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 equipments/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.

1.9.1. Steam Generator and all the equipments and auxiliaries under this package 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.

1.9.2. 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:

Sl.No.	Type of Starts	Number of Starts
i.	Hot start (after 8 hours of unit shut down)	4000
ii.	Warm start (after 36 hours of unit shut down)	1000
iii.	Cold start (after 72 hours of unit shut down)	150

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. Contractor 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.

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 valvesshall also be provided by contractor.

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 of 140°C at economizer inlet. 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 140°C. The superheater and reheater outlet temperature shall be maintained during HP/LP bypass operation at above mentioned superheater outlet flow

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, the Steam Generators 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 40% SGMCR to 100% SGMCR rating for SH and 60% TGMCR to 100% SGMCR rating for 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 elsewhere in the specification. The Contractor shall also take into account all interface requirements with the equipment furnished by the others, during the detailed engineering.

1.16. Electrostatic Precipitator

Refer subsequent chapter.

1.17. Ash Handling System

Refer subsequent chapter.

1.18. Provision for Future Installation of FGD System

1. A flue gas desulphurization (FGD) system may be installed by the Employer in future to meet the requirements of pollution control.

2. Following provisions need to be kept by the Contractor for this purpose:

   a) Suitability of duct between ID fan and chimney for future interconnection of FGD system with minimum modification

   b) The ducting and supporting structure to be designed to take care of future 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 at a later date. Bidder to furnish the details being provided by him and to be provided in future during installation of FGD. This will be reviewed by owner for reducing the period of shut down required for FGD installation.

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:

	Design Metal Temperature	**Material**
i.	Upto & including 400 degree Celsius	Carbon steel to ASME SA-106Gr. B/C or SA 210 Gr. C or approved equivalent.
ii.	Above 400°C and up to & including 550 degree Celsius	Alloy steel to ASME SA-335: P-11/P-12/P-22/P-23; ASME SA213:T-11/T-22/T23/ or approved equivalent
iii.	Above 550°C and upto &	Alloy steel ASME SA-335/213:P91/T-91, T-

	including 605°C	92, or approved equivalent
iv.	Above 605 degree Celsius	Austenitic stainless steel, Super304H, TP347H or approved equivalent

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1.20. Limits of No_x Emission

The guaranteed maximum NO_x emission (thermal as well as fuel) from the Steam Generator unit shall not exceed 260 gms of NOx per Gigajoule (GJ) of heat input to the Steam Generator.

The above value of NOx shall include both fuel and thermal NOx and shall not be exceeded during the entire operating range of Steam Generator for the whole range of specified coals.

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

Because of grid hunger, employer envisages extension the operation of unit beyond three (3) years by delaying the capital overhaul.

Under such special circumstances, employer may like to carry out the capital overhaul of unit after six (6) years of operation. The design philosophy and selection of material for various equipments/auxiliaries of steam generator sub-systems shall be selected / configured by contractor keeping in view the above requirement of employer.

The basis of engineering of steam generator to conform that no major repairs / replacements, requiring shut down of the unit, are needed in between two subsequent capital overhauls.

Contractor, based on his experience & practice, may recommend important 'DOs, & DON'Ts' during operation & maintenance of the power plant (as well as spares management) for fulfilling this requirement of customer.

1.22. Maintenance

1. The Contractor 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 each steam generator, from pent house level to ground level for disposal of debris & scrap generated during erection, operation and maintenance. The chute shall be provided with

branch connections with doors and suitable access to the doors at all platform levels. Garbage collection trolleys shall also be provided at the ground level.

1.23. Noise level

The equivalent weighted average of sound level measured at a distance of 1.5 m above floor level in each elevation and 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). 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 Employer, 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 Employer and utilization of various parameters and their values in the specification by the Contractor shall in no way relieve the Contractor of his responsibilities to meet all guarantee requirements or of providing completely safe and reliable operating equipment/systems. The specified requirements shall be complied for the most stringent conditions resulting either from the range of coals (design / worst / best / adequacy) specified or from the range of operating conditions specified (like 100% BMCR or HP Heaters out of operation etc.), or from both occurring simultaneously, unless specifically mentioned otherwise by the Employer.

1.25. 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 Employer. It is however, the responsibility of the Contractor 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.

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 Contractor 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 Employer 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 deg 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 6.00 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 sea water to be protected with shield plates.

3.0. Furnace/Evaporators and Water Walls

1. 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)	1.55 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(*)	675 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 1600Kg/m^3.Further load cells shall be installed in the furnace roof enclosure to give indication of ash build up in the furnace bottom hopper.

NOTE:
Definition(s) of acronyms/terms for the above are as given at the end of this clause 3.0.

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

(**) Selected Furnace Residence time by the Contractor 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.

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 initial operation of respective Steam Generator, the cost of carrying out such flow readjustment/modifications including cost towards rectifying any damages to the Steam Generator tubing resulting from the inappropriate mass flow in the tubes shall be borne by the Contractor. Contractor in 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. Flame impingement on steam/water walls is not permitted.

6. 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.

7. Minimum 10 mm dia. wear bars of suitable wear resistant material shall be welded along the full length of first 40 tubes of inclined water wall tubes of S-panel of bottom hopper from each corner up to hopper opening. In case of spiral tube arrangement, wear bars shall be welded on each of inclined water wall tubes of S-panel up to a length of 3.3 m from each corner.

8. 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 5 above. For this purpose appropriate thinning allowance shall be considered by the contractor while calculating the thickness of the bends.

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

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

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

Sl.No.	PARAMETER	REQUIREMENT
i.	Soot Blowing Frequency	Once daily (max.)
ii.	Preferred mill combination	Any combination of mills (to Employer's choice without any restriction).
iii.	Max. coal flow unbalances in coal pipes from same mill, from the average	5.0%
iv.	Slagging :	
a)	Inter burner	Nil
b)	In furnace/ash hopper/water wall areas	Nil
v.	Control range of boiler	50% TMCR to 100% BMCR
vi.	Maximum permissible Reheat Spray Water Flow with rated steam temperature at Reheater outlet	3% of steam flow at reheater outlet
vii.	Min. load without oil support	30% 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 unbalance (steam side)	6 % (Maximum)
xii.	Air ingress from furnace bottom hopper	As per manufacturer's Predictions

Note:-
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.

12. 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.

13. 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 Contractor shall install these soot blowers and associated access and platforms without any cost implication to the Employer.

b) Erosion resistant shields for tubes/header affected by gas impingement/laning effects (E.g. in a between SH/RH, Economizer and furnace walls openings for economizer bypass etc.)

c) Tapping points at five levels for furnace vacuum monitoring (in addition to routine monitoring)

d) All round seal plates of stainless steel type 430 or better (6-mm thick minimum) welded to furnace hopper for sealing against air ingress.

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

15. 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

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

Note:
i. 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.
ii. Alarm set point for tube metal temperature shall not exceed the design temperature of respective tube

Definitions of Acronyms/Terms used in clause no. 3.0

CLAUSE 3.0 (1) (a) "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 H2 in the fuel plus the sensible heat of combustion air (Primary plus Secondary air), all above 27°C.

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

CLAUSE 3.0 (1) (c) "BURNER ZONE HEAT RELEASE RATE" (BZHRR)

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

CLAUSE 3.0 (1) (d) "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).

CONTRACTOR 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 Contractor shall be the actual MHVT value and not the HVT values.

CLAUSE 3.0 (1) (f) "FURNACE COOLING FACTOR"

Furnace Cooling Factor in Kcal/hr/sq.m., is the ratio of NHI (Cl. 3.0 (1) (a)) 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.

CLAUSE 3.0 (1) (g) "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 1350 kg/m³.

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 at clause no 1.19 of this section to 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 pump	1x100% (sized for maximum flow as specified at Clause 6.0 (1) (b) above)
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 Employer'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 deg C while the pump is in operation. The design shall be such that during hot standby service of the pumping unit, sufficient cooling effect is provided by natural circulation of the coolant so as to prevent over heating of the motor.

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 no 1.24 of this section also)

Sl.No.	Parameter	Requirement
1.	Rated Steam Temperature	
a)	At Super heater outlet	At least 568°C
b)	At Reheater outlet	At least 596°C
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	12 m/sec. (The maximum localized velocities across the cross- section shall not exceed 13m/ sec.)
3.	Maximum allowable tube metal skin temperature	40 degree Celsius 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 each 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 Contractor intends to utilize design with Radiant wall reheater, the use of such radiant wall reheater shall be restricted to only on one of the furnace walls (i.e. either on the front wall or on one of the side walls). Further, the lowest portion of wall RH shall not be below the furnace nose tip level.	
2.	Minimum transverse tube pitching in the direction of gas flow path
a)	600 mm for banks/sections placed in areas where gas temperature exceeds the FEGT (MHVT) value
b)	For bank/sections placed in areas where gas temperature exceeds IDT of ash for the range of coals specified, the minimum transverse pitching shall be under: 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 only steam cooled hanger tubes such that the failure of even 50% of hanger tubes shall not cause any dislocation/damage to the tube banks/sections. 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 2.5 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 contractor while calculating the thickness of the bends
8.	Tube/Header Material
a)	Appropriate for most adverse operating conditions and as per conditions specified in this Sub-Section (Alloys containing Molybdenum only, without any suitable stabilization with Vanadium and Chromium shall not be used. Total content of Molybdenum, Tungsten, Silicon, Vanadium, Titanium, Tantalum etc., individually or all together, if not otherwise specified, shall not exceed the limit specified in relevant material codes).
b)	Contractor to minimize/limit use of different grades of tube materials in one SH/RH bank to three. One SH/RH bank is defined as tubes/elements connected between two headers.
c)	Dissimilar Metal Welds (DMW) in gas path are not allowed.
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	At least 568 degree Celsius
2.	RH outlet Steam	At least 596 degree Celsius
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.		
3.	Preferred mill combination	Any mills (To Employer'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
	Above permissible limits shall be applicable to all boiler loads with any combination of Mills in service and shall be guaranteed by the Contractor. The SH/RH attemperation system shall, however, be sized for 12% of the rated 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 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.		

a) For continuous monitoring of tube metal temperatures of SH and RH elements, minimum number of thermocouples shall be provided:

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

ii. 80 numbers of Acromat thermocouples located inside the gas path for measurement of gas side metal temperature covering all stages of Superheaters and Reheaters.

Note:

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

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

7.4. 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 Contractor 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.

7.4.1. 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 condition 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.	11 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.
		(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 contractor 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 Meters or maximum soot blowing radius, whichever is lower.

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 such that the failure of even 50% of hanger tubes is not to cause any dislocation/damage to the tube banks/setting.

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.

Contractor 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. Contractor 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 Contractor 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

9.1 Regenerative Air Preheaters (Tri-sector type)

I. Air preheaters shall be sized / designed to cater to following requirements:

1.	Type	Regenerative type tri-sector air pre heaters with provision of steam coil heating on secondary air side to guard against low cold end temperature.
2.	Sizing shall be based on following criteria, all conditions considered to be occurring together:	
a)	Design ambient air temperature & humidity	27 °C & 72% RH
b)	Load Range	a) 60% BMCR with worst coal and maximum moisture with one APH in service. b) 100% BMCR with worst coal and maximum moisture with both APHs in service
c)	Minimum average cold end metal temperature at 100% BMCR	76°C
3.	Minimum AH flue gas exit temperature (corrected) at 100% TMCR (660 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% TMCR i.e. 660 MW unit load for complete range of coals)	Less than 8 % of the Flue gas weight entering air heater

II. 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 Contractor may, if required, provide economizer bypass duct along with necessary dampers, expansion joints, structures etc. Even in case economizer bypass is provided by the Contractor, 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 (660 MW) to 100% BMCR loads with economizer bypass fully closed.

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

IV. Air preheater Construction shall conform to following:

S.No.	Design	Requirements	
1.	Type	Rotary regenerative, (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	Spherical roller thrust
		d) Hot end	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 contractor shall also demonstrate that the drift in air heater leakage (percentage change in air-in-leakage) does not exceed 2%, subject to a maximum air leakage of 12%, one year after demonstration of above guaranteed air-in-leakage. Within this period of operation till all air heater leakage demonstrations are completed only external adjustments of seals without needing any shut down for replacements or internal adjustments shall be allowed. The seal design/construction shall be such that the above requirements are satisfied.	
		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.	

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

VI. 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.

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

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

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

X. Provide:

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

b) Basket removing facility alongwith removal gear

c) 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

d) Hinged access doors in air heater housing for internal inspection / cleaning / maintenance and for replacements of elements without dismantling airheaters,

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

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

g) 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

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

XI. 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.

10.0. COAL PREPARATION AND FIRING SYSTEM

10.1. GENERAL

I. 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.

II. 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

I. 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 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.

II. 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

III. 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.

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

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

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

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

Coal Chute Minimum I.D

i.	Between bunker outlet gate & feeder inlet *	914.4 mm
ii.	Between feeder outlet & pulveriser inlet	600 mm
*Note: Chute length and gate size shall be to 'Employer's' approval.		

II. Chutes shall be made of minimum 12 mm thick stainless steel SS-410 material and shall be of full welded construction.

III. 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

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

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

VI. 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.

VII. 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

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

II. 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

III. The feeder casing shall be designed to withstand an explosion pressure of 3.5 Kg/cm2 (g).

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

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

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

VII. Provide suitable arrangement to adjust belt tension.

VIII. Provide following facilities for the feeders.

a) Spraying water inside the casing

b) Providing purge air to the feeder

IX. 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.

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

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

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

10.5. Coal Pulverizers

I. Pulverizer Type:

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 each Steam Generator shall confirm to following stipulations:

Sl.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, (660 MW unit load) worst coal firing	Two
b)	At 100% BMCR worst coal firing	One
c)	At 100% BMCR design coal firing	Two

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 typr/model) complying with requirement at clause 10.5 above	80% of 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	Minimum Possible
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 preferred.

III. Classifier design

a) The classifier design shall be of static type and shall be capable of maintaining rated conditions of fineness under all conditions of operation, load changes and specified fuels. Further, the classifier vanes shall be adjustable externally and shall be lined with suitable wear resistant material to ensure the guaranteed wear life.

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

c) The classifier shall ensure improvement in quality of fineness and ensure uniform sizing and distribution of particles at all loads and with all types of blending as specified.

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

IV. Ensure adequate vibration isolation of mills so that no adverse affects 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 42 degree Celsius, relative humidity of 88% 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 preferably be located at ground floor.

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.

Sl.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
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.) The material shall be insert type sinter case rolls of hardness 59-66 HRC.
4.	Minimum difference in Hardness of rings/rolls	100 BHN

	and race.	

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:

Sl.No.	ITEM	MINIMUM LIFE IN EQUIVALENT HOURS
a)	Seals	20000
b)	Grinding elements (Rolls and Rings/Race)	12000[See note (a) below]
c)	Mill discharge valves	15000
d)	Classifier cone and other items lined with Ceramic material	25000
e)	Classifier vane	25000

Note:

a) The expected wear life of mill grinding elements (Rolls and Rings/Race) in equivalent hours, under conditions stipulated above shall be atleast12000 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 Employer's approval.

XV. Ensure that flap in the power 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 4:1.

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

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

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

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

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

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

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

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 Employer) 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.

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.

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 PF pipes shall be increased by at least 25% to arrive at the design load, to take care of the shock loading occurring in the pipe work under abnormal conditions of operation.

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 PF 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 manual operation mechanism in addition to its normal actuator 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 2:1 (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 Nox emission (fuel as well as thermal NOx) shall not exceed 260 gms /Giga Joule of heat input of the boiler.

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 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.

10.8. PRIMARY AIR FANS

I. Fan Design

a)	**Fan Design**	
b)	Type of Fan	Two stage, constant speed, variable pitch, axial type / Radial type with variable speed
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. – 42 degree Celsius & RH 88%.
4. Air-heater leakage of 15% 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. – 42 degree Celsius & RH 88%
4. Air-heater air-in-leakage of 15% or guaranteed whichever is higher.
5. All mills including standby mill shall be in service.

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 (660 MW load) operating point of fan.

IV. Fan control System:

a) Fan flow control

i. By Blade pitch control for axial fans or VFD for Radial fans.

ii. The final control element shall be electrically operated.

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

b) The system shall be designed to achieve:

1. Stable and satisfactory operation
2. Primary air flow control
3. Primary air pressure control

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

b) The fan design shall be overhung type for Axial Fan or Simply Supproted for Radial fan.

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

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

e) 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.

f) The fan suction shall be so located that it does not suck-in dirty air and shall be subject to Employer'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 Contractor 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. In addition sump lubrication with ring shall also be provided.

d) Two nos. Duplex RTD, (100 ohm at 0 deg.) and temperature indicators shall be provided for local and remote monitoring of each bearing metal temperature of fans for each bearing.

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 then 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.

XI. Fan Vibration Monitoring

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

11.0. FUEL OIL SYSTEM

11.1. GENERAL

(HFO/LSHS/HPS) and HSD firing requirements of Steam Generators and Auxiliary Boiler, as per characteristics specified in subsequent chapter. Refer Chapter-1, Section-1, clause 1.19 (I) & (II) for proposed future installation of third unit.

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 Heavy fuel oil (HFO/LSHS/HPS) firing system and HSD firing system.

a) Heavy Fuel Oil Firing System

Heavy Fuel Oils shall be used for initial start-up, low load operation and as secondary fuels for pulverized coal flame stabilization at the startups/low load operation. The fuel oil shall be drawn from HFO storage tank(s) by fuel oil pressurizing pumps and pumped through steam oil heaters. The oil shall be taken in Steam Generator unit(s) and recirculated back to the storage tank(s) through oil coolers. The oil requirement of oil burners of the Steam Generator shall be tapped off from a ring main formed at the respective Steam Generator area. The oil pressure shall be maintained to the required value in the pressure main by means of automatic pressure regulating valve(s). Oil temperature shall be controlled by regulating steam flow to fuel oil heaters. All facilities required for functioning of fuel oil supply to the burners under certain operating conditions etc. shall be incorporated in the design. For each Steam Generator between pressure oil line and return oil line an interconnecting line shall be provided with automatic control system to maintain the pressure of the oil to the Steam Generator at a predetermined value. Electric tracing shall be provided for HFO supply & return piping. Fuel oil tank with steam tracing facility in tank shall be provided by bidder.

b) HSD Firing System

The HSD firing system shall be provided to facilitate 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.) HSD firing system shall also be used for cold start up of Steam Generators, generation of auxiliary steam using auxiliary boiler and for flushing of heavy fuel oil lines. Basic scheme for light oil system shall be the same as that discussed above for heavy fuel oil system, except that there shall not be any heating requirements. HSD system including pumps, piping, valves etc. shall be sized to facilitate simultaneous cold/black start.

c) Fuel Oil Drain System

The fuel oil drains from different equipments and piping etc. of a Steam Generator shall be brought by gravity to a common drain oil tank provided for each steam generator. 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 and pumped to Fuel Oil Storage Tanks

d) Fuel Oil Condensate system

Condensate from complete fuel oil plant shall be brought to a common condensate flash tank in fuel oil unloading area. Drains from this condensate tank shall be connected to station drains.

11.3. Fuel Oil Preparation and Firing System

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

	Description	**Heavy Oil Firing**	**HSD Firing**
a)	Purpose of fuel oil firing	Initial start up, Coal flame stabilization at start up/low load,	To facilitate black start of unit, when no auxiliary steam is available from
b)	Type of fuel oil	Heavy fuel oils (HFO/HPS/LSHS- As per Characteristics given in subsequent chapter)	HSD (As per characteristics given in subsequent chapter)
c)	Oil firing system capacity	To cater to 30% BMCR requirements of Steam Generators without any coal firing	To cater to 7.5% BMCR requirements of Steam Generators without any coal firing
d)	No. of independent oil firing streams	1 (catering to requirements of steam generator)	1 (catering to requirements of steam generator)

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

III. The heavy fuel oil firing system shall have following design features:

a) Electric tracing for all lines.

b) No cooled legs in heavy fuel oil supply/recirculation piping.

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

d) For all in line items on fuel oil lines like pumps, heaters, flow meters, filters, control valves etc, required to be taken out for maintenance, provided following on both upstream and downstream sides:
   i. Single isolation valves up to suction of pressurizing pumps.
   ii. Double isolation valves from discharge onwards of pressurizing pumps.

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

f) Facility for flushing of complete system handling Heavy Fuel Oil by HSD.

g) All steam and condensate traps and drains shall be brought to one place.

h) Steam flushing points with isolation valves (for HSD system also) for cleaning during commissioning.

IV. Design/Sizing of various pump shall be based on following Criteria

	Design Criteria	**Requirement**			
		HFO pumps	**HSD pumps**	**Drain pumps**	**Sump pumps**
1.	Type of fuel oil to be handled	HFO/HPS	HSD	HFO/HPS	Oil and Water
2.	Pump Suction Temperature	Oil pour point temperature	Ambient	Oil pour point temperature	Ambient
3.	Max. Temperature of fuel oil to be handled	90°C	Atmospheric	90°C	50-85°C
4.	Pump design / construction code	Hi Standard, ASTM, ASME or equivalent (subject to Employer's approval)			
5.	No. of pumps	3 (2working+ 1standby)	3 (2working+ 1standby)	3	2 (1working+ 1standby)
6.	Capacity of each pump	To cater to 30% BMCR requirements of steam generator without coal firing plus 10%	To cater to 7.5% BMCR requirements of steam generator without coal firing plus 10%	$4M^3$/hr	$10M^3$/hr
7.	Pump suction head	Considering zero tank level	Considering zero tank level	Considering zero tank level	---
8.	Pump discharge head	To suit the requirements of burners	To suit the requirements of burners	25 MLC (minimum) or as required to pump oil from drain to main oil storage tank @ 4m3/hr, whichever is higher	50 MLC (minimum)or suiting site requirements whichever is higher

V. Construction of fuel oil pressuring pumps, HSD 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.
4.	Materials	

a)	Casing	Close grained Cast Iron
b)	Shaft	Carbon steel
5.	Type of bearings	Antifriction

VI. Design/Construction of Heavy Fuel Oil Heaters shall conform to following:

1.	Type and No. of heaters	3 (Three), shell and tube type, with oil through tubes (oil through shell is also acceptable).
2.	Capacity of each heaters	To suit the rated capacity of each heavy fuel oil pressurizing pump.
3.	Heater inlet fuel oil temp. (considered for sizing)	30°C
4.	Heater outlet temp.	To suit the viscosity requirements at the fuel oil burner tips for the grade of oil (HPS/HFO/LSHS) used
5.	Metal temperature of heater heat transfer surface	210 deg C(Maximum)
6.	Heater Design/ Construction Standards	TEMA, ASME Boiler and pressure normal code, HEI, USA. Pipe connections to heater as per TEMA class C BEV type.
7.	Heater Tubes	Seamless

VII. Filters

a) Following filters shall be provided in the HFO line:
   (i) Coarse filters at each pressurizing pump suction
   (ii) Fine filter at each oil heater outlet in fuel oil pump house.
   (iii) 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.

VIII. Trip and Nozzle Valves

1. Heavy Fuel oil and light oil 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

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

IX. Oil Burners/Burner Components

a) Type - Steam atomized, to be able to operate together with pumping and heating system offered.

b) Burner tips shall be provided as per following table:

SL.NO.	Description	HFO Firing System	HSD Firing System
i.	Type of burner	Steam atomized	Air atomized (terminal point)
ii.	Burner cooling medium	Steam or air	Air
iii.	Burner tip material	Resistant to corrosion due to fuel oils containing sodium, vanadium, sulphur, chloride etc.	Resistant to corrosion due to oil containing sodium, vanadium, sulphur, chloride etc.
iv.	Minimum life of burner tips, before needing any maintenance / replacements	16000 hrs	16000 hrs
v.	Hardness of atomizer (The hardness to be retained even at 400°C)	Minimum vickers hardness number of 400	Minimum vickers hardness number of 400
vi.	Type of oil igniters	High Energy Arc Igniters*	High Energy Arc Igniters*
vii.	Oil burner turndown	4:1	4:1
* If Contractor can not guarantee reliable performance of these, then Light Diesel Oil (properties in subsequent chapter) ignition system shall be offered. In such case all equipment / accessories like pumps, piping valves, fittings, controls/instrumentation etc. as for Heavy Oil System shall be provided to make light fuel oil igniter system complete.			

X. 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) Tube bundles of HFO heaters of removable design.

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

e) 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.

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

a) Facilities for Auto start of standby Heavy Fuel Oil//HSD 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.

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

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

b) Adequate potential free contacts for status of individual pumps

11.4. Fuel oil drain & condensate system

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

S.No	Description	Drain Oil Tank	Condensate Flash Tank
1.	Medium to be Stored	Oil (HPS/LSHS/HFO/LD	Heavy Fuel Condensate water/Flash steam
2.	No. of tanks	One for each Steam generator in SG area and one in FO pressurizing pump house area	One (1) in the FO pressurizing pump house area.
3.	Tank capacity	$6m^3$ in SG area and $10m^3$ in FO pressurizing pump house area	$6m^3$
4.	Dimensions	Bidder to specify	Bidder to specify
5.	Design and construction code	IS:800	IS:2825 Class-II or equivalent
6.	Design temperature	120 deg.C (min)	215 deg.C (min.)
7.	Tank design pressure	-	3.5 Kg/cm^2 (gauge)
8.	Type of construction	Rectangular	Vertical cylindrical with dished ends
9.	Material of Construction	As per IS:2062 plates	As per IS:2002

S.No	Description	Drain Oil Tank	Condensate Flash Tank
			(grade2A Plate)
10.	Corrosion allowance in tank thickness	1.8 mm	1.8 mm
11.	Insulation	Required	Required
12.	Nominal Venting capacity	-	Vent pipe of 250Nb and 3.5 m height.
13.	Heater tube material	50 NB steel tubes as per IS1239 (Heavy grade or ASTM 106 Gr. B)	-
14.	Painting & Protective coating	As per mentioned in the spec	
15.	Tank design, fabrication, erection, commissioning and testing	-	Testing as per IS:2825

Steam coil heaters shall be provided at the bottom of drain oil tanks to maintain the oil temperature to facilitate its pumping. The heaters shall be sized considering ambient air temperature of 6 degree Celsius. Total heating surface of heaters shall not be less than 8 m² per drain oil tank. Steam for the heaters shall be drawn from the contractor's auxiliary steam supply system.

II. Piping fitting and valves in fuel oil (HFO & HSD) firing system:-

a) The Piping in fuel oil (HFO & HSD) firing shall confirm to following codes:

	Piping	Code
1.	Steam and condensate piping below 20 Kg/cm² pressure	IS 1239 (Heavy Duty) or ASTM-A- 106 Gr. B or approval equivalent.
2.	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).
3.	Piping/Valve sizing	**HEAVY OIL:** All piping system shall be sized to meet the fuel oil requirements of 1 (one) number Steam Generator operating simultaneously at 30% BMCR load. **LIGHT OIL:** All HSD piping system shall be sized to meet the fuel oil requirements of 1 (one) numbers Steam Generator operating simultaneously at 7.5% 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 Iron
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.

e) Fuel oil coolers

One no. of HFO cooler of adequate size along with its 100% bypass per unit on the heavy fuel oil return line shall be provided for cooling of the return oil to the temperature of oil in the fuel oil storage tanks, complete with all connecting pipings, valves, supports etc. for HFO oil as well as cooling water. The cooler shall be located in the FO pressurizing pump house area.

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

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

SL.NO.	Description	FD Fans	ID Fans
1.	Type of fans	Constant speed, axial type	Variable speed radial/ 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 occurring together	Each fan to be sized for 60% BMCR load (one stream in operation) calculated taking into account following factors 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	42°C with 88% relative humidity	Gas temperature corresponding to 42°C ambient temperature and 88% relative humidity
e)	Air-heater air-in-leakage	Min. 10% of flue gas flow entering APH, or actual guaranteed whichever is higher	Based on min. 15% leakage from primary air and 10% leakage from seconday sir or actual guaranteed value, whichever is higher
f)	Pressure drop through ESP	Not applicable	25 mm WC
g)	Air in leakage	Not applicable	1% of ESP inlet gas flow

SL.NO.	Description	FD Fans	ID Fans
			& 2% through ducts
h)	Pressure required at chimney inlet	Not applicable	+ 10 mm WC

12.2.
b.

SL.NO.	Description	FD Fans	ID Fans
The fans shall also fulfill following sizing criteria in addition to those mentioned at SN 12.1 above Each fan to be sized for 50% BMCR flow calculated taking into following conditions occurring together.			
1.	Margin over 100% BMCR flow	20%	20%
2.	Margin over 100% BMCR pressure requirement	44%	44%
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	42°C and 88%	150°C or actual gas temperature corresponding to 42°C ambient and 88% relative humidity, whichever is higher
6.	Air-heater air-in-leakage	Min. 10% of flue gas flow entering APH, or actual guaranteed whichever is higher	Based on min. 15% leakage from primary air and 10% leakage from seconday sir or actual guaranteed value, whichever is higher
7.	Power supply frequency	50 Hz	50 Hz
8.	Pressure drop through ESP	Not applicable	25 mm WC
9.	Air in leakage	Not applicable	1% of ESP inlet gas flow & 2% through ducts
10.	Pressure at chimney inlet	Not applicable	+10 mm WC
11.	Air & flue gas control	Blade Pitch Control	Variable frequency control for radial type fan and blade pitch control for axial type fans

Note to 12.1 & 12.2: ID/FD fan shall have a minimum stall margin of 10% over the Design duty points.

c. Both FD fans and both ID fans shall operate with highest possible efficiency which shall be nearly equal at the 100% TMCR (660 MW) and test block points.

12.3. 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.

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

SL.NO.	Description	FD Fans	ID Fans	
		(Axial type)	(Axial type)	(Radial type)
1.	Type of fan blades	Stream lined, aerofoil shaped section	Stream lined, aerofoil shaped section	Backward curved single thickness plate bladed type or aerofoil type
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	25mm (min.) thick blade plate provided with renewable liners of wear resistant material having minimum 10 mmthickness.
3.	Fan rotational speed	1500 rpm (max.)	600 rpm (max.)	600 rpm (max.)
4.	Air/Flue gas flow	Blade pitch control	Blade pitch control	VFD
5.	Fan critical speed	not less than 125% of fan maximum operating 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	To withstand torsional stresses three (3) times the normal full load motor torque at all speeds
7.	Fan casing material thickness	6.00 mm (min.)	Abrasion and wear resistant, high BHN steel having minimum 8.0mm thickness or 12mm mild steel with liner of thickness 10mm (min.)	Abrasion and wear resistant, high BHN steel having minimum 8.0mm thickness or 12mm mild steel with liner of thickness 10mm (min.)
8.	Fan Housing design	for shut off head of fan	for shut off head of fan	for shut off head of fan

*Note:

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

b) Although employer 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.

12.5. 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
d) Two number duplex Pt-RTD (100 ohm at 0 degree Celsius) and temperature indicator shall be provided for each bearing. Local as well as remote monitoring features shall be provided.

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

12.6. 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.

12.7. FD and ID fans shall meet following operational requirements.

	Description	**FD Fans**	**ID Fans**
a)	Mode of operation	**i.** two fans in parallel	**i.** two fans in parallel
		ii. one fan (one stream in operation)	**ii.** one fan (one stream in operation)
b)	Fan control system	i. capable of operating in automatic mode for all regimes of operation in a steady and stable manner	i. capable of operating in automatic mode for all regimes of operation in a steady and stable manner
		ii. The final control element shall not have 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.
c)	Vibration	For mounting of vibration monitoring pads/pickups, flat surfaces shall be provided both in X-Y directions, by the Contractor on the bearing housing.	Same as that for FD Fans.
d)	Bearing metal	shall be possible from remote as	shall be possible from

	temperature monitoring	well as locally, using atleast 2 nos. of duplex platinum RTD's per bearing(100 ohms at 0 deg.C)	remote as well as locally, using atleast 2 nos. of duplex platinum RTD's per bearing(100 ohms at 0 deg.C)

12.8. 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

12.9. Flow Measuring Devices

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

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

c) 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.

12.10. Fan Casing:

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

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

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

12.11. Drain Connection:

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

12.12. Fan Suction:

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

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

c) Location of FD fan suction hood shall prevent entry of dusty air into fan and shall be subject to Employer's approval.

12.13. 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 air velocity shall be 16 m/sec.
   ii. Maximum gas velocity shall be 13 m/sec except flue gas duct from ID fan out-let to chimney inlet.
   iii. Maximum Flue gas duct from ID fan out-let to chimney inlet shall be 15m/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. Air heater air in leakage 10% for secondary air and 15% for primary air or actual guaranteed whichever is higher.
   iv. Design ambient temperature of 27 degree Celsius and 72 % RH.

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

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 1350 kg/m3.

d) Expansion joint reaction.

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

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

f) The ductwork and its structure shall take into account loads due to future 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) Min. 6 mm thick steel plates for gas ducts.

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) Provision of wear resistance plates of special materials such as BORON & TITANIUM alloy in flue gas ducts at corners and direction changing areas (min 5 mm thick)

e) Duct stiffening shall be by means of rolled sections.

f) 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.

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 Employer'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 at clause no 21.00.00 of this chapter.

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 Employer 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.

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 Contractor.

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) Contractor 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.

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.

a. 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.

b) On each inlet and outlet to each ESP stream (there being at least four ESP streams, with eight inlets and outlets)

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

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

e) Before and after each of the Regenerative Air Pre-Heater.

f) At discharge of each of PA and FD fans.

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

II. Heavy Duty multi louver dampers shall be provided at locations not requiring tight shut off duty.

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 each air preheater outlet on flue gas path

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

a) Guillotine Gate Type at locations Cl. no. 30.2 (1) (a), (b), (c), (d) and (f). Also at location (g) if economizer bypass duct is provided.

b) Double multilouver type at location Cl. no. 30.2 (e)

V. Damper Gas Tightness

The dampers at mentioned at Clause No. 12.2 (IV) (A) above shall have a guaranteed gas tightness efficiency (on flow) of not less than 99.95% 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.

VI. Pressurization Fans (if applicable)

a) All dampers/gates at ID Fan discharge, primary and secondary APH outlets on air side, APH inlets on flue gas side and in hot air ducts to mill inlet shall be provided with 2x100% pressurization fans to achieve 100% sealing efficiency.

As an alternate offer, the above dampers can be provided with a sealing air from cold air bus duct suitably meeting the specification requirement of 100% sealing. The Bidder shall furnish the applicable rebate for such alternate offer in the relevant Bid Proposal Sheets for Employer's review and acceptance.

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

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

XII. Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

XIII. Outlet dampers of seal air fans, scanner air fans and emergency dampers of scanner air shall be pneumatically operated, suitable for remote manual operation.

XIV. 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.

XV. 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 99.95% on flow without seal air, however with seal air it shall be 100%.

b) **Multilouver 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 Employer shall be provided on all damper blade shafts.

x. 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.

xi. The double multilouver type damper sealing efficiency shall be 99.5% on flow without seal air, however with seal air it shall be 100%

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.

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) Powered dampers shall have provision for manual operation during emergency/maintenance along with graduated local position indicator.

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.

14.1.1 In addition to the stipulations of as specified at clause no 33.1 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:

	VALVE	MINIMUM DISCHARGE CAPABILITIES
a)	Spring loaded safety valves	
i.	Separator & Superheater	Combined capacity105% 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. Other means of operation (Opening and Closing) for all valves shall be in line with control and monitoring philosophy specified under 'Control and Instrumentation'.

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

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

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

IV. 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
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 dBA

V. 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.

VI. 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.

VII. 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 14.02 (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.

VIII. 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 down stream 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.

IX. 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.

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

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

XII. Provide all required sampling points alongwith root valves including that for feed water at economizer inlet, separator drain, separator outlet steam pipes, superheated steam, reheated steam. 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 Employer. Sampling arrangement shall include valve, pipe work and the necessary connection. The cooling water shall be taken from the main cooling water system. Drain from sample coolers shall be terminated at basement floor level. Each steam and water terminal connection for vent, drain, instrument tapping point and sampling shall be equipped with two valves except the reheater inlet and outlet where single valve will be acceptable.

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

XIV. 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.

XV. 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	Long Rotary, Multiple nozzle, retractable type
c)	Air-preheaters	LRSB

a. Soot Blowing System shall be

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

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

c) The soot blowers shall be capable of selective operation in areas of ash deposition (SMART) type or equivalent.

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 Contractor.

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

e. Material of Construction

1.	Soot Blower Elements	Extra heavy seamless tubing from solid bars with heat, corrosion & erosion protection in permanent contact with hot gases
2.	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)

1. Shall be retractable even during emergencies such as :

   a) Drop in steam supply pressure,

   b) Low steam flow, etc.

2. 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), Contractor shall install additional soot blowers(s) along with proper approach and platform(s), as specified for other soot blowers, without any cost implication.

16.0 AUXILIARY STEAM PRESSURE REDUCING & DESUPERHEATING STATION

16.1 GENERAL

To meet the continuous and startup auxiliary steam requirements of the unit(s), 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/cm2 and cold reheat pressure inadequate, the low capacity PRDS shall be inoperative and the auxiliary steam requirements shall be catered only by the high capacity PRDS. The auxiliary steam systems of two (2) units shall be interconnected through the high temperature & low temperature auxiliary steam station headers. A branch connection alongwith isolating valve(s) and a blanking flange(s) shall also be provided for interconnection with the future units on both high and low temperature station headers. Output steam of the auxiliary boiler shall be connected to the low temperature station header.

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 Contractor 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 Employer'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) Boiler feed pump turbine

d) Deaerator pegging

e) Turbine gland sealing

f) As standby to low capacity PRDS station.

g) Capable of delivering at least 25 tonnes per hour steam to low temp. aux. steam station header.

h) For coal mill inerting (if required).

i) Bidder to consider for any other requirement.

I. 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.

II. 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.

III. 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.

Note: Bidder shall furnish unit rates for increase or decrease in auxiliary PRDS capacity with respect to the above.

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:

Sl.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. 17.5, 17.6 & 17.14. 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 client 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 (1.5 sq.m. minimum) shall also be provided for all damper actuators, valve actuators, safety valves, instrument source connection point, Y pieces, Expansion joints and other areas requiring access only monthly or annually. 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 Contractor 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 50 Sq m of platforms on each side) prior to commencement of maintenance/overhaul activities. Weight of maintenance cradle/quick erected scaffoldings shall be accounted in the structure and platform design.

b) APH Baskets

Platforms with proper approach near APH(s) for storage of at least 40 no's of APH baskets (minimum 50 Sq m of platforms for each set). Weight of stored APH baskets shall be accounted in the structure and platform design.

Note:

i. Weight of APH baskets indicated above shall be including the weight of elements.

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

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

17.13. 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 Employer to erect scaffolding, temporary ladders, platforms and safety nets to safely perform the work involved.

17.14. Access to all pent house cooling doors shall be provided through maintenance walkways.

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 18,000 m2 (clear of all intervening pipes, columns, actuators, instrument enclosures, racks etc. and excluding area covered by stairways)

Contractor shall furnish detail floor plan drawings covering all platforms and shall clearly indicate all the dimensions of platforms and clear platform floor area in each drawing.

18.0 ELEVATORS

18.1. Elevators shall be designed based on following criteria:

1.	Type of service	Two (2) no's passenger cum goods elevator per unit.
2.	Design/construction/ installation codes	a) Latest edition of IS:14655 (All parts) AND also meeting any additional requirements of IS:4666, IS:1860 and IS:3534
		b) Any other equivalent code, subject to Employer's approval
3.	Load carrying capacity	3000 kgs for passenger cum goods elevator
4.	Rated speed	0.55 meter/sec. for 3 Ton elevator
5.	Total Travel	As per Steam Generator supplier's recommendations subject to Employer'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 (ii) 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.) (Subject to Employer's approval after Award)	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
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

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 Cl. 37.1 (3) and shall have following additional features:

a)	Flooring of Cabin	Passenger cum goods elevator - 6 mm thick Checkered Plate flooring
b)	Passenger Elevator	Checkered Plate flooring with heavy timber underlay over steel sheeting, and replaceable felt spreading, total 25 mm thick
c)	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
d)	Car entrance and landing doors	As per BS:476 (Part 20 & 22)

e)	Door construction	Hollow metal construction from 16 guage thick steel sheet spray painted
f)	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.
g)	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 Electrical chapter

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 Employer'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 THERMAL INSULATION, LAGGING, CLADDING & REFRACTORIES

19.1 Thermal Insulation alongwith aluminum cladding shall be provided for all the equipments/surfaces (excluding coal pulverizers) having skin temperature more than 60degree Celsius, the insulation thickness shall be designed based on following criteria.

Sl.No.	Criteria	Requirement
1.	Ambient Temperature	45°C
2.	Surface velocity	0.25 m/sec.
3.	Emissivity of Aluminum	0.2
4.	Insulation surface temperature	60 °C. (max.)
5.	Thermal conductivity of insulation material	Not less than maximum values as per IS: 8183.
6.	Pipe/Equipment/Wall Temperature	Maximum fluid design temperature
7.	Overall heat transfer coefficient and insulation thickness	To be calculated as per ASTM-C- 680-89.

19.2 The minimum insulation thickness, however, shall not be less than 75 mm for Steam Generator surfaces and 25 mm for other surfaces. Also refer as specified at clause no 19.8 of this section. 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

19.3 Insulation material for all equipments, 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. (Hand made 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 (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	
	For use upto 400°C	100 Kg/m³
	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 19.3 (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

19.4 The Insulation mattress shall be rated incombustible when tested by the method prescribed in clause 15 of IS:3144 and shall meet the requirement of the Mercantile Marine department, Lloyd's Register of shipping, underwriter, fire hazards codes and other International standards.

19.5 In addition to requirements of as specified at clause no 19.2- of this chapter 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.

19.6 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 hrs.

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 temp.) of use.

19.7 The use of insulation of finishing materials containing asbestos in any form is not permitted.

19.8 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.

19.9 For pipe work having surface temperature above 60°C, the insulation material shall be provided conforming to the requirements indicated relevant clauses of this Specification.

19.10 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 as per following:

S.No.	Description	With Lightly bonded mattress	With preformed pipe sections
a)	For dia of insulated surfaces of 450 mm & above and for flat surfaces	(16 Swg)	
b)	For dia of insulated surfaces less than 450 mm	0.914 mm (20 Swg)	0.914 mm (20 Swg)
c)	For steam generator outer casing	16 SWG ribbed Aluminum	**-**

19.11 Binding and lacing wires shall be provided in line with following:

	Temperature	Range Material	Thickness wire
a)	Upto 400°C	Galvanized Steel	20 SWG
b)	Above 400°C	Stainless Steel	20 SWG

19.12

i. Straps and bends shall conform to materials as under:

Temperature Range	Material
Upto 400°C	Galvanized Steel
Above 400°C	Stainless Steel

ii. Bends shall be 20 mm wide and 0.6 mm thick
iii. For securing Aluminium sheathing material, stainless steel or anodized aluminium bends shall be used.

19.13 Screws shall be of galvanized steel, check headed self tapping type. Above 400°C temperature, screws shall be stainless steel.

19.14 Hexagonal wire mesh shall be conforming to following:

Temperature range	Material	Mesh size
Upto 400°C	Galvanized Steel	10-13 mm aperture 0.56mm diameter
Above 400°C	Stainless Steel	—do—

19.15 Non metallic components like 3 mm thick mill board, aluminium pigment sealent, white glass cloth, insulating cement, neoprene washer shall be provided.

19.16 APPLICATION OF INSULATION

I. 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 contractor shall check that all instrument tapping, clamps, lugs and other connections on the surface to be insulated have been installed properly.

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 temp. So as to form a smooth base for the application of cladding.

II. 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 atleast 150 mm and longitudinal joints shall be staggered by atleast 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 alongwith 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.

III. 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.

c) Flanges on lines having temperature upto and including 150 deg C shall not be insulated.

d) Union shall not be insulated.

e) Expansion joints, metallic or rubber, shall not be insulated unless otherwise specifically indicated.

f) Safety valves shall be insulated.

IV. Application on Steam Generator and other flat surfaces and equipments

Insulation to various areas shall be applied as under.

	Insulation Area	**Form of Insulation**
a)	SG surfaces, hot air & gas ducts	Mineral wool block Mineral wool blankets
b)	All other surfaces/not enclosed Calcium silicate block or as per (a) above by SG casing	

V. For the Steam Generator furnace, if provided with skin casing and the super heater, reheater and economizer casings where water cooled walls are involved, a first covering of refractory material shall be applied to the external tube surfaces before the application of any further heat resistant insulating material

VI. The access doors and inspection doors in the Steam Generator shall be lined with refractory material. The access doors in other portions of the Steam Generator shall be insulated in a similar manner corresponding to any casing, flue-ducts or air, ducts where such openings and access doors occur.

VII. 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 per as specified at clause no 19.11 of this chapter.

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.

VIII. Air & 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. Other requirements are same as given in as specified at clause no 19.10 of this section.

19.17 Application of Metal Cladding

a) All surfaces of Steam Generator, air heater, air & flue gas ducts, fuel oil and other tanks, pipe line etc. where thermal insulation has been applied shall be covered with Aluminum cladding of 16 or 20 SWG as applicable as per as specified at clause no 19.10 of this chapter above.

b) Weather proof flushing shall be installed where the panels intersect with columns and at other similar joints.

c) Removable insulated covers shall be provided over the manholes.

d) Cladding on top surface of Steam Generator and ductwork and equipments shall be suitably reinforced to prevent damage by personnel walking thereon.

e) All cladding for outdoor application shall be with neoprene washers.

f) All openings and joints in outdoor cladding for piping connections, supports of access shall be suitably flashed and weatherproofed. Where such flushing or weatherproofing can not effectively control the entry of moisture, then such openings and joints shall be weather-proofed by application of aluminum pigmented sealer.

g) All insulation shall be protected by means of an outer covering of aluminum 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 bitumastic paint.

h) All longitudinal joints shall have a minimum overlap of 50 mm and shall be located at 45 degree or more below the horizontal for horizontal equipment. Joints shall be made with cheese headed self tapping galvanized steel screws at 150 mm centers.

i) All circumferential joints shall have a minimum overlap of 100 mm and shall be held in position by stainless steel or anodized aluminum bands, stretched and clamped.

j) Removable box type cladding for valves and flanges shall be fitted on the connected pipe cladding, with bands.

k) Aluminum 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.

l) For bends, fittings etc. the cladding shall be provided in segments as to ensure a smooth finish of the cladding.

m) For cladding on vertical pipes/equipment, provision for load take up shall be made at every 2 to 4 meters along pipe/equipment axis.

n) All joints shall be sealed with acrylic emulsion weather barrier.

o) Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminum cladding with copper, copper alloys, tin, lead, nickel or nickel alloys including monel metal.

19.18 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 startup/shut down of Steam Generator.

II. The refractory material shall

a) Have high bulk density and minimum moisture content,
b) Be capable of withstanding service temperature of 1700 degree Celsius.
c) Be resistant to slagging products due to coal, and to impurities of oil like V_2O_5, Fe_2O_3, K_2O_2, Na_2O etc. and to erosion due to fly ash.
d) Be chemically inactive towards alkalis, iron, silica etc. shall pose no health hazard to working personnel, and shall not have any explosive properties.
e) Have sufficient strength to withstand forces generated in boiler, without any rupture or damage.

III. Application of refractory shall be such that:

a) To ensure perfect sealing, easy maintenance, minimum time for application.

b) To ensure minimum number of joints All the joints to be filled and tightly packed with loose powder of same material.

c) Selection of Refractory shall consider the applied stress, stress distribution and expansion allowance.

d) Refractories shall have good thermal cycling properties to ensure quick start up and shut down of Steam Generators.

19.19.1. Testing of Installation

All tests, as per the applicable material standards and as specified shall be carried out in accordance with the methods prescribed. Employer shall have the right to witness any or all of the tests conducted by the contractor at the shop or laboratory.

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.

20.0 PAINTING

Supply of paints including painting of all surfaces, equipment's and structures for Steam Generator shall be as per Volume II.

21.0 BLOW DOWN SYSTEM

I. The blow down system shall comprise of an atmospheric flash tank and drain receiving vessel, 2 x100% 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 21.0 (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.

22.0. 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.

23.0 TYPE TEST

23.2.1 Full scale type tests using actual equipment shall be conducted by the Contractor for the equipment mentioned in the subsequent clauses below:

23.2.2 Full range and full scale performance testing shall be conducted at shop on one number each 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)

23.2.3 The performance testing at shop shall be conducted using actual fans

23.2.4 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.

23.2.5 Following tests for Steam Generator Startup drain recirculation pump at shop on assemble unit:

a) NPSH test

b) Temperature rise test

c) Under voltage test

d) Quality assurance proof test

e) Tests to establish unit functioning of pump at temp. & pressure

f) Hot standstill and startup tests

23.2.6 Following tests on Coal Feeder

a) Explosion proof test at 50 psi as per NFPA codes

b) Degree of protection test as per relevant Indian or equivalent International Standards

c) Weighing accuracy, calibration and repeatability test at various speeds with coal flow.

23.2.7 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 Employer's Engineer.

23.2.8 The type tests shall be carried out in presence of the Employer's representative. Contractor shall inform the Employer about his readiness for conducting the type test and issue such notice to the Employer 30 days in advance, alongwith schedule of the type tests. The Contractor shall obtain the Employer's approval for the type test procedure before notifying the Employer about his readiness for conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be

used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

23.2.9 Irrespective of the requirement of conducting the type tests under this contract, the Contractor 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 client. The Employer reserves the right to waive conducting of any or all of the specified type tests under this contract, in which case the type test charges shall not be payable for the type tests waived by the Employer.

23.2.10 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.

CHAPTER – 1

SECTION – 3

1.00.00 **ELECTROSTATIC PRECIPITATORS (ESP)**

Bidder scope shall include supply of two (2) Electrostatic Precipitators complete in all respects with all components and accessories etc, one ESP for each of steam generator of 660 MW units. The characteristics of the coal, ash and other relevant design data are specified in the technical specification.

1.01.00 One ESP for each Steam Generator of 660 MW unit complete in all respects including all components and accessories stated in this section.

1.01.01 Each Electrostatic Precipitator serving one steam generator, shall have atleast four (4) numbers of independently operated passes (gas streams) housed in four (4) no's of 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.

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, 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 following models:

(a) Scale 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 .

(i) The Bidder shall develop three dimensional CFD model for the ESP along with its up stream and down stream 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.

(ii) Configured model for **"Tamil Nadu Generation & Distribution Corporation"** (2x660MW) ESPs and duct work along with the results

recommendation of the Computer modeling shall be supplied to the Owner on completion of the model testing .

1.01.08.1 Opacity monitors complete with all accessories at the outlet of each pass (gas stream) of ESP but upstream of the ID Fan i.e. four (4) no's per ESP serving one steam generator.

1.01.08.2 High voltage transformer- rectifier sets complete with bus sections, grounding switches, controls, leveling wheels, etc.

1.01.08.3 Insulators along with heating and ventilation system for insulator compartments complete with fans, heaters and necessary controls etc. to avoid moisture condensation.

1.01.08.4 Complete microprocessor based ESP control system one for ESPs serving one boiler including the intermittent changing TR set controllers, rapping systems controllers, communication controllers etc. The system provided shall be capable for integrated operation from UCB and shall be provided with compatible PC, printer, keyboard, CRTs etc. For control of all other ESP auxiliaries.

1.01.08.5 Drive motors and actuators, couplings and coupling guards for all rotating auxiliaries

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.

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 Furnishing of foundation loading data, anchor bolt plans, pocket details, embedments and inserts details etc in the form of input drawings to the Owner, for the Owner's engineering work.

1.01.16 Corrosion protection painting for structures as described in the specification.

1.01.17 Rain water drainage arrangement from Roof/penthouse of ESP.

1.01.18 Sheeting work for roof (pent house)/ canopy/ side cladding of ESP.

1.01.19 Placement of the embedments/ anchor bolts supplied by the Bidder, shall be done by the Owner. However the accuracy of the embedments/ anchor bolts in plan and elevation shall be checked and ensured by the Bidder during the placement of the same. Any modification required on these embedments/ anchor bolts subsequent to their placement shall be done by the Bidder.

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 each 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 HSD as well as HFO 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 a long 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 four (4) independently operating gas streams viz. each precipitator shall have four (4) 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 aquisition functions. The MMI may be suitably located in UCB.

2.00.0 **MODEL STUDY**

2.01.01 The Bidder shall perform model study (Physical scale modeling as well as CFD 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 IGCI 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 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.

Three(3) nos. of staircases (with two located towards boiler side while the other towards the chimney side in between ESP) 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 each ESP stream with the adjacent stream.

3.03.00 Each one of the streams of Electrostatic Precipitator shall be provided with isolation dampers at inlet and outlet for carrying out maintenance work on one stream while the other streams are in service, by completely isolating it electrically and grounding it. For this purpose, double isolation Guillotine dampers with intermediate venting may be used. Suitable safety interlocks etc. for ESP shall be provided and elaborated in the offer by Bidder.

3.04.00 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.

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

4.00.00 **GAS DISTRIBUTION SYSTEM**

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

5.03.00 The Bidder can offer plate spacing greater than 300 mm for the last two electrical fields (in the direction of gas flow), as per design requirements mentioned in ESP Sizing Criteria, 11.00.00 of this section.

6.00.00 **DISCHARGE ELECTRODES**

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

7.00.00 **RAPPING SYSTEM**

7.01.00 Independent rapping system shall be provided for discharge and collecting electrodes with control systems as per the requirement specified in Electrical Section. The rapping mechanism shall be of either electric impact type or tumbling hammer type. This shall

be adjustable in frequency, intensity (for electric impact type only) and duration (for tumbling hammer type) to provide an efficient cleaning rate. Separate rapping equipment, shall be provided for the discharge and collecting electrodes served by one T/R set so that each mechanism can be suitably adjusted when required. It shall be so arranged that the rapping frequency can be independently set from the control room in accordance with the operating requirements. The rapping frequency range shall be adjustable in wide range from 0 to a minimum of 24 hours, and this facility shall be such that it does not require any 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 4.33% 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 650 kg/m3 (maximum) for calculating storage capacity and 1350 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. 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. 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 deg .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 Each dust hopper shall be provided with a high level and a low level dust level monitor operating on proven Radiofrequency measurement principle. The level monitoring system shall incorporate all the necessary accessories including two nos. level switches per hopper (one for high and other for low level), each with 2 NO + 2 NC contacts, local and remote 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.

8.07.00 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. The exposed surfaces shall be self draining and seal welded to prevent ingress of moisture during monsoon.

9.03.00 The precipitator casing and its elements shall be designed to withstand a pressure ± 660 mmwc at 67% of yield strength and a temperature of 200°C. In case of any unscheduled outage of the air heater, the temperature of flue gas at inlet to ESP may rise to about 300°C. This temperature excursion may persist for about five (5) to thirty (30) minutes until preventive measures are taken. The precipitator and its elements shall be designed to withstand this temperature excursion without damage or increased maintenance. All the calculations shall be furnished to substantiate this. Adequate provision shall be made to accommodate thermal expansion and movements as required by the arrangement and operating conditions. The casing shall be gas tight. In order to prevent distortions, the structural design shall take care of unequal expansions. Care shall be exercised in the design and fabrication of the precipitators to reduce air in leakage to a minimum. All joints which do not require opening during maintenance and/ or inspection shall be seal welded.

9.04.00 The precipitator casing and hoppers shall form a common structure reinforced to withstand the wind load (in accordance with IS: 875), load due to dust storage in the hoppers etc.

9.05.00 The inlet of the precipitators shall be provided with suitable flanged connections with the flue gas ducting which shall be completely seal welded inside and outside after assembly.

9.06.00 Access door of quick opening type, shall be provided to allow entry to all sections of the precipitators for maintenance and access, the size of these doors shall not be less than 600 mm dia if circular or not less than 450 mm x 600 mm if rectangular. They shall be provided with safety chain and grounding strap. Doors shall be capable of being pad locked. Design shall be such as to eliminate air in leakage through the doors. All doors providing access to high voltage parts shall have warning signs permanently attached and marked "Danger High Voltage".

9.07.00 The precipitator shall be guided, anchored or supported by lubricated plates/roller bearings at such locations as may be required to limit precipitator, duct work or expansion joint forces or movement. Each casing shall be restrained to grow in a radial direction from the anchor point. In case lubricated plates are used these shall be covered under all conditions of precipitator movements by 1.6 mm, type 305 stainless steel plates.

9.08.00 The casing shall be gas tight. In order to prevent distortion, the structural design shall take care of unequal expansion.

10.00.00 **PENT HOUSE COVERING**

ESP's shall be provided with weather proof pent house. The pent house shall be covered continuously with sheet.

11.00.00 **ESP SIZING CRITERIA:**

The Electrostatic Precipitator (s) shall be designed to comply with the requirements stipulated under 'Guarantee point and design point' in the table below:

SL.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
1.	Boiler Load		660 MW TMCR	660 MW TMCR	660 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 72%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#.	m3/sec	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
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
6.1	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
6.2	ESP dust collection efficiency	%	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
6.3	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
7.0	Inlet Dust Burden # (Considering maximum Fly Ash)	gms/Nm^3	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify	Vendor to specify
8.1	ESP Dust Collection loading at outlet, when all fields of each pass in	mg/Nm^3	<40mg/Nm^3	<35mg/Nm^3	<45mg/Nm^3	<45mg/Nm^3	<40mg/Nm^3	<50mg/Nm^3

SL.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
	service							
8.2	Minimum specific collection area	$m^2/m^3/$ sec	240	240	240	240	240	240
9.	Maximum flue gas velocity through the ESP	m/sec	<1	<1	<1	<1	<1	<1
10.	Treatment time of the flue gases	Sec.	Minimum Twenty (20)					
11.	Other Design Parameters							
a)	Minimum Aspect Ratio		2	2	2	2	2	2
b)	Design internal pressure at 67% yield strength	mmwc	$\pm$660	$\pm$ 660	$\pm$ 660	$\pm$660	$\pm$ 660	$\pm$ 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
e)	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)
f)	Maximum collection area	m^2	Vender to	Vender to	Vender to	Vender to	Vender to	Vender to

SL.NO.	ITEMS	UNIT	GAURANTEE POINT					DESIGN POINT
	served by one T/R set		specify	specify	specify	specify	specify	specify
g)	Minimum no. of bus sections per T/R set		One (1)	One (1)	One (1)	One (1)	One (1)	One (1)
h)	Minimum dust hopper storage capacity each (upto the maximum trip level based on design point conditions (while firing range of coal(with maximum ash)	hours	Eight (8)	Eight (8)	Eight (8)	Eight (8)	Eight (8)	Eight (8)
i)	Minimum hopper valley angle to the horizontal	degrees	Sixty (60)	Sixty (60)	Sixty (60)	Sixty (60)	Sixty (60)	Sixty (60)
j)	Spacing between the collecting electrodes (Centre line to centre line) transverse to the gas flow *	mm	300	300	300	300	300	300
k)	Minimum installed corona power per unit effective collection area **	Watts/m^2						
l)	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:

* 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.

** 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.

The marked value are only the anticipated figure. Bidder may opt for their best engineering practice based upon approval from owner/Authorized representative.

- Nm^3: calculated at NTP.
- Discharge side of ESP shall be suitable for either of the two (2) ID Fans
- ESP shall be suitable for Tri-sector type Air preheater.
- ESP auxiliary power consumption shall be included in Liquidated Damages (L.D) for total auxiliary power consumption.
- Space provision for one no. dummy field in downstream side of ESP shall be provided

CHATER-1

SECTION - 4

PERFORMANCE GUARANTEE TEST FOR BOILER

FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE AND PERFORMANCE GUARANTEE TESTS

1.00 General

1.01 The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

1.02 The term “BMCR” (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of Steam Generator (as guaranteed) at superheater outlet at rated parameters.

2.00 PERFORMANCE GUARANTEES / PERFORMANCE TESTS

2.**01 General Requirements**

I. The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

II. The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

III. The Contractor shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III. The various tests which are to be carried out during performance guarantee tests are listed in this chapter. The guarantee tests shall be conducted by the Contractor at site in presence of Employer.

IV. All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

V. The performance tests shall be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall be used only for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

VI. It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.

VII. **Test Instrumentation, Flow Measurement and their Calibration**

All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these

instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation required for performance tests shall be supplied by the Contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.

The Performance test shall be carried out as per the agreed procedure. The detailed PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 90 days from the date of Notification of Award.

VIII. The P&G test procedures shall be submitted for equipments/ system & subsystem under Contractor's scope for all Guarantees under category I, II & III as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

IX. The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following:

(a) Object of the test
(b) Various guaranteed parameters & tests as per contract.
(c) Method of conductance of test and test code.
(d) Duration of test, frequency of readings & number of test runs.
(e) Method of calculation.
(f) Correction calculations & curves.
(g) Instrument list consisting of range, accuracy, least count, and location of instruments.
(h) Scheme showing measuring points.
(i) Sample calculation
(j) Acceptance criteria.
(k) Any other information required for conducting the test.

The Performance test shall be carried out as per the agreed procedure.

X. **Test Reports**

After the conductance of Performance test, the Contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Employer after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to Employer for approval.

XI. The performance guarantee test will be carried out within three months after the successful completion of Initial Operation of facilities or as per the time frame specified for a particular equipment/ plant/ system in the Technical specifications. Delay in conductance of the test beyond this period will not be normally permitted by the EMPLOYER. In the event of EMPLOYER agreeing to conductance of such tests after three months, for reasons not attributable to the EMPLOYER, as

assessed by the Employer, no factor for ageing shall be considered for computing performance of the equipment.

Performance Guarantee Tests on the equipments/systems not covered in this Sub-section shall be carried out as per the procedure/test codes specified.

XII. In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met by the contractor even after modification and/or replacement but are achieved within the Acceptable Shortfall Limit as specified at clause 3.00 of this chapter, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 3.00 of this chapter. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following (at Employer's discretion):

(i) **For Category-I Guarantees**

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Liquidated Damages.

(ii) **For Category-II Guarantees**

Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

(iii) **For Category-III Guarantees**

Reject the equipment /system / plant and recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Employer. Such damages shall, however be limited to the cost of replacement of the equipment(s)/system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as "Category-III" Guarantees.

3.00 **AMOUNT OF LIQUIDATED DAMAGES (LD) APPLICABLE FOR CATEGORY-I GUARANTEES**

Refer Volume-I

4.00 **SPECIFIC AND LIMITING REQUIREMENTS FOR STEAM GENERATOR EFFICIENCY**

4.01 Guaranteed Steam generator efficiency shall be calculated as per the requirements of BS EN 12952-15:2003 (by loss method) and as per stipulations of Clause 9.00 of this chapter.

4.02 The guaranteed efficiency quoted by the Bidder shall comply with following limiting parameters with design coal firing:

a)	Excess air at economizer outlet at 100% TMCR load)	20% (min.)
b)	Corrected flue gas temperature at air preheater outlet (at 100% TMCR)	125 degree C or as predicted by the Bidder whichever is higher

Bidder/Contractor to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions/ guarantees etc. if the values considered by the Bidder/Contractor for parameters indicated at a), b) & c) above are lower than those specified above.

4.03 For the purposes of guarantees the ambient air temperature and relative humidity shall be taken as 27 degree Celsius and 72% respectively.

a. Unless otherwise specified, the guarantees shall be based on design coal firing with coal/ ash analysis as given in subsequent chapter.

5.00 AUXILIARY POWER CONSUMPTION (PA)

The unit auxiliary power consumption shall be calculated using the following relationship.
Pa = Pu + TL
Pa = Guaranteed Auxiliary Power Consumption.
Pu = Power consumed by the auxiliaries of the unit under test.
TL = Losses of the transformers supplied by bidder based on works test reports.
While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating auxiliaries under this package. The auxiliaries to be considered shall include but not be limited to the following:

UNIT AUXILIARIES (to be considered for calculating Pu) – Refer Volume I

6.00 GUARANTEES UNDER CATEGORY-I

6.01 **The Performance Guarantees which attract Liquidated Damages (LD) are as follows:**

i. Efficiency of the Steam Generator at 100% TMCR (660 MW unit load) with 27 degree Celsius ambient temperature and 72% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air. (To be demonstrated as per clause 9.00 of this chapter). The guaranteed efficiency shall be based on Heat Input GCV of coal.

ii. **Auxiliary Power Consumption**

Auxiliary Power Consumption at 100% TMCR (each 660 MW) unit load. The total auxiliary power consumption for all the steam generator auxiliaries, Equipment cooling water pumps, Mill Reject Handling system, compressed air system etc. required for continuous unit operation at 100% TMCR (660 MW unit load) under rated steam conditions and with ambient air temperature of 27 degree Celsius & RH of 72%, shall be guaranteed in line with the requirements stipulated in clause 5.00 of this chapter.

iii. ESP Efficiency

The Bidder shall guarantee that ESP efficiency at TMCR condition while firing design coal with all fields in each stream at 660 MW. (To be conducted as per the stipulation of cl. no. 11.00 of this section).

Note:

Power consumption of each of the pump/fan/compressors/coal pulverizer /heater etc. wherever mentioned shall be measured with its own drive.

7.00 GUARANTEES UNDER CATEGORY-II

7.01 **The Performance Guarantees, conformance to which are mandatory are as follows:**

NOx emission

Contractor shall guarantee that maximum total NOx emission from the unit shall not be more than 260 grams of NOx (from thermal as well as fuel) per giga joule of heat input to the boiler during the entire operating range of steam generator for the range of coals specified.
The emission shall be measured during steam generating capacity test. The bidder shall furnish the methodology of measurement and demonstration of variations w.r.t. load upto 50% of total load.

ESP Air in Leakage

Bidder shall guarantee that ESP air in leakage shall be limited to 1 % of the total gas flow under guarantee point conditions.

Pressure Drop Across ESP

Bidder shall guarantee that the maximum flue gas pressure drop across the ESP under specified guarantee point conditions shall not exceed 20 mm WC for base offer ESP

8.00 GUARANTEES UNDER CATEGORY-III

The parameters/capabilities to be demonstrated for various systems/ equipments shall include but not be limited to the following:

8.01 Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency.
The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment/machine, furnished & installed under these specification, expressed in decibels to a reference of .0002 microbar shall not exceed 85 dba except for –

- Safety valves & associated vent pipes for which it shall not exceed 105 dba.
- Regulating drain valves in which it shall be limited to 90 dba.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A – weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar, shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

8.02 STEAM GENERATOR AND AUXILIARIES

(i) **Coal Pulverizer capacity at rated fineness**

Performance testing shall be conducted on coal pulverizers toward establishing their guaranteed capacity meeting the specification requirement. Corrections may be applied for the variation in coal characteristics i.e. HGI & Total Moisture of test coal with respect to specified design coal.

Capacity demonstration test shall be carried out for the following conditions:

(a) The Contractor shall demonstrate capacity output on one coal pulverizer (of Employer's choice) of each Steam Generator for establishing its capacity at 100% mill loading, at rated pulverized coal fineness with specified design coal with new set of grinding elements.

(b) Further, Contractor shall also demonstrate capacity output on four coal pulverizers (of Employer's choice) of each Steam Generator, not less than the 90% of guaranteed value of (a) above, at 100% mill loading with the originally installed grinding elements in nearly worn-out condition or at the end of guaranteed wear life of grinding elements, whichever is earlier.

Capacity test as mentioned at a & b above shall be demonstrated at the following conditions occurring simultaneously during testing:

Rated pulverised coal fineness	(a) not less than 70% through 200 mesh and (b) not less than 99% through 50 mesh screen
Test Coal	Any available coal from the specified range

In case the Contractor successfully demonstrates the guaranteed capacity of coal pulverizers as stated above, remaining coal pulverizers of corresponding steam generator will also be considered to have successfully met the above

capacity guarantee requirement. However, in the event of any of the coal pulverizers not meeting the guarantee test, all the coal pulverizers of corresponding steam generator will have to be tested by the contractor to demonstrate guaranteed capacity.

During the demonstration of the pulverizer capacity output, manufacturer's operating instructions will be followed and pulverizer will be operated with the specified range of coals without any such readjustment that requires a shutdown of the pulverizer or reduction of the load and/or any replacement of any pulverizer wear parts. For the purpose of testing to demonstrate the capacity, if HGI (grindability) and total moisture vary from those given in coal characteristics, the above pulverizer measured capacity shall be corrected using the capacity correction curves furnished by the Contractor and approved by the Employer. HGI versus coal pulverizer capacity curve shall be furnished for HGI variation upto a value above which the capacity remain constant.

(ii) **No fuel oil support shall be required above 30% BMCR**

Contractor shall guarantee that oil support for flame stabilization shall not be required beyond 30% of BMCR load when firing the coals from the range identified. The Contractor shall demonstrate that with any combination of mills/ adjacent mills in service (to Employer's choice) the Steam Generator does not require any oil firing for stable and efficient boiler operation at and above 30% BMCR loads.

(iii) **Run back capabilities**

The contractor shall demonstrate automatic runback capability of the unit (boiler turbine- generator) on loss of critical auxiliary equipment (such as tripping of one ID fan/ FD fan/PA fan/ airheater / BFP/ CEP etc.) ensuring smooth and stable runback operation.

(iv) **Rate of change of load and sudden load change withstand capability**

The contractor shall demonstrate capability of boiler-turbine-generator in regards to ramp rate and step load change as specified.

(v) **Furnace Exit Gas Temperature (FEGT**)

The contractor shall conduct a comprehensive thermal performance test (TPT) on one unit only, by indirect method.
Such test should demonstrate that FEGT does not exceed the specified max. temperature limit.

(vi) Steam Temperature Imbalance

The Contractor shall demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10 deg C under all loads including transients.

(vii) Air Preheater air in leakage

Contractor shall demonstrate that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed or specified value (whichever is lower) of Technical specifications. Above requirement needs to be complied with recirculation of flue gas from downstream of ESP.

(viii) Reheater & Superheater attemperation spray water flow

The following shall be guaranteed and tested:

Reheater Spray flow while firing design coal and maintaining rated RH outlet steam temperature at 100% TMCR (660 MW unit load).

It shall be demonstrated that the spray water flow of SH attemperation system does not exceed 8% of main steam flow, at superheater outlet, while firing any coal from the range specified with HP heaters in service while maintaining the rated SH outlet steam temperature at all loads upto and including BMCR.

It shall also be demonstrated that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions (100% TMCR)

(ix) **Coal Mill Wear Parts Warranty**

Life of coal pulveriser wear parts, in hours of operation, for the entire range of coal characteristics specified. (To be demonstrated as per clause 10.00 of this chapter).

8.03 **Power Cycle Piping**

Actual hanger readings under cold and hot condition (at rated parameters) to match with those of design cold and hot hanger readings for MS/CRH/HRH/HP & LP bypass piping system

.

8.04 **Passenger & Goods Elevator:**

Over load tests, travel and hoist speed checks.

8.05 **Mill Reject System**

Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system.

8.06 **Equipment Cooling Water System**

(i) Capacity, head & power consumption of all the pumps with the respective job (own) motors to be demonstrated at shop. For the pumps which are included under "Unit Auxiliaries for calculation of Pu" as defined elsewhere the power consumption value (at rated duty point) during shop testing shall be considered for computation.

(ii) Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site

(iii) Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

8.07 **Air Compressors and Air drying Plant**

(i) Parallel operation of air compressor shall be demonstrated at site.

(ii) Pressure drop across Air Drying Plant, Capacity and outlet dew point of each air

drying plant shall be demonstrated at site.

(iii) Vibration level and noise level of each air compressor, blowers and any other rotating equipments of each air drying plant shall be demonstrated at site.

9.00 MAJOR REQUIREMNTS/ METHOD OF STEAM GENERATOR EFFICIENCY TESTS

i.	**Test Code**	**As per PTC 4**
ii.	**Test Loads**	105% TMCR (VWO unit Load) 100% TMCR (660 MW unit Load)
iii.	**Test Conditions**	Boiler operating with rated excess air, coal fineness and firing design coal.
iv.	**Ambient air condition**	27 degree Celsius temperature (Dry bulb) and 72%relative humidity. The reference air temperature for the efficiency guarantee/ testing shall be taken as the temperature of air (i.e. 27 degree Celsius) entering PA and FD fans.
v.	**No. of readings**	Two sets of consistent readings for each of test loads. Average of the test efficiencies based on above two readings for each load shall be considered for guaranteed efficiency.
vi.	**Measurement and computation of heat losses will include but not be limited to the following: As Per PTC 4**	
vii.	The guaranteed steam generator efficiency shall be without any heat credit.	
viii.	The Steam Generator efficiency shall be guaranteed based on ambient air temperature of 27 degree Celsius and relative humidity of 72%.	
ix.	Correction to tested efficiency shall be applicable for variation in following parameter only :	
a)	Ambient air temperature.	
b)	Relative humidity of ambient air.	
c)	Hydrogen in coal.	
d)	Moisture in coal.	
e)	GCV of coal.	
f)	Percentage of ash in coal.	
x.	The duration of the test shall be at least four hours. No soot blowing shall be allowed during the test period or during stabilization period of four hours prior to commencement of the test.	
xi.	The Bidder shall furnish the correction curves, for Employer's approval covering the expected ranges of variations for all these parameters for the range of coal specified	
xii.	For all other aspects, not spelt out above, or in the specifications, where BS code stipulates the agreement between the parties concerned before commencement of the test, the Bidder shall get these approved by the Employer. However no correction to SG efficiency on account of variation in turbine cycle parameters, or vice versa shall be allowed.	

xiii.	The number, location, type and accuracy of the test grade thermocouples and pressure gauges shall be to Employer's approval
xiv.	The Steam Generator efficiency testing shall be carried out with any combination of mills in operation to Employer's choice, with fineness of pulverized coal not exceeding 70% through 200 mesh.
xv.	Steam generator efficiency shall be with guaranteed or actual air heater leakages, whichever is higher.

10.00 MAJOR REQUIREMENTS FOR COAL PULVERISER WEAR PART WARRANTY

10.01 The Contractor shall warrant the wear life of all wear parts of the coal pulverizer when grinding the specified range of coal(s). Pulverizer wear parts are defined as those parts of the pulverizer which are in contact with coal or coal dust and are likely to wear out during the operation of the pulverizer. The guarantee/warrantee shall be demonstrated on each pulverizer during the Guarantee Trial Period (GTP).

10.02 **Minimum Guaranteed Life** for various coal pulverizer wear parts shall be as indicated.

10.03 The wear parts shall be considered to have passed their warranted operating life when they have successfully demonstrated their capability to meet the full load rated capacity of the pulverizer (as per requirements of Technical Specification) during the guaranteed life of the wear part. No weld buildup or reversing of grinding elements will be permitted for achieving the guaranteed wear life.

11.0 Method of Computing Test Efficiency of ESP

11.01 The performance test on electrostatic precipitator will commence after a minimum period of three thousand (3000) hours of continuous operation after completion of initial operation. During the interval between the commencement of initial operation and the commencement of performance test only routine maintenance shall be carried out. No physical or chemical cleaning of ESP shall be permitted during this period or immediately before the conductance of the performance tests.

11.02 The test efficiency shall be based on the overall performance of the electrostatic precipitator over a mutually agreed period of operation under the conditions given in this specification and allowing the normal operation of the unit including rapping and normal soot blowing and/or when fuel oil is being fired in the igniters and/or warm up guns.

The overall test efficiency and test temperature/inlet dust burden for one set of ESP passes (stream) serving one Steam Generator shall be worked out as follows:-

a) Vm (guarantee point test flow) shall be the total of in let gas flows to the six gas streams at the time of test.

b) Test inlet dust burden (Di) shall be weighted mean of the inlet dust burdens for the individual streams i.e.:

$$Di = \frac{(Vm1 \times Di1)+(Vm2 \times Di2)+ (Vm3 \times Di3)+(Vm4 \times Di4)+(Vm5 \times Di5)+(Vm6 \times Di6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

Where suffix 1, 2, 3, 4, 5 & 6 represent the six gas stream.

Similarly the test outlet dust burden (Do) will be calculated based on outlet gas flow.

c) The weighted test inlet gas temperature (Ti) shall also be worked out in a similar manner i.e.

$$Ti = \frac{(Ti1 \times Vm1)+(Ti2 \times Vm2)+ (Ti3 \times Vm3)+(Ti4 \times Vm4)+(Ti5 \times Vm5)+(Ti6 \times Vm6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

d) The measured test efficiency shall be :

$$Em = \frac{Di - Do}{Di} \times 100\ (\%)$$

e) The corrections for the variation in flue gas flow, inlet dust burden and ESP inlet flue gas temp. shall be based on the above computed test values and the procedure indicated in the next para.

Note:
5^{th} & 6^{th} gas stream if applicable

11.03 At the time of performance testing if the inlet flue gas conditions are not consistent with the specified conditions, due to variation in coal characteristics from the design coal and boiler operating conditions the precipitator performance conforming to this specification, shall be determined using performance curves and correction factors accepted at the time of award of contract. However, the test efficiency shall be corrected to the guarantee point conditions in the following manner:

1. $Ec = 1 - e^{Z}$

Where Ec = Corrected test efficiency to guarantee point conditions.

$Z = C.Ln\ (1-Eg)$

$$\text{and } C = \frac{1}{Ca.\ Cb.\ Cc.\ etc.}$$

Ca.Cb.Cc are Correction factors for flue gas at temperature, ESP inlet dust loading & sulphur based on correction curves furnished by the Bidder and approved by the Owner.

2. $Eg = 1 - e^{Y}$

Where $Y = (Vm/Vg)^{0.5}\ Ln\ (1-Em)$

Eg = Measured test efficiency corrected to the specified guarantee point flow.

Vg = Specified Guarantee point gas flow (m^3/sec).

Vm = Measured gas flow (m^3/sec)

Em = Measured test efficiency

Ln = Logarithm, natural base.

The correction curves should be realistic for expected range of operation and variation in characteristics specified.

The test efficiency shall be the average of at least two corrected test efficiencies.

11.04 The Performance tests shall be carried out in accordance with method-17 of EPA (Environmental Protection Agency of USA) code. The details of the test shall, however be mutually agreed upon between the Owner and the Bidder.

CHAPTER - 1

SECTION - 5

QUALITY ASSURANCE PLAN

1.0. **SHOP TESTS FOR STEAM GENERATOR**

2.0. **Pressure parts**

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

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

I. Separator

(a) Each plate shall be subjected to a 100% normal ultrasonic at the mill to meet the minimum requirements of EN 10160 1999 / equivalent ASTM standards. Elevated temperature tensile tests shall also be carried out on plate material for each heat.

(b) After cutting to size and removal of cut outs, the plates shall be subjected to magnetic particle test along the edges of the plate and on areas adjacent to the cutouts.

(c) All forged connections shall be examined by 100% UT before machining.

(d) Fully machined connecting pieces of internal diameter 100mm and above, shall be subjected to magnetic particle examination.

(e) Mechanical tests shall be carried out on specimens prepared from the production control test plates of the longitudinal welds.

(f) Mechanical tests shall be conducted on the specimens from manhole cutouts of dished ends.

(g) All butt welds shall be subjected to 100% radiographic examination before stress relief.

(h) On completion of welding, the entire Separator shall be subjected to stress relieving in the furnace.

(i) All butt welds shall be subjected to 100% ultrasonic and magnetic particle examination after stress relief.

(j) All full penetration welds shall be subjected to ultrasonic examination after stress relief.

(k) After stress relieving (SR) all welds, internal and external shall be examined by MPI methods depending on size and accessibility and all butt welds shall be subjected to 100% radiography.

(l) All connecting tubes & pipes shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.)

(m) **Hydraulic Test and Pneumatic Test :**

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

II. Headers

(a) Raw material for headers shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.
(b) All butt welds shall be subjected to RT examination. Also MPI after SR.

(c) All full penetration nozzle and attachment welds shall be subjected to UT prior to stress relieving.

(d) All nozzles, branches, stubs and load bearing attachment shall be examined by MPI techniques after the toes of the weld have been ground smooth and stress relieved.

(e) Non-load bearing welds shall be examined by MPI techniques after the toes of the welds have been ground smooth and stress relieved.

(f) Completed closed end headers shall be subjected to hydraulic pressure tests and all compensating pads to be pneumatically tested.

(g) All weld joints in alloy steel headers of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. 3% hardness check shall be carried out on welds of other alloy steel Headers.

III. Tubes & Tube Elements

a) Raw material pipes/ tubes for water wall, superheater, reheater, Economiser, riser, supply and connecting tubes including nozzle/stubs, connections, headers Pipe work etc. shall be subjected to 100% UT prior to fabrication as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.

b) All bent tubes/stubs shall be checked for ovality and thinning by ultrasonic method on first off and random checks on subsequent pieces.

c) All tubes/stubs/panels/coils shall be checked for clearance by steel ball test and for cleanliness by sponge passage.

d) Finished butt welds shall be subjected to RT or UT. Wherever the code/standard/process specifies random sampling, the same shall be minimum 20%.

e) Minimum 10 % of the fillet joints shall be subjected to MPI/LPI. However Fillet welds of material grades P 5B and above or any other equivalent new material grade subject to the acceptance by Client/ Consultant shall be subjected to 100% MPI/ LPI.

f) Tubes and fabricated panels/coils shall be subjected to hydraulic pressure test excluding loose tubes but including burner panels, reheaters, superheaters & economizers.

g) 10% hardness survey on butt welds of P5B material group and above.

h) In case of RT of tube welds with DWDI (elliptical view) number of exposure shall be as per relevant code/ plant standard and will not be less than two exposures for each weld.

IV. Boiler Piping

a) All raw materials used shall have co-related mill test certificate meeting material specification.

b) All pipe lengths shall be subjected to 100 % ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

c) All bent pipes shall be checked for ovality and thinning by UT on first off lot & on random samples for subsequent pieces. Outer surface of bends shall be subjected to MPI/LPI.

d) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrant check. Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

e) All butt welds in alloy steel piping of P91, X20 and X 22 shall be checked for RT/ UT and MPI after SR. UT shall be of Digital Recordable Type.

f) All weld joints in alloy steel piping of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. For PWHT Induction Heating shall be deployed. However PWHT can be done in furnace also. 3% hardness check shall be carried out on welds of other alloy steel piping.

g) All load bearing attachment welds shall be subjected to MPI after SR.

h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with.

1. Temperature > 400 Deg, C and/or pressure exceeding 71 bar.
   i. 100% RT/UT on butt welds and full penetration branch welds.
   ii. 100% MPI.

2. Temperature > 175 Deg, C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar.
   i. 100% RT/UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.
   ii. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.
   iii. 100% MPE.

3. For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of under ground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

i. Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

V. Fittings :

1. Raw material of all forged fitting shall be ultrasonically tested. All mother pipes used for formed fitting shall be ultrasonically tested as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

2. Fittings shall be subjected to suitable NDT as per applicable standards. However following minimum. NDE requirement shall also be applicable / met.
   i. 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
      - For use above 71 bar design condition.
      - For use above 400°C design condition.
   ii. For fittings X20, P-91 and material group 5B & above
      - 100% MPI &
      - 10% hardness check &
      - For fittings of 200 NB & above 100% UT/RT
   iii. 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.
   iv. 100% UT/RT for fittings of all other piping of size OD 508mm & above.

VI. VALVES

a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table A.

b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/ IBR.

e) Air seat leak test shall be carried out as per applicable Standards/Codes.

f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet.

   1. Smooth operation
   2. Valve travel, closing and opening time.
   3. Current drawn by actuators.

g) Springs for safety valves shall be tested with suitable NDT and for spring rate.

h) Safety and safety relief valves shall be tested for performance.

i) All forgings rounds above diameter 40 mm shall be ultrasonically tested.

Table - A
NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

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

Note:

For body and bonnet forgings UT with MPI may be adopted in place of RT.

For austenitic steel MPI may be replaced by LPI.

VII. Non Pressure Bearing Attachments

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

VIII. Fuel oil heater

Hydraulic pressure test shall be carried out on the heating coils. All pipes, valves steam traps and mountings shall be subjected to hydraulic test as called for under IBR, BS or other approved codes.

IX. Soot Blowers

a) Butt weld between nozzle and lance tube shall be subjected to 20% radiography tests.

b) Hydraulic test on valve body

c) Soot blower shall be subjected to operational checks as below:
   1. Smooth operation
   2. Long Tube travel, closing and opening time.
   3. Current drawn.

X. Steam Generator Boiler Start up Drain Re-circulation Pump

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

b. All forging and castings shall be subjected to 100% UT/RT and MPI/DP check.

c. Static and dynamic balancing of the rotary parts shall be carried out.

d. Hydraulic pressure test shall be conducted on pumps casing at min. 1.5 times the Design Pressure.

e. Interchangeability shall be maintained and checked.

f. Each pump shall be subjected to a performance test at the manufacturer's works under as near actual site conditions as possible.

g. Following test shall be carried out on assembled units : -

Type Test:

i. NPSH test

ii. Temperature rise test.

iii. Under voltage test.

iv. Quality assurance proof test.

v. Tests to establish unit functioning of pump at temp and pressure.

vi. Hot standstill and start up tests.

Routine Test:

i. Hydrostatic test of complete unit.

ii. Overspeed test.

iii. Tests to determine unit characteristics

iv. Pump performance.

v. Unit run at rated voltage

vi. Starting current at rated voltage.

vii. Cold start up test.

viii. Endurance test of motor windings, joints and terminal seals

ix. Noise level.

x. Inspection of dismantled unit.

xi. High voltage test.

xii. For heat exchanger for these pumps, butt welds on pressure parts shall be tested with RT/UT and all other welds shall be

tested with MPI/LPI. Hydraulic test shall be carried out both on tube side as well as shell side at min. 1.5 times the design pressure.

XI. Hydraulic Test

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

b) The temperature of the fluid used for the pressure test shall be such as to avoid any possibility of brittle fracture at a low temperature and the same to be modified and submitted to the Engineer for approval, before commencing the test.

c) The fluid used shall be of a sufficient purity and where relevant, inhibits to avoid excessive corrosion and /or damage to temporary parts either during the test or prior to drying and cleaning.

XII. Pneumatic Test of Compensating Pads:

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

2.0. ROTATING AND OTHER EQUIPMENTS/ITEMS FOR STEAM GENERATOR

2.1.

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

b) For sleeve bearing, UT shall be carried out on the babbitting of bearing. Dye penetrant check shall be done on edges.

c) Blue matching is to be performed between components.

2.2. Air Preheater

(a) Forged shafts coming under air preheater like stub shaft, main rotor forging, housing hub shall be subjected to 100% UT at mill and magnetic particle inspection after machining.

(b) For non-modular design trial assembly is to be carried out at shop prior to despatch to site.

(c) Critical welds of rotor post shall be subjected to radiographic examination.

(d) Trial run of Airpreheater Rotor drive assembly (Gear Box + pinion + Electric motor + air motor) needs to be carried out at shop.

2.3. Fans: Induced Draft, Forced Draft and Primary Air fans and GR fans

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

(b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI /DPT after stress relieving.

(c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO 1940.

(d) **Test for Natural Frequency of Fans**
Full range performance test shall be carried out on one fan of each type and size as per BS 848, Part-1.

2.4 Fans: Seal air Fan, Scanner air fans

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

b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI / DPT after stress relieving.

c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO 1940.

2.5 Coal Mills, PF Piping and Burners

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

Wear-resistant parts shall be UT/ RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out. For ceramic materials check for various properties including hardness, density, wear rate and composition shall be carried out.

Butt welds in the tube/ separator /body casing of the mill shall be tested by RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.

All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.

Fabricated pipe welds should be examined by MPI.

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

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

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

2.6 Coal Feeders

a) Any welds in the casing/ pulley fabrication shall be checked with MPI.

b) Type tests including degree of protection and routine tests shall be done as per relevant Indian Standards or equivalent International Standards.

c) All major items like plates for casings, head pulley, tail pulley, Pulley shaft and major castings shall be procured with respective material test certificates.

d) Explosion proof test at 50 psi as per NFPA code shall be done as type test. Leak tightness test shall be done on individual feeder casing. Endurance test for load cell shall be carried out.

e) Test for weighing accuracy, calibration and repeatability shall be carried out at various speeds by a coal flow on one feeder.

f) Calibration check shall be carried out on all feeder cabinet/assemblies prior to despatch

2.7 Fuel Oil Pumps

(a) Bar stock/forging above 40 mm diameter shall be subjected to UT. Impeller and rotor shall dynamically balanced.
(b) Pump assemblies shall be subjected to hydraulic test.
(c) All pumps including spare cartridges shall be subjected to performance test at the manufacture's works under as near site conditions as possible and strip down examination after the test.

2.8 EOT CRANES

1.0 Hooks
1.01 All Tests including Proof Load Test as per relevant IS shall be carried out.
1.02 MPI/DPT shall be carried out after proof load test.

2.0 Steel Casting
2.01 DPT on machined surface shall be carried out.

3.0 Griders, End Carriage, Crab, Gear Box, and Rope
3.01 The plates of thickness 25mm and above shall be ultrasonically tested.
3.02 NDT requirements on weldments shall be as follows:

a)	Butt Welds in Tension	100% RT and 100% DPT
b)	Butt Welds in Compression	10% RT and 100% DPT
c)	Butt Welds in Rope	100% RT and 100% DPT
d)	Fillet Welds	Random 10% DPT

4.0 FORGINGS (wheel, gears, pinions, axle, hooks & hook trunion).
4.01 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to **Ultrasonic test**.
4.02 PT/MPI shall be done after hardfacing and machining.

5.0 Wire rope shall be tested as per relevant standard.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per IS-3177 shall be carried out at shop.

All electric hoists shall be tested as per is-3938 and chain pulley blocks shall be tested as per IS-3832.

2.9 Lube Oil systems/ Hydraulic Power Pack

Lube Oil system/ hydraulic power packs shall be tested for performance.

Fans & pumps which are not mentioned in other clauses above shall be dynamically balanced and functionally tested at Manufacturer's works. Complete performance tests shall be carried out on first pump/fan of each type and capacity to verify its output against total head, power input, efficiency, vibration and noise level. Head/volume, efficiency and power input curves corrected for site conditions shall be furnished.

2.10 Dampers

a) All the dampers shall be subjected to operational test/checks.

b) Leak tightness of test of Dampers / Gates.

c) All dampers shall be checked for sealing dimensions to establish guaranteed tightness.

2.11 **Boiler Structure, Ducts, Hoppers etc.**

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

a) Only material which has been identified against mill sheet or test certificates shall be used for construction. All plates above 40mm thickness shall be 100% ultrasonically tested.

b) Visual inspection of all welds shall be performed in accordance with AWS D.1.1.

c) NDT requirements of structural steel welds (other than Coal Bunkers) shall be as under:-
   i. 100% RT/UT on butt-welds of plate thickness > 32 mm.
   ii. For plates of thickness > 25mm & < 32mm - 10% RT and 100% MPI
   iii. For plates of thickness < 25mm - 10% MPI/LPI.
   iv. All fillet welds of built up plate girders shall be inspected 100% by MPI.

d) (Edge for field weld shall be examined by MPI for plate thickness > 32mm. Edge for field weld for ceiling girders shall be examined by UT for 100mm from the edge).

e) Ceiling girders/columns, ducts hoppers & tunnels shall be trial assembled and match marked prior to dispatch/erection. At least two consecutive girders along with cross member shall be assembled at a time.

f) Production test coupons for Butt and fillet welds of Main columns, ceiling grinders shall be carried out.

g) Coal Bunkers / Bins
   i. 10% DPT after back gouging.
   ii. 5 % spot radiography test on butt welds. Where access not available, UT shall be carried with prior approval of Client/Consultant.
   iii. Full penetration welds (other than butt welds) shall be subjected to 10% Ultrasonic testing.

2.12. **Hangers & Supports:**

a) All major raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

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

2.13. **Metallic Expansion Joint (if applicable)**

a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

c) All welds shall be subjected to 100% magnetic particle/dye penetrant check and butt welds shall be subjected to 100% radiographic testing.

d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). In case these tests have already been accepted by Client/Consultant on a prototype expansion bellow, as defined in Sec.D Clause 3.2 of Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

2.14. Thermal Insulation, Lagging & Cladding:

a) Lightly resin bonded mineral wool:

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

b) Castable Refractory:

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

c) Lagging &Cladding:

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

3.0. **FIELD /ERECTION CHECKS FOR STEAM GENERATOR & AUX.**

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

a) All rotary equipments shall be checked for its direction of rotation and free movement after placing it on the foundation.

b) All Valves shall be checked for its direction of flow.

c) Insulation shall be carried out only after satisfactory inspection of leak test.

d) Erection checks, tolerance limits and Quantum of NDE are indicated in respective Drawing, Field Quality plan and Field Welding Schedule.

3.1. **Hydraulic Tests of Pressure Parts**

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

4.0 POWER CYCLE PIPING

4.1 H.P.PIPING FOR STEAM GENERATOR AND AUX.

I. Piping:

a) All raw materials used shall have co-related mill test certificate meeting material specification. All test, 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 ASTM code that the tests is to be carried out when specified by the purchaser or any such indication, in the code.

b) All pipe lengths shall be 100 % ultrasonic tested. However for critical piping applications (Main Steam, CRH, HRH, Feed water, spray to superheater and Reheater, HP/LP Bypass, Upstream of Aux PRDS and any other system in which alloy steel is used) shall be subjected to 100% ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.

c) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrate check.

d) Pipe bend shall be checked for ovality and thinning by ultrasonic or other acceptable methods on first off lot & on random samples for subsequent pieces for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination/LPI.

e) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

f) All butt welds in alloy steel piping of P-91, X -20 , X-22 & material P-5B group & above shall be checked for RT/ UT & MPI after SR.

g) For welds in P91, X20 & X22 and material P5B group & above Materials requiring heat treatment, induction type of heating shall be deployed for post weld heat treatment, or heat treatment can be carried out in furnace.

h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with

1. Temperature > 400 Deg, C and/Or pressure exceeding 71 bar.
   i. 100% RT/UT on butt welds and full penetration branch welds.
   ii. 100% MPE.
2. Temperature > 175 Deg, C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar.
   i. 100% RT/UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.
   ii. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.
   iii. 100% MPE.
3. For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of under ground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

i) Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

j) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping (100% Hardness survey of welds on P91, X20 & X22 & above material grade of P5B above piping) and 3% hardness survey on welds of other alloy steel).

II. Fittings:

a) Raw material of all forged/formed fitting shall be ultrasonically tested. All mother pipes used for fitting shall be ultrasonically tested or hydraulic tested. Forged fitting shall be ultrasonically tested and formed fittings shall be MPI tested.

b) Fittings shall be subjected to suitable NDT as per applicable standards. However, following minimum NDE requirements shall be applicable / met.

i. 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
   - for use above 71 bar design condition.
   - for use above 400°C design condition.

ii. For fittings X20, P-91 and material group 5B & above
   - 100% MPI &
   - 10% hardness check.
   - Also 100% UT/RT, For fittings of 200 NB & above

iii. 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.

iv. 100% UT/RT for fittings of all other piping of size OD 508mm & above.

III. Hangers & Supports:

a) All raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test.

IV. Thermal Insulation & Lagging, Cladding:

a) Insulation:

Insulation shall confirm to and tested as per relevant clauses of Indian Standards and shall meet the requirements of specification. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per specification.

b) Lagging &Cladding:

Aluminium sheeting confirming to ASTM B-203-1060 temper H14 from reputed manufacturer meeting the requirements of specification.

V. Valves:

a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table 1.

b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/IBR.

e) Air seat leak test shall be carried out as per applicable Standards/Codes.

f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet
   i. Smooth operation
   ii. Valve travel, closing and opening time.
   iii. (Current drawn by actuators.

g) Springs for safety valves shall be tested with suitable NDT and for spring rate.

h) Safety and safety relief valves shall be tested for performance.

i. All forgings rounds above diameter 40 mm shall be ultrasonically tested.

Valve size NB in mm	ANSI Class upto 300	ANSI Class above 300 upto 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above But below100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT on100% area)

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

VI. Metallic expansion Joint (if applicable)

a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

c) All welds shall be subjected to 100% magnetic particle/dye pentrant check and butt welds shall be subjected to 100% radiographic testing.

d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA).
Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

VII. CHEMICAL DOSING SYSTEM

a) Pumps of chemical dosing system shall be performance tested as per relevant international codes.

b) Dosing skid shall be subjected to leakage test and functional test.

c) Oxygen cylinders shall be as per relevant standard meeting statutory requirements.

Low Pressure Piping

	Tests/Check Items / Components	Material test	DPT/MPI	Ultrasonic Test	WPS / WQS / PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional / Operational Test	Performance test	Other tests	All tests as per relevant Std	Adhesion / Spark Tests	Remarks
1.	Pipes & Fittings and Metered Bends	Y[a]	Y[b]		Y		Y			Y			Y[15]			
2.	Diaphragm Valves	Y[a]					Y[5]			Y				Y[6]		
3.	Butterfly Valves(Low Pressure)															
a)	Casted Butterfly Valves						Y		Y	Y	Y		Y[7]			
i.	Body (Cast)	Y[a]	Y[b]													
ii.	Disc (Cast)	Y[a]	Y[b]													
iii.	Shaft	Y[a]	Y	Y[C]												
b)	Fabricated Butterfly Valves															Refer note 14
4.	Gate/ Globe/Swing Check Valves	Y[a]	Y[b]	Y[C]			Y[5]	Y	Y	Y	Y		Y[8]			
5.	Dual Plate Check Valves	Y[a]	Y[b]	Y[C]			Y	Y	Y	Y	Y		Y[4]			
6.	Rolled & Welded Pipes	Y[a]	Y[3]		Y		Y[1]			Y						
7.	Coating & Wrapping of Pipes	Y[2]											Y[2]			
8.	Tanks & Vessels	Y[a]	Y[b]		Y		Y						Y[11]			
9.	Strainers	Y[a]	Y[b]				Y									
10.	Rubber Expansion Joints	Y[a]					Y[12]		Y				Y[13]			

	Items / Components	Material test	DPT/MPI	Ultrasonic Test	WPS / WQS / PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional / Operational Test	Performance test	Other tests	All tests as per relevant Std	Adhesion / Spark Tests	Remarks
11.	Rubber Lining of Pipes	Y[a]	X		X		Y			Y				Y[9]	Y	
12.	Hangers & Supports	Y[a]								Y						
13.	Fasteners	Y[a]		X				X								
14.	Site Welding		Y[10]		Y		Y									

Notes:

1. Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91
3. DPT on route run and after back gouging and on finish welds.
4. Dry Cycle Test (Dual Plate Check valve) for one lakh Cycles shall be carried out as a type test.
5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.
6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.
7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Employer's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.
8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes

9.

i. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material
ii. Dry film thickness check, humidity check, pipe temperature check, adhesion check and Holiday Detection test shall be done.

10. 10% of welds shall be subjected to DPT.(100% DPT for compressed air line and boiler & deaerator fill line.)

11. Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by Client/Consultant.

12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.

13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.

14. In addition of all tests as indicated for Cast Butter Fly valve being applicable for fabricated butterfly valves, following test shall be done for fabricated butter fly valve:

- UT as per ASTM A-435 on plate material for body and disc shall be carried out for plate thickness 20mm and above.
- 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done.
- Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc if thickness is more than 30mm.
- Welders and WPS shall be qualified as per ASME- section IX.

a) One per heat/heat treatment batch/lot.
(**b**) On machined surfaces only for castings and on finished butt welds.
(**c**) For shaft/spindles > or = 50 mm

15. **If applicable:** Segmented flange exceeding 30 mm thickness shall be stress relieved and not more than 4 segments is allowed. For stainless segmented flanges and stainless steel fabricated fitting, 100% radiography of all weld seams including mother pipe weld seam shall be employed.

16. **If applicable:** For pressure vessel welds RT shall be done as per design code requirements

SECTION - 6

SPARES AND MAINTENANCE TOOLS & TACKLES

1. GENERAL

The Bidder shall include in his scope of supply all the necessary Mandatory spares, Start-up and commissioning spares and Recommended spares and indicate these in the relevant schedules of the Bid Forms & Price Schedules. The general requirements pertaining to the supply of these spares is given below:

1.1 MANDATORY SPARES

a) The list of mandatory spares considered essential by the Employer is indicated in Volume II. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Employer to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid Forms & Price Schedules. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.

b) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number. Wherever the requirement has been specified as a 'set' (marked by **) it will include the total requirement of the item for a unit, module or the station as specified. Where it is specified as 'set' (marked by *) it would mean the requirement for the single equipment / system as the case may be. Also one set for the particular equipment e.g. 'set' of bearings for a pump would include the total number of bearings in a pump. Also the 'set' would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.

c) The assembly / sub assembly which have different orientation (like left hand, right hand, top or bottom), different direction of rotation or mirror image positioning or any other regions which result in maintaining two different sets of spares to be used for subject assembly / sub-assembly shall be considered as different type of assembly/sub assembly.

d) The Employer reserves the right to buy any or all the mandatory spare parts.

e) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.

f) All mandatory spares shall be delivered at site at least two months before schedule date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipments.

g) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until & unless specified otherwise.

1.2 RECOMMENDED SPARES

a) In addition to the spare parts mentioned above, the Contractor shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and total prices in relevant schedule of the Bid Forms & Price Schedules.

This list shall take into consideration the mandatory spares specified in this chapter and should be independent of the list of the mandatory spares. The Employer reserves the right to buy any or all of the recommended spares. The recommended spares shall be delivered at project site at least two months before the scheduled date of initial operation of first unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

b) Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to 6 months after placement of Notification of award for the main equipment. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the Employer.

1.3 START-UP & COMMISSIONING SPARES

a) Start-up & commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used till the Plant is handed over to the Employer shall come under this category. The Contractor shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipments are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Contractor.

1.4 The Bidder shall include in his scope of supply all necessary Mandatory spares, Start-up and commissioning spares and indicate these in the relevant schedules of the Bid Forms & Price Schedules. The general requirements pertaining to the supply of these spares is given below:

1.5 The Contractor shall indicate the service expectancy period for the spare parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

1.6 All spares supplied under this contract shall be strictly inter-changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desiccator packs as necessary.

1.7 All the spares (both recommended and mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

1.8 The Contractor will provide Employer with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Employer to identify and finalize order for recommended spares.

1.9 Each spare part shall be clearly marked or labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed.

All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

1.10 All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Employer

1.11 The Contractor will provide the Employer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipments covered under the Contract and will further ensure with his vendors that the Employer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

1.12 The Contractor shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship

1.13 In addition to the recommended spares listed by the Contractor, if the Employer further identifies certain particular items of spares, the Contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request with a validity period of 6 months for consideration by the Employer and placement of order for additional spares if the Employer so desires.

1.14 The Contractor shall guarantee the long term availability of spares to the Employer for the full life of the equipment covered under the Contract. The Contractor shall guarantee that before going out of production of spare parts of the equipment covered under the Contract, he shall give the Employer at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to Subcontractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his Sub-Contractors, Contractor will provide the Employer, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/ procurement of such items.

SECTION – 7

AUXILIARY BOILER

1.0 Introduction

The intent of auxiliary boiler is to supply auxiliary steam for erection, commissioning and post commissioning activities of the entire EPC (including main boiler). This auxiliary boiler will be of quick start up type and available as and when required. Bidder will arrange this as a part of his EPC supply and de-commission it after its requirement is over. Bidder will be allowed to take this equipment out of customer's premises (with due permission of customer) after the performance Guarantee test of main plant is concluded.

If bidder feels that this auxiliary boiler will be needed even after the Performance guarantee test and should be retained by customer, then he should explain this future need of auxiliary steam (from the auxiliary boiler) with justification. Bidder will include in his bid, description of such situations when auxiliary boiler will be required to support the main boiler, for the review of customer. If customer is convinced then he will decide to retain the auxiliary boiler permanently. The steaming capacity and the pressure and temperature parameters of the auxiliary boiler will be decided by bidder as per the exact requirement of entire EPC in his scope of supply.

2.0 BRIEF SCOPE OF SUPPLY

One (1) number Water Tube type, natural circulation, pressurized furnace, HSD fired, outdoor type Auxiliary Boiler of required capacity with desired steam parameters at super heater outlet, complete with, piping, valves, fittings, mounting, draft plant, fuel oil pressurizing & firing system, Boiler's safety & protection system, associated feed water systems including feed water pump, Boiler's filling system, chemical dosing system, blow down tanks, ducting, dampers, chimney, approach & maintenance platforms, complete Electrical system, C&I system & all associated structural works.

The scope shall also include one (1) no. of feed water storage tank, downstream of deaerator along with feed water pumps, for half hour storage capacity of auxiliary Boiler operation at full load.

Items though not specifically mentioned herein but needed to complete the equipment and system to meet the intent of the specification and safety of equipment & operating personnel, shall be deemed to be included in the scope of the work of the Contractor, unless otherwise specifically mentioned.

Base plates, foundation bolts, Anchor materials, matching pieces, inserts & packing shims etc as required for Auxiliary Boiler and associated equipments.

3.0 DESIGN BASIS

3.1 Type and Rating

One number outdoor installation type, natural circulation, pressurized furnace, water tube Boiler suitable for firing HSD and having required steaming capacity (to be decided by EPC bidder), but not less than 60 T/hr (Excluding steam requirement of Auxiliary Boiler) with matching operating steam parameters (Pressure and temperature) at super-heater outlet.

Boiler and its supporting auxiliaries are capable to generate 110% MCR steaming capacity for half hour every shift of eight hours.

Auxiliary Boiler shall be capable of achieving full load from cold conditions within maximum (2) hours time from cutting in of first burner.
The design of Auxiliary Boiler shall meet (or exceed) all requirements of IBR. The Contractor shall be responsible to obtain necessary approval of Inspection Authority / Chief Inspector of Boiler on behalf of Customer as may be required for design & design calculation, manufacturing & erection procedures, testing etc as called for under IBR.

The auxiliary Boiler, including its interlock & protection system shall conform to NFPA – 85.
The Contractor shall also be responsible for obtaining approval from the statutory authorities applicable in India, as may be required for any other plant and system supplied by him such as fuel oil system installation etc.

3.2 Boiler Steam & Water Circuit

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

3.2.1 Furnace

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

3.2.2 Drum

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

3.2.3 Super Heater

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

3.2.4 Feed System

The feed system shall comprise of a feed water pressure type deaerator (common for boiler) complete with necessary mountings and fittings and 2 x 100% electric motor driven Boiler feed pump sets (One running & other standby) with auto changeover facility on failure of duty pump, together with all pipe work, valves fittings, controls etc as necessary.

Three feed pumps shall be identical multistage centrifugal pumps complete with drive. Each pump shall be rated for continuous operation at 100% Boiler's MCR with an additional margin of 15% on flow. The pumps shall have stainless steel impellers. The shaft seals shall be hard faced water wear resistant material with automatic wear adjustment take up and alignment. Each pump discharge is fitted with NRV.

The contractor shall also provide one no DM Water storage tank sized for half an hour makeup water requirement of Boiler at 100% BMCR. 2 x 100% makeup water pumps along with necessary valves, piping and fittings shall also be supplied.

OR ALTERNATIVELY: the bidder can offer deaerator feed water storage tank having a capacity adequate for continuous operation of Auxiliary Boiler for minimum half an hour without feed water makeup. In this case, bidder will be provided DM water at the terminal point at a pressure of 3-4 Kg/cm2 (g).

3.3 Fuel System

The main burners are to be designed for firing HSD. The characteristics of HSD are given in technical specification. The ignition system will use spark ignition system Complete HSD piping from HSD day tank to pressurizing pumps & from pump to burners, any recirculation/return line etc complete line with necessary valves & fittings etc are to be provided.
Two (2) nos. positive displacement type HSD pressurizing pumps will be provided with motor drive. Each pump shall be sized for 100% MCR requirements of auxiliary Boiler and an additional margin of 10%.

3.4 Ducting

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

3.5 Structural Steel Work

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

3.5.1 Ladders, Platforms

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

3.5.2 Auxiliary Boiler Canopy

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

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

3.6 Chimney

1 No. 35 M minimum height designed as per Indian chimney code IS-6533. The chimney shall be manufactured from CORTEN steel plate with insulation and cladding and shall be provided with access door with cover and a drain connection. The chimney shall be insulated with mineral wool.

3.7 Safety Valves

At least three safely valves, at drum of 75% MCR combined capacity and one at SH outlet of 30% MCR capacity shall be provided.

3.8 Draft Plant

Complete draft system comprising of 1x100% FD fans complete with grease lubrication system and associated ducting system etc. shall be provided.

3.9 Equipment Handling Arrangement

Where it is necessary to handle any item in excess of 50 kg weight on the Boiler for purpose of erection or maintenance, a suitable lifting beam arrangement is to be provided.

For loads one ton (and above), on lifts exceeding three meters, electric hoists shall be provided.

4.0 INSTRUMENTATION & CONTROL

All necessary sensors, transmitters, switches & local instruments including flame scanners shall be provided by the Contractor for safe, efficient operation of the plant. The control, interlock & protection shall be implemented in Control System.

CHAPTER – 2

TURBINE GENERATOR & AUXILIARIES

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 two (2) Steam Turbine Generator units along with auxiliaries of the type specified to be installed at Kattupalli, Tamil Nadu.

Each 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 seven (7) 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.

2. Steam turbine shall be complete with casings, rotors, bearings, temperature detectors, couplings, steam gland seals, rotor turning gear preferably hydraulic type and having local/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.

3. Hydraulic power operated quick closing non-return valves and ordinary non-return valves for each extraction line (except for heater(s) located in condenser neck) including steam lines to BFP turbine drives and for each cold reheat line one hydraulic power operated QCNRV shall be provided.

4. Turbo generator set shall be either suitable for installation on spring supported Reinforced Cement Concrete (RCC) foundation or on flat footing RCC foundation.

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.

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 2x660 MW units.

5. Steam turbine governing and protection system shall be complete with electro hydraulic governor with mechanical hydraulic back-up or electro hydraulic system with 100% hot back-up, 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.

8. 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.

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. Sea water cooled, divided water box, horizontal surface condensers for each unit shall be complete with all accessories such as hotwells, valves, drains, vents, strainers, CW line expansion joints and fittings, isolating butterfly valves with matching flanges, associated CW piping to and from the condenser, suitable handling arrangement(s) for water box & butterfly valves, 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.

12. HP and LP 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. In addition one atmospheric flash tank will also be provided to accept the drains from feed water heater safety valves.

13. Condenser air evacuation system shall be complete with 2x100% vacuum pumps for each condenser, associated motors, all accessories, associated piping, valves & fittings, specialties, duplex filter, 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.

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 for each unit 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. Likewise, condensate spill pipe line consisting of piping, valves, control station etc. are in the bidder's scope.

3.0. FEED WATER HEATING PLANT

Complete regenerative feed heating system including full capacity drain cooler, minimum three (3) nos. of low pressure heaters, one (1) deaerator and feed storage tank, minimum three (3) nos. of high pressure heaters (HP), all accessories, associated piping, valves, Nitrogen gas and filling arrangement, instrumentation and controls etc. shall be provided for each unit. 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.

4.0. CONDENSATE POLISHING UNIT (CPU)

Condensate Polishing Plant including filters, mixed bed unit, regeneration unit, piping, valves and instrumentation shall be included in the Bidder's scope. The CPU shall be provided with associated chemical feed system for preparing, measuring and dosing the required chemicals.

5.0 CONDENSER ON LOAD TUBE CLEANING SYSTEM

Sponge rubber ball type condenser on load tube cleaning system separately for each half of the condenser. Each Condenser on load tube cleaning system shall be complete with one number Ball recirculation pump, one number Ball separator, one number 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. CONDENSATE EXTRACTION PUMPS

3x50% capacity motor driven condensate extraction pumps alongwith all accessories, drives, suction strainers, associated piping, and valves, instrumentation and control etc for each unit

7.0. BOILER FEED PUMPS FOR EACH UNIT

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) number 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, Electro-hydraulic governing system, Turbine Supervisory system alongwith all control and accessories as specified elsewhere 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.

d) Boiler feed pump sets shall be suitable for installation on spring supported Reinforced Cement Concrete (RCC) foundation.

2. Feed regulating station (FRS) for feed water flow control during unit startup, consisting of the following:

a) One pneumatically operated (0 to 30% BMCR capacity range) feed control valve.

b) Two numbers 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.

8.0. 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
c) Cycle make-up system
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
k) Compressed air system (Service Air and Instrument Air)
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.

9.0. TURBINE HALL EOT CRANES

For details refer chapter 17.

10.0. 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).

11.0. 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 as per approval of the Employer.

6. Chemical cleaning of all equipment and systems after their erection shall be in Bidder's scope.

7. All the environmentally clear waste shall be suitably routed to the storm water drainage system through drains by the Bidder. All the vents to atmosphere shall be suitably led to outside the main plant building.

8. Thermal insulation and removable metal cladding shall be provided for all the equipment, piping and piping support frames as required.

9. Necessary blanking arrangements required to protect the valves and turbine internals and other auxiliaries during steam blowing shall be provided.

10. All oils, chemicals etc. to waste shall be routed to a 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.

11. The oil drains from the Lube oil system in TG area which are collected in a common collection tank, will be transferred to drums for further disposal/reuse.

12. Similar arrangement will be provided for the oil drains in control fluid system also.

13. Suitable HOT/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

14. 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.

12.0 ACW System

ACW system shall be engineered, supplied and erected. ACW system shall be close-loop type using PHEs and DM water in the primary circuit. In the secondary circuit the DM water will be cooled by sea water.

13.0 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.

14.0 Design of TG foundation.

Detailed civil, structural design, BOQ for TG foundation & supervision during erection shall be under the scope of supplier. Foundation shall be suitable for installation on spring supported Reinforced Cement Concrete (RCC) foundation.

15.0 Tool and Tackles

1. One set of all special tools and tackles required for the maintenance of equipment/system have to be supplied by the Bidder. 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.

16.0 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.

17.0. 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	660 MW
(ii)	Turbine throttle steam pressure	247 Kg/cm^2 (abs)
(iii)	Turbine throttle main steam temp	565°C (Minimum)
(iv)	HPT Exhaust Pressure	As optimized by bidder
(v)	Reheat steam temp. at turbine inlet	593°C (Minimum)
(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	About 10% of H.P turbine exhaust Pressure
(viii)	Condenser design pressure	76 mm Hg (abs) / 0.101 ata
(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 throttle steam flow
(xii)	Final feed water temp. for Heat Rate guarantee point & EMCR condition	294°C (approx.) / To be optimised by bidder.
(xiii)	Turbine protection against water induction	As per ASME-TDP-I-1985
(xiv)	Turbine Heat Rate (Maximum)	1850 Kcal/Kw hr with TDBFPs

The conditions corresponding to economic maximum continuous rating (EMCR) at generator terminals shall be 660 MW output under rated steam conditions with 13T/hr of steam extracted from CRH for auxiliaries steam and total cycle makeup of 1% of throttle steam flow and design condenser pressure.

Note:

a) "Throttle/Main Steam Conditions" means initial/main steam conditions (i.e. pressure, temperature and flow) at inlet to Main Steam Strainer.

b) "Reheat Steam Conditions" means reheat steam conditions (i.e. pressure, temperature and flow) at inlet to Reheat Steam Strainer.

c) 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.

d) 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 described in "Functional Guarantee & Liquidated Damages.

1.1.3 Other Features

a) Turbine shall be capable of operating continuously with valves wide open (V.W.O) to swallow at least 105% of TMCR 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 condenser pressure of 76 mm Hg (abs) with 1% makeup. Load requirement beyond 102% of rated load can be met with overload valve. The steam generator for each unit having Boiler maximum continuous rating (BMCR) of 102% of the turbine VWO steam flow requirement subject to a minimum of 2100 TPH. For sizing of various auxiliaries in Bidder's scope of supply like BFP, HP-LP Bypass system etc. the Bidder shall therefore consider BMCR steam flow of 2100 TPH or 102% of turbine VWO steam flow, whichever is higher.

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 seven 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 no’s of HP heaters with extraction for top HP heater from HP turbine, one no. of deaerator and minimum 3 nos of LP heaters for each unit.

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 High Temperature unit auxiliary steam header at 16 ata /310^{0}C, and Low Temperature unit auxiliary steam header at 16 ata /210^{0}C as 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 280^{0}C to 340^{0}C depending on the unit load and the CRH steam Parameters. 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^{0}C. If auxiliary steam

parameter is not sufficient to meet the bidder's auxiliary steam requirement, bidder can provide his own steam system for his own consumption to meet specification requirement.

The Package Boiler to be arranged by the bidders based on the requirement of auxiliary steam and can be taken back after commissioning. Bidder will furnish their standard practice for sizing Package Boiler along with proper justification. This will be subjected to Owner's Approval.

1.1.4 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 660 MW
2.	Overpressure Operations	a) Bidder shall indicate the turbine over pressurization (under V.W.O) possible and ensure corresponding continuous output of TG set (if applicable). b) Turbine shall be capable of accepting variation in steam temperature & pressure as per IEC-45 in case 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.

1.2. 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. The contractor shall be required to furnish necessary information during detailed engineering for connection of HP and IP inlet nozzles, HP turbine exhaust nozzles, HP and IP stop cum control valve inlet and outlet MS and HRH strainer, inlet and outlet HP bypass and LP bypass valve inlet and outlet and CRH non return valve inlet and outlet nozzles in this scope to the employer's piping.

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. d) Bidder to supply one set of latest portable

		Videoimagescope system kit (with recording facility) for inspection of turbine internals as per following: 1. System should consist of video probe of suitable diameter and length (with Closed Circuit Display i.e. CCD located at the top of the probe), light and power source, CCD Camera having suitable resolution, Camera control unit function, handy LCD monitor (size not less than 5 inch), suitable USB video port with software for simultaneous view of inspection at personal computer. 2. Video-probe tip should have tip angulations of 120 to 150 degrees in up, down, left and right direction and the facility of dual view (forward & side) or proper tip adaptor for side and forward viewing. 3. System to have integrated temperature warning system for protection of the probe and system from high temperature damages. 4. It should have the facility of measuring defects / cracks during inspection. 5. It should have rigid sleeve which simply fit and lock the sleeve onto the tip of the insertion tube and allow the insertion tube to perform as a rigid borescope. 6. System should operate with power supply of AC, 220-230 Volt, Single phase, 50 Hz. 7. The scope includes on-site commissioning and demonstration of the complete operation of the equipment and guarantee of one year after successful installation and commissioning of the equipment. 8. Bidder to furnish the write up on offered instruments and diagnostic philosophy i.e. run / repair / replace criteria.
v.	Bidder to indicate cost implication due to withdrawal of supply of one set of latest portable Videoimagescope system kit mentioned at (d) above from their scope in relevant schedule of BPS.	

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 should be welded to casings except for LP casing(s) extractions which can be bolted connections.

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.

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) Exhaust hood spray cooling water shall be supplied from the main condensate extraction pump discharge.

u) 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.

v) 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 or the range recommended by IEC-45.

f) Complete rotor including coupling shall be capable of withstanding the shock loading and excess torque resulting from a generator short circuit without damage.

g) 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 Contractor shall state in his intentions with regard to thermal stability tests for the LP rotors.

h) Critical speed of composite rotor and blade assembly shall not be within ±15% of operating speed i.e. 3000 rpm. Contractor shall furnish studies carried out for combined critical speeds for the offered TG set.

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) Provide LP stage blade hardening up to 1/3rd (min) of blade length & width 25mm (min) or stelliting as per the proven standard practice.

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 at least last three stages of LP blading offered.

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

a) 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.

(b) Provide following instrumentation for each Journal/Thrust bearings.

(i) Local temperature indicators in each bearing lube oil drains.

(ii) Embedded redundant duplex resistance elements for monitoring temperature of bearing.

(iii) Necessary pick-ups and accessories for remote monitoring of bearing metal temperature & vibration (Horizontal & Vertical).

(iv) Complete even loading of the bearings is to be ensured by suitable measures. The thrust bearings must be capable of taking load from both sides and be self-aligning. They must be axially adjustable. The journal bearing shall be self aligning type with spherical seats.

(v) The thrust bearing shall be of the Michell or Kingsbury tilting pad type and shall be capable of handling the maximum possible thrust in either direction under any combination of operating conditions. A thrust bearing wear indicator shall be provided with an alarm for excessive thrust wear. It must be possible to check the thrust bearing wear during operation.

(vi) No oil leakage shall take through bearings.

(vii) Provision shall be made to permit vertical and horizontal adjustment of each bearing by shim manipulation, and not by scrapping or remetalling, in order to accommodate realignment without complete dismantling. It must be possible to dismantle the bearing shells without removing the turbine casings

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.

© 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).

(e) 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.
(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) Suitable arrangement to bypass gland Steam Condenser which shall be designed to operate under vacuum condition also along with desuperheating arrangement (if required) for the bypass. The exhaust is to be left above the TG hall roof level. The gland steam condenser should be provided with bypass on steam side.

(3) Seal material shall be proven.

© 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.

(d) Suitable arrangement shall be provided to drain the gland seal steam header during startup and shutdown conditions shall be provided. Suitable arrangement such as pressure relief valve shall be provided to maintain the desired pressure in the gland seal steam header

(e) A steam strainer shall be provided before the pressure reducing valve(s) of the steam supply to the glands. The strainer shall be sized to prevent entry of any foreign material which could damage the shaft glands. Details of the mesh size of the strainers proposed shall be given in the proposal. The strainer shall be arranged to permit easy inspection and cleaning. Provision shall be made for measuring the differential pressure across the strainer.

(f) 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. aux. 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) Permit easy examination & replacement of glands.

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) 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.

(f) 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.

(g) Lagged with insulation and provided with lifting eyebolts.

(h) 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.

(i) 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.

(j) Valves to close simultaneously & automatically when the over-speed governor trips and upon the action of other protective devices.

(k) 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.

(l) 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.

(m) 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

(n) 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.

1.12. Non – Return Valves

1.12.1 Design and Constructional requirement:

(a) Bidder shall provide Hydraulic power operated Quick closing type & ordinary NRVs of proven design for each Steam extraction line (except for heaters in condenser neck) including steam extraction line to BFP drive turbine. For each CRH line one hydraulic power operated 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) Provide two sets of Limit Switches for both open & close position with two changeover contacts.

(e) Valves shall be of proven design w.r.t. type, size and rating offered (Furnish sufficient experience data for the same).

(f) Ensure valves closure during unit trip.

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:

(i) Alloy steel (WC9) or equivalent compatible for NRVs on CRH line & extractions to H.P. heaters with the connected piping.

(ii) 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.

(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 should be covered with prefabricated 'blanket' type insulation. These blankets shall consist of high temperature felted mineral insulation fully enclosed in wire inserted asbestos free cloth for temperature exposure to 445^0 C to 595^0 C. 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 AND 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 8% of the rated speed.

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.

1.14.2 Speed Load Changer

The governing system shall be equipped with speed and load changers to control the speed or power output of the steam turbine within the limits. The speed / load changer provided shall be capable of adjusting the speed of the turbo set to any value in the range of 94% to 106% of 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.

1.14.3 Load Limiting Device

The governing system shall be equipped with a 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 separately actuated over speed device called emergency governor to trip the Unit at 110% of rated speed in case speed governor fails to limit the turbine overspeed. Additional trip device shall also be provided at 112% of the rated speed to trip the turbine in case of 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) **Turbine Trip**

Turbine trip should occur under following condition.

Over speed, backup over speed, complete EHG failure, Low lube oil pressure, High axial shift, high condenser pressure (low vacuum)-fixed set point & variable set point, thrust & Journal bearing wear, boiler tripped, shaft vibration very high, AC generator tripped, all circulating water pumps tripped, Fire protection, Main steam temperature very low, high HP exhaust steam temperature etc.

(c) **Emergency Hand Trip**

Bidder shall provide emergency hand trip device on Governor Pedestal to facilitate manual tripping of the unit along-with facility to trip turbine from UCB.

(d) **Other protection devices**

Other turbine protection devices including vacuum trip gear, solenoid trip gear and thrust baring trip shall be provided as per standard practice of the bidder.

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.

1.18 TURBINE LUBRICATION OIL SYSTEM

(a) A self contained LUBRICATION oil system for each 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 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.

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.

(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.

(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.

(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 and constructed from high grade stainless steel. Purified oil with no free moisture & maximum particle size conforming to code 15/12 as per ISO 4406. This shall be demonstrated with inlet oil quality conforming to code: 21/18 as per ISO: 4406.

(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) **Type test(s) to be conducted:**

Particle size impurities test, as detailed out in the technical specification, is to be carried out on one purification system of main turbine.

(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.

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.

(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.

1.19 TURBINE CONTROL FLUID SYSTEM

(a) Provide control fluid system for each unit 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.

(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.

(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)

(7) Filters at downstream of all pumps having mesh size as per Bidder's standard practice alongwith differential pressure switches for alarm.

(8) DM water cooled control fluid 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 shall be maintained within permissible limits.

(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 and spray water service) to be electro hydraulically 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.

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 atmospheric/HP/LP flash tanks. The steam turbine drain system shall be designed in accordance with the recommendations outlined in ASME TDP-1 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. Each drain shall be provided with one locked open manual valve followed by one motor/ pneumatic operated leak proof angle valve on downstream side to be used for draining and warming-up the pipes as applicable. 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.

1.22 PERFORMANCE REQUIREMENTS FOR EACH UNIT

(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 89 mm Hg 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 13 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 an 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 for auxiliaries shall conform to Zone-A of ISO10816.

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) 693 MW (i.e. 105% of rated load) under rated steam condition at condenser pressure 76 mm Hg (abs), with zero make up (GUARANTEED OUTPUT).

(b) 660 MW output under rated steam conditions at condenser pressure of 76 mmHg (abs) with zero make-up (GUARANTEED HEAT RATE).

(c) 528 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure operation and rated steam temperature at condenser pressure of 76 mm Hg (abs) with 0% & 1% make-up.

(d) 396 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure at condenser pressure of 76 mm Hg (abs) with 0% & 1% make-up.

(e) 330 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure operation at condenser pressure of 76 mm Hg (abs) with zero make-up.

(f) 660 MW output under rated steam conditions at condenser pressure of 76 mm Hg (abs) with 1% make-up.

(g) 660 MW output under rated steam conditions at condenser pressure of 89 mmHg (abs) with 1% make-up.

(h) 198 MW output under turbine throttle inlet steam conditions corresponding to sliding pressure operation at condenser pressure of 76 mm Hg (abs) with 0% & 1% make-up.

(i) VWO with over pressurization corresponding to boiler capability at condenser pressure of 77 mm Hg (abs) with 1% make-up (If applicable).

(j) VWO output under rated steam conditions at condenser pressure of 89 mm Hg (abs) with 1% make-up.

(k) VWO output under rated steam conditions at condenser pressure of 76 mm Hg (abs) with 0% makeup & 1% makeup.

(l) HP heaters out of service (One string and both strings) under rated steam conditions at condenser pressure of 76 mm Hg (abs) and 89 mm Hg (abs) with zero percent make up and 1% make-up and maximum continuous output.

(m) All HP heaters out of service under rated steam conditions at condenser pressure of 76 mm Hg (abs) and 89 mm Hg (abs) with zero percent make up and 1% make-up and rated output

(n) 660 MW output under sliding pressure conditions at condenser pressure of 76 mm Hg (abs) with zero percent make-up and 1% make-up.

(o) HP-LP bypass operation under rated steam conditions with bypass valves open to full capacity and turbine on house load operation.

(p) HP-LP bypass operation under rated steam conditions with steam generator output of 60% of BMCR.

(q) 60% unit load with one pass of condenser(s) in isolated condition.

(r) 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.

(s) 462 MW output under sliding pressure operation at condenser pressure of 76 mm Hg (abs) with 0% and 1% makeup.

(t) Steam Generator output corresponding to BMCR flow under rated steam condition, turbine under VWO operation, condenser pressure of 76 mmHg, 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.

(u) Turbine operation at 40% rated pressure at condenser pressure of 76mmHg, 0% and 1% make up, under sliding pressure operation.

(v) 65% unit rated output under sliding pressure operation at condenser pressure of 76 mm Hg (abs) with 0% and 1% make up.

Note:

- Any additional heat balances deemed necessary by the Owner shall be furnished. All the heat balances shall show turbine output, mechanical and 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 660 MW output at 38°C cooling water inlet temperature also.

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.

1.22.3 Correction Curves

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 reheater circuit pressure drop.
(d) Variation in SH spray flow. (Applicable in case the spray water is tapped off from regenerative feed cycle up stream of the final HP feed water heater).
(e) Variation in RH sprays flow.
(f) Variation in condenser pressure for main condenser.
(g) Variation in power factor, frequency, generator hydrogen pressure and voltage.
(h) 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

(j) Change in CW inlet temperature
(k) Change in net heat load
(l) 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 various load conditions alongwith stage by stage 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 660 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.

b) Life cycle test and burst test on one rubber expansion joint of each type and size in condenser CW inlet and outlet line.

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) Isolating butterfly valves and expansion bellows at inlets and outlets of condenser cooling water of each half of condensers.

e) Design for installation of LP heater(s) in condenser neck. The drain cooler to be installed outside the condenser neck.

f) Air evacuation pumps (2x100%) for each condenser. 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.

g) Separate sponge ball type condenser on-load tube cleaning system for each half of condenser including ball circulation pumps, strainer and ball monitoring system.

h) 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 and directly welded to the turbine exhaust. Alternatively condenser can be solid supported with expansion joint

(of fully stabilised austenetic stainless steel all welded type) in the condenser neck.

(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 seamless type titanium as per SB 338 Gr 2 and continuous without any circumferential joint suitable for intended duty with average wall thickness 22 BWG (0.71mm) (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. Welded condenser tubes shall not be accepted.

(h) Water box, tube plates and support plates material carbon steel as per SA 516m Gr 485 and suitable for intended duty. Water box interiors to be FRE lined with min 3 mm. 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 provisions to be made for expansion between shell and tubes.

(m) Suitable provision (like sliding and fixed base plate of condenser support feet etc.) for expansion of condenser shell to be made.

(n) All extraction pipes routed through the condenser shall be provided with stain less steel shroud to prevent erosion.

(o) All bolts, nuts and stays etc. inside the steam space shall be of Low Alloy Steel as per SA 193 Gr B7 and SA 194 Gr 2H 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.

(p) Shell material shall be carbon steel conforming to SA 516m Gr 485 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 shall be longitudinally divided and with proper drainage provisions.

(q) In order to protect the condenser from excessively high temperature an automatically acting cooling device has to be supplied for the exhaust steam. The cooling shall be from main condensate pump discharge side.

(r) 2X100% capacity, fully automatic debris filter of suitable mesh size for sea 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 sea water quality. Debris filter flushing line outlet shall be routed to ash dyke by suitable arrangement.

2.2 DESIGN REQUIREMENT

(a) The 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 (upto tip of last stage of LP turbine blades) for hydraulic and hydrostatic testing of condenser without installation of temporary supports or bracing.

(h) C.W. butterfly valves with actuators to be designed as per AWWA-C-504-80 or Owner approved equivalent standards. Valve's material shall be suitable for duty intended.

(i) C.W. expansion joints made from high quality natural / synthetic rubber with carbon steel reinforcement rings and with flanges of 125 LB as per ANSIB16.25. The material used shall be suitable for service intended. The expansion joints shall be designed to the deflections and fluid pressure through out plant life and shall be suitable to withstand full vacuum without collapse and the proposed arrangement for this shall be indicated in the offer. Further the design shall limit the reaction forces/moments on condenser CW nozzles and on C.W. piping.

(j) Design, Material and construction of CW piping and butterfly valves shall be as per relevant standards and as specified elsewhere in the specification.

(k) The condenser pit and CEP pit shall be partitioned and separate so that sea water and DM water do not get mixed.

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 upto the tip of the LP turbine blades. Any leakage detected shall be rectified immediately.

(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) Provide in 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 unit alongwith 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.

(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 Titanium. Material of shell and tube plates as M. S. type ASTM-A285 Gr. C properly coated. Water side of tube plate is gladded with Titanium.

(g) For U-tube type : Removable tube bundle provision.

(h) Sizing as per latest HEI.

(i) Capacity of each pump in free dry air at standard condition with condenser operating at design pressure of 1 inch (25.4 mm) of Hg (abs) and sub cooled to 4.17 deg.C below temperature corresponding to absolute suction pressure shall not be less than 30 scfm (51 m3 per hour) under standard conditions i.e. 760mm Hg (abs) and 21.1 deg. C.

(j) Capacity of each pump during hogging operation shall not be less than 800 scfm (1360 m3 per hour under standard conditions i.e. 760mm Hg (abs) and 21.1 deg. C) at 10" (254 mm) Hg (abs).

(k) Selection of materials for vacuum pumps and seal water recirculation pumps as below:-

(1) Casing - Nickel cast iron

(2) Shaft - Carbon Steel (EN8)

(3) Impeller - Nodular iron/stainless steel

(4) Shaft sleeves-Nodular iron/stainless steel

(l) Operational flexibility of all pumps during hogging and must be able to evacuate the condenser in specified time as per HEI.

(m) The stand-by pump shall cut in automatically in case running pump fails or when condenser pressure falls back to a preset value.

(n) No cavitation under all operating conditions without air ejector.

(o) Noise levels should not exceed limitations as specified in Section of General Technical Requirements and vibration levels shall be "Good" as per VDI-2056.

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.

(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)

For maintaining the feed water purity condensate polishing plant will be provided in the feed water cycle at the downstream of condensate extraction pumps. The function of the CPU will be to purity the condensate effluent from the condenser by removing solids and dissolved salts with the intent of reducing corrosion and depositions in the steam-water cycle. The condensate polishing units shall be of deep mixed bed type. Condensate Polishing Plant including filters, mixed bed unit, regeneration unit, piping, valves, instrumentation as described in Chapter 6, Vol III is included in the Bidder's scope. The CPU shall be provided with associated chemical feed system for preparing, measuring and dosing the required chemicals and with its external regeneration system located in DM plant building.

5.0 CONDENSATE EXTRACTION PUMP FOR EACH UNIT

(a) **Configuration:**

3 X 50 % Condensate extraction pumps.

(b) **Drive**

Constant speed squirrel cage induction motor with speed of 1500 rpm (Synchronous)

(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 at least 500mm 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 20m/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.

(7) Each strainer shall be provided with differential pressure indicator and switch along with isolation valve and piping.

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

5.2 DRIP PUMP (IF OFFERED) FOR EACH UNIT

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 at least 500mm 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 FOR EACH UNIT

(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-1-1985 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 294^0C / 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 shall be stainless steel as per ASTM. A 213 Gr. TP 304 for seamless tubes without circumferential joints or ASTMA 688 Gr. TP 304 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. These shall be self sealing type and bolted design is not acceptable.

(m) Preservation by nitrogen blanketing during shut down.

(n) Minimum tube size and minimum wall thickness after bending shall be as per applicable codes.

(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.

6.1 LOW PRESSURE HEATERS AND DRAIN COOLER

(a) Horizontal and U-tube type with integral drain cooler. Heater(s) in condenser neck will not have integral drain cooler.

(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) Straight or U-tube for drain cooler of LP heater in condenser neck and U-tube for other LP Heaters.

(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, 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). For LP Heater(s) having extraction from IP turbine it should not be less than the maximum extraction steam pressure with appropriate margins.

6.2 DEAERATOR

(a) Horizontal, spray-cum-tray with integral direct contact vent condenser mounted on horizontal storage tank.

(b) Alternatively, Spray type STORK 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.

(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 /CRH 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. Bidder to take into account the transient operating conditions such as sudden load throw off, cold condensate entering into the deaerator, low water level in feed water storage tank etc. w.r.t. NPSH requirement of booster pump while calculating the capacity of feed water storage tank.

(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.

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.

6.3.2 Design Pressure

(a) Tube side: Discharge pressure of HPHs shall be 105% of discharge pressure corresponding to emergency point of BFP operation. However, pressure relief valve across the HPHs shall also be provided, so that HPHs are not subjected to shut off condition.

(b) Shell side: Not less than maximum extraction steam pressure with adequate margins. For heaters taking extraction from CRH line, the maximum expected HPT exhaust pressure shall be taken into account.

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 FOR EACH UNIT

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.

(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 3% over steam generator highest safety valve set pressure corresponding to 105% of boiler maximum continuous rating. MDBFP set should be designed to meet this condition at 50 Hz grid frequency. Bidder to note that the highest saftey valve set pressure in steam generator is tentatively 305 Kg/cm^2 (g).

(5) 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.

(6) 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.

The above data are tentative. Based on finalisation of boiler data, which would be furnished during detail engineering stage, the contractor shall furnish detailed calculations as per design criteria as specified as per clause no. 6.1(f) (i) to (ii) above for employer approval.

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. (To be finalized during detail engineering stage).

(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, AC motor driven auxiliary oil pump, one 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**

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 Pump

(i) Barrel:
(ii) Inner casing impellers, stage pieces:
(iii) Wear rings, balancing drum bush:
(iv) Balancing drum:
(v) Pump shaft:
(vi) Shaft sleeves:

(b) Booster pump

(i) Shaft:
(ii) Wearings/Shaft sleeves:
(iii) Casing:

The materials adopted shall be field proven for the rated parameters. The proposal shall include the schedule of material indicating chemical composition and designation of material of above BFP components.

(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) **Instrumentation**

Two oil level gauges, drain fill vent thermometer dipstick with approved mounting valves, fitting etc. on gear casing.

(c) **Service Factor**

MDBFP (combined gearing/Hydraulic coupling)	1.4
Between turbine drive and booster pump	2.0

(d) **Bearings**

Gear box with separate thrust bearings to meet worst duty conditions. Bearings shall be of split sleeve type bronze backed with a high grade centrifugally cast Tin-base babbit lining. Gear journal bearing shall have babbitted thrust faces next to the gear to act as locating surfaces for the gear train.

(e) **Applicable Code**: **AGMA 420 and 421 (Latest)**

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, 1x100% lube oil cooler, 1x100% 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 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) **Instruments**

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 likely 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 and 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 and one additional temporary strainer 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) **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.

7.8.9 Codes

Design of drive turbines generally in accordance with API 612 and 614 except as modified here in and proven practice of the 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/300 deg.C at high temperature header and 16 ata / 210 deg. C at low temperature header, if these parameters suit the drive turbine requirement.

d) All other auxiliaries to be designed for auto start-up on tripping of running auxiliaries.

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:

Please refer Chapter 17 for details.

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 equipment covered under the scope exceeds the specified values, as given in the technical specification, suitable acoustic enclosures alongwith 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 subject to Owner's approval.

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

a) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.

b) Regulating drain valves in which case it shall be limited to 90 dBA.

c) TG unit in which case it shall not exceed 90 dBA

d) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 90 dBA.

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.^{o}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. Other conditions for computing heat balance diagrams:

1.	Throttle steam pressure	Kg/cm2(abs)	247
2.	Throttle steam temperature	°C	565 (minimum)
3.	Reheat steam temperature	°C	593 (minimum)
4.	Worst pressure in the condenser	mm Hg (abs)	89
5.	Design condenser pressure	mm Hg (abs)	76
6.	Make up water (as applicable)	% throttle flow	1.0
7.	Quantity of steam tapped off from cold reheat line for meeting normal (tentative) auxiliary steam requirement	TPH	13 (normal)
8.	Final feed water temperature optimized at 100% TMCR	°C	294^0C (approx.) / To be optimized by the Bidder
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	10
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
ii.	Steam extraction line deaerator	% of the pressure (abs) at the turbine extraction flange	8
iii.	Steam extraction line boiler feed pump drive turbine	% of the pressure (abs) at the turbine extraction flange	12
12.	Feed Water Pressure at economiser inlet		

(i)	At 105% TMCR (693 MW) Unit load	Kg/cm²(abs)	To be optimised by bidder
(ii)	At 100% TMCR (660 MW) unit load under modified sliding pressure operation.	Kg/cm²(abs)	To be optimised by bidder

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 660 MW output at 76 mm Hg 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 13 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 565 deg.C and 593 deg.C shall be used for main steam and hot reheat steam respectively.

(7) Tentative figures wherever indicated are for the purpose of preparing heat balance diagrams.

(8) 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.

(9) 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.

(10) Feed water pressure at economiser inlet to be considered for computation of the guaranteed heat rate and computation of heat balance diagrams for guarantee conditions, shall be as tabulated under Sl.No.15 (i) & (ii) above. Bidder shall be entitled of heat rate correction for variation in feed water pressure at economiser inlet (from the values tabulated above) as per correction curves to be submitted alongwith his offer.

(11) Pressure drop across reheat circuit specified above at point no - 9 of 'Other conditions for computing heat balance diagrams' is inclusive of pressure drop across CRH NRV. For arriving at pressure drop across reheat circuit, pressure drop across

CRH NRV has been considered 0.4% of HPT exhaust pressure. If the pressure drop across CRH NRV envisaged by the bidder is more than 0.4% of HPT exhaust pressure, then bidder shall increase the pressure drop to be considered in reheat circuit accordingly for HBD.

1.	Condenser Design Parameters	
a)	Number of Passes	Single pass/Double pass
b)	Design cold water temp.	33°C
c)	Min. size (O.D) of the tube	To be optimized by bidder
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	76 mm Hg (abs)
g)	Max. tube length between tube plates	15 meters (Indicative)
h)	Temperature rise in circulation water across the condenser	9°C
i)	Tube material	Titanium
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.	5 mmwc
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) & as per ACW System Design Pressure
e)	Pressure of make-up water	CEP discharge pressure
f)	Maximum temperature of condenser cooling water	36°C
g)	Duty code	HEI (Latest)
h)	Design condenser pressure	25.4mm (1 inch) of Hg (abs)
10.	Design pressure for CW piping, valves	0.1 kg/cm² (abs) & 5 kg/cm² (g) CW

	fittings, COLTCS equipment on the CW line etc	line etc

SECTION - 3

LP CHEMICAL DOSING SYSTEM

1.0. General

1.0.1. It is proposed to maintain chemistry of boiler feed water using Combined Water Treatment (CWT) using Oxygen Dosing in the feed water, generally 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:

Cation Conductivity	< 0.2 micro siemens / cm
Hydrazine	Nil
pH value (25 degree C)	8-8.5
Oxygen	20-200 ppb
Iron	< 10 ppb
Copper	< 2 ppb
Silica	< 20 ppb

1.1. 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.

Cation Conductivity	< 0.25 ms/cm
Hydrazine	10-15 ppb
pH value (25 degree C)	9.0-9.6
Oxygen	< 7 ppb
Iron	< 10 ppb
Copper	< 2 ppb
Silica	< 20 ppb

1.2. Sodium and Chloride limit in case of both CWT & AVT feed water shall be maintained upto 2ppb each at Condensate Polishing Plant outlet. It is proposed to install 100% capacity Condensate Polishing Unit for 2x660 MW units. The proposed design features of the Condensate polishing plant is indicated below and considering the above the Boiler Feed Water Treatment System shall be designed, supplied and installed by the Contractor.

1.3. 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.

1.4. Design Features of Condensate Polishing (CPP) Plant:

a) Each unit shall have Three (3) service vessels (2W+1S), each of 50% capacity.

b) The design flow shall be the corresponding condensate flow shall be as indicated in Chapter 6.

c) The following dissolved solids concentration and conditions shall be used as a basis of design for the condensate polishing system

Sl. No.	Parameter	Unit	Normal Condition		Start-up or Condender Leak	
			I/L	O/L	I/L	O/L

Sl. 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.

f) 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.

2.0 Oxygen Dosing System

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 dosage points if required as per manufacturer's standard practice shall also be included by the Bidder.

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.

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.

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 and actual design flow shall be intimated to the successful contractor later.

3.0 All Volatile Treatment (AVT)

3.1 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:

3.2 Tanks

Vertical and cylindrical design with dished/conical ends, SS-304 material of construction, shell thickness 3 mm for the tanks

Sl.No.		**Ammonia Measuring tank**	**Ammonia Mixing/ storage tank**	**Hydrazine Measuring tank**	**Hydrazine Mixing/ Storage tank**
i)	Storage Capacity (in litres)	125	2300	30	2300
ii)	Nos.	1 No./skid	1 No./skid	1 No./skid	1 No./skid
iii)	Concentration of aqueous ammonia solution shall be 29.4%				
iv)	Concentration of hydrazine solution shall be 35%				

3.3 Transfer pumps

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	35% concentration
Type of pump	Hand pump	Hand pump

3.4 Metering pumps

Item Description	**Ammonia pump**	**Hydrazine pump**
Material (Pump internals in contact with chemicals)	SS-304	SS-304
Capacity (LPH)	0-50	0-50
No's required	2 no's (2x100%) / per skid	2no's (2x100%) / per skid
Rated pressure	45 Kg/sq.cm(g)	45 Kg/sq.cm(g)
Type of pump	Reciprocating Pump	Reciprocating Pump
CHEMICALS TO BE HANDLED		
Normal	30% conc. Ammonia solution	0.6% conc. Hydrazine solution
Wet Laying	15% conc. Ammonia solution	35% conc. Hydrazine solution

3.5 MATERIAL FOR PIPING & FITTINGS

Item Description	**Ammonia pump**	**Hydrazine pump**
Piping	SS-304 /316	SS-304/316
Fittings VALVES END CONNECTION	A 182 GR.F304/316 A182 GR.F304/316 SW/ ANSI B16.11	A 182 GR.F304/316 A182 GR.F304 /316 SW/ ANSI B16.11

Note:

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 Employer for approval. The minimum storage capacity for storage tanks of both Ammonia & Hydrazine shall be for 48 hours requirement.

3.6 Unit shall be provided with a skid of hydrazine & ammonia dosing comprising of metering pumps (2x100%), strainer (2x100%), piping, valves, instrumentation etc. for both normal operation dosing as well as dosing required for wet laying of boiler. The capacity of tanks and parameters of pumps given are indicative & minimum. Final parameters shall be as per system requirements.

SECTION - 4

PERFORMANCE GUARANTEE TEST FOR TURBINE

FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS

1.0. General

(The term "Performance Guarantees" wherever appears in this Section shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)". The term "TMCR" (Turbine maximum continuous rating) appearing in the Technical Specification shall mean 660 MW electrical power output at generator terminals (power at generator terminals as per clause indicated in this section) under 0% cycle make-up and 76 mm Hg (abs) condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure.

2.0. PERFORMANCE GUARANTEES

2.1. General Requirements

a) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

b) The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

c) The Contractor shall demonstrate all the guarantees covered herein during functional guarantee / acceptance test. The various tests which are to be carried out during performance guarantee / acceptance test are listed in this section. The guarantee tests shall be conducted by the Contractor at site in presence of Employer on each unit individually.

d) All costs associated with the tests shall be included in the bid price.

e) In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. However if the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit specified at clause 3.2 of this section, Employer will accept the equipment / system / plant after levying liquidated damages as per clause 3.2 of this section. If, however, the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, even after the above modifications / replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:

(i) For Category-I Guarantees

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Liquidated Damages as specified hereunder. The liquidated damages for shortfall in performance indicated in Volume-I shall be

levied separately for each unit. The performance guarantees coming under this category shall be called 'Category-I' Guarantees.

(ii) For Category-II Guarantees

Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

(iii) For Category-III Guarantees

Reject the equipment /system / plant and recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Employer. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters / capacities shall be termed as Category-III Guarantees.

3.0. Guarantees under Category-I

3.1. The performance guarantees which attract liquidated damages are as follows:

(i) Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at 76 mm Hg (abs) design condenser pressure with zero make up at 660 MW unit load (i.e. 100% of rated load).

(ii) Continuous TG output of 693 MW unit load (i.e. 105% of rated load) under rated steam conditions at 76 mm Hg (abs) design condenser pressure with 0% make-up.

Note: The condenser pressure measurement while conducting the guarantee tests from (i) to (ii) above shall be measured at 300 mm above the top row of condenser tubes.

(iii) Auxiliary Power Consumption

Auxiliary Power Consumption at 100% TMCR (660 MW) Unit Load

The total auxiliary power consumption for all the Turbine Generator auxiliaries and turbine cycle equipments and other common auxiliaries required for continuous unit operation at 660 MW (i.e. 100% rate load) under rated steam conditions and at design condenser pressure of 76 mm Hg (abs) with 0% make-up shall be guaranteed in line with the requirements stipulated in Clause 3.3 of this Section.

Note: Power consumption of each equipment, shall be measured with its own drive.

3.2. AMOUNT OF LIQUIDATED DAMAGES APPLICABLE FOR CATEGORY-I GUARANTEES

Refer Volume - I

3.3. Auxiliary Power Consumption

Refer Volume – I

Note:
The bidder shall furnish a list of equipments to be covered under auxiliary power consumption, which shall be subject to Employer's approval.

3.4. HEAT RATE

Turbine Cycle Heat Rate shall be calculated as follows & indicated in all computed heat balance diagrams:

$$\text{HEAT RATE} = \frac{M1\,(H1-h1) + M2\,(H3-H2) + Mis\,(h1-his) + Mir\,(H3 - hir)}{Pg}$$

The expression "Mis (h1-his)" in the numerator of the formula is not applicable if spray water to superheater is completely internal to the boiler (i.e. tapped from a location downstream of economizer inlet).

Where,
M1 - Quantity of live steam entering the turbine stop valve including any live steam supplied to valve stems, or glands etc. in Kg/hr.
M2 - Quantity of steam from turbine to reheater in Kg/hr.
Mir - Quantity of desuperheating water flowing into reheater system for regulation of steam temperature in Kg/hr.
Mis - Superheater desuperheating spray flow in Kg/hr.
H1 - Enthalpy in kcal/kg of live steam.
H2 - Enthalpy in kcal/kg of steam to reheat.
H3 - Enthalpy in kcal/kg of reheated steam.
h1 - Enthalpy of feed water in kcal/kg at the downstream of the junction of feed flow and bypass flow of HP heaters.
hir - Enthalpy of desuperheating water flowing into reheat system in Kcal/Kg.
his - Enthalpy of superheater desuperheating spray water in Kcal/Kg.
Pg - Unit output after deducting the power consumption by auxiliaries as listed below

a. Power taken by Excitation system (KW) including transformer losses, as applicable for various guarantee points, in case of static excitation system is offered. (The transformer losses at various points shall be based on factory test to be conducted).
b. Power required for ventilation of oil and control fluid tanks, if ventilating fans are separately driven (KW).
c. Power required for lubrication, if lubricating pumps are separately driven (KW).
d. Power required for control fluid pumps, if control fluid pumps are separately driven (KW).
e. Power required for hydrogen, seal oil auxiliaries, if separately driven (KW).
f. Power required for stator water cooling system, if cooling pumps are driven separately (KW).
g. Power required for motors, heaters etc. of any other auxiliary service for the turbine generator (KW).

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

4.0. GUARANTEES UNDER CATEGORY - II

Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 1% make up, design CW temperature and CW flow.

5.0. GUARANTEES UNDER CATEGORY – III

The parameters/capabilities to be demonstrated for various systems/ equipments shall include but not be limited to the following:

5.1. Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

5.2. Condenser On Load Tube Cleaning System

Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer and accepted by the Employer.

5.3. Steam condensing plant

a) Temperature of condensate, at outlet of condenser, shall be demonstrated to be near to saturation temperature corresponding to the condenser pressure at all loads.

b) Oxygen content in condensate at hotwell outlet shall not exceed 0.015 cc/litre over 50-100% load range and shall be determined according to calorimetric Indigo-Carmine method.

c) Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system.

d) When one half of the condenser is isolated, condenser shall be capable of taking at least 60% T.G. load under TMCR conditions.

e) The design capacity of each vacuum pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17^0C below the temperature corresponding to absolute suction pressure shall be demonstrated. Correction curves for establishing the capacity at site conditions shall also be furnished.

f) The air and vapour mixture from air cooling zone of condenser shall be 4.17^0C below the saturation temperature corresponding to 25.4 mm Hg (abs) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished.

5.4. Feed Water Heaters and Deaerator

The following parameters shall be demonstrated:

a) TTDs and DCAs of feed water heaters shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.

b) Outlet temperature from final feed water heater(s)

c) Dissolved O_2 content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine method.

d) Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving the deaerator shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.

e) Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions

5.5. HP & LP Bypass System Capability

The HP & LP bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:

a) Generator circuit breaker opening

b) HP & IP stop valves closing due to turbine tripping

c) Sudden reduction in demand to house load

Under all above conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible values. The same shall be demonstrated.

5.6. Power Cycle Pumps

Satisfactory operation of BFPs and CEPs without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site.

5.7. Condensate Polishing Unit

(i) Effluent quality at outlet of each vessel at its rated design flow and design service length between two regenerations.

(ii) Pressure drop across the polisher service vessel (as defined elsewhere) in clean and dirty condition of resin at rated design flow.

6.0. PERFORMANCE GUARANTEE / ACCEPTANCE TEST

6.1. General Requirements

a) It is the responsibility of the Contractor to perform the Performance Guarantee/Acceptance test as specified in this Section. The performance tests will be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used for instructional purposes or data collection. At all

times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

b) The Contractor shall make their system ready for the performance guarantee tests.

c) All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation required for performance tests shall be supplied by the contractor and shall be retained by him upon satisfactory completion of all such tests at site. All costs associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the bid price. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.

d) The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following:
   (i) Object of the test.
   (ii) Various guaranteed parameters & tests as per contract.
   (iii) Method of conductance of test and test code.
   (iv) Duration of test, frequency of readings & number of test runs.
   (v) Method of calculation.
   (vi) Correction curves.
   (vii) Instrument list consisting of range, accuracy, least count, and location of instruments.
   (viii) Scheme showing measurement points.
   (ix) Sample calculation.
   (x) Acceptance criteria.
   (xi) Any other information required for conducting the test.

The Performance / Acceptance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. After the conductance of Performance test, the contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one month from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Employer after completing each test run.

e) Test Interruptions

In the event of a test interruption resulting from an Event of Force Majeure or Employer-Caused-Delay, Contractor shall be entitled to relief as provided in the contract, provided that, the interrupted Performance Test must be started again and test data that were collected during the interrupted test must be ignored.

6.2. Turbine Generator Performance/ Acceptance Test

a) Performance test for the turbine generator set will be conducted in accordance with the latest edition of ASME PTC-6. Such test shall be binding on the parties to the contract to determine compliance with the guaranteed heat balance conditions at 693 MW (105% TMCR) MW and 660 MW (100% TMCR) unit outputs corresponding to the conditions stipulated under Clause 1.22 of chapter-2, section-2 (Turbine Generator and Auxiliaries). Power consumed by the auxiliaries mentioned under clause 3.3 of this section which is to be deducted from electrical power generated, shall be measured during the performance / Acceptance Test. Wherever

the measurement is not possible, design values of power consumption by an auxiliary shall be considered.

b) The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes. All the necessary instruments (in duplicate) required for the tests shall be furnished by the contractor so as to meet the accuracies specified in the codes. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the contractor, if required. For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap nozzle assembly including required machined straight lengths meeting the requirement of ASME PTC-6 shall be provided. The test procedures, Calibration Standards, Calibration procedures etc., shall be subject to Employer's approval. All the instruments including the flow nozzle shall be calibrated by the contractor before and after the test, in a reputed international institute as approved by the Employer.

However, post test calibration of flow nozzle shall not be mandatory. These calibrations shall be performed in the presence of the Employer. All calibrations shall be made available prior to the test and calibration certificates in original submitted to Employer at least 15 days before conductance of the test for Employer's approval.

The instruments shall be sealed after calibration by calibrating lab. The percentage calibration error/deviation should not be more than accuracy class of the instrument. Calibration low beta ratio throat tap nozzle assembly including flow straightner, upstream and downstream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC-6. Secondary flow devices shall be calibrated flow nozzle / orifice plate as per ASMEPTC 19.5.

c) Corrections to the test results for steam turbine shall be applied as per the correction curves listed in technical specification. When the system is properly isolated for a performance test, the unaccounted for leakages should not be more than 0.1% of the design throttle flow at that load. To achieve the above value of unaccounted for leakages, the Bidder shall prepare the unit during pretest available shutdown. However, during the test, if it is found that the unaccounted for leakage is more than 0.1% of design throttle flow at that load, then heat rate will be increased by an amount equal to half the difference between actual unaccounted for leakage expressed as percentage of design throttle flow at that load and 0.1% (allowed by the code).

d) The performance guarantee test will be carried out after successful completion of initial operation. Ageing allowance will be given during evaluation of PG test results and hence guaranteed heat rates shall be increased by the amount calculated as per the formula given in Cl.No.3.07, Sub-Section-3 of ASME PTC-6 Report 1985 (Reaffirmed 1991). Period of ageing shall be considered from the date of successful completion of initial operation to the date of conductance of PG test,

In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered.

e) The tests shall be arranged in a manner that the EMPLOYER's operation is not disrupted. Duplicate test runs shall be performed at 693 MW and 660 MW unit loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, third test shall be run at the same point. The corrected result of any one of the three test runs, which deviates from the corrected averaged result of all the runs by more than 0.25%, shall be eliminated; otherwise the results of all the three tests runs shall be accepted.

f) During Performance/ Acceptance test, following tests shall be carried out for T.G. set with test grade instruments as per ASME code:

(i) Guarantee Turbine Cycle Heat rate test at 660MW corresponding to the heat balance diagram specified in the tender specification.

(ii) Guarantee Output test of 693 MW (105% rated load) corresponding to the heat balance diagram specified in the tender specification.

(iii) Maximum continuous output corresponding to both strings of HP heaters out of operation, under rated steam conditions at a condenser pressure of 76 mm Hg (abs) and 1% makeup.

g) Performance test for the condensers

(i) Performance test for design condenser pressure shall be conducted in accordance with latest edition of ASME PTC- 12.2.

(ii) Condenser pressure will be measured at 300 mm above the top row of tubes under VWO conditions, 1% make-up and design C.W. flow & design temperature. The condenser pressure shall be measured with a vacuum grid utilizing ASME basket tips. The grid is fitted at 300 mm above top row of condenser tubes.

(iii) Tube plug margin of 5%, as per design condition, shall be considered for condenser performance calculation at design condition.

(iv) If tube side fouling resistance for actual test condition is not measured as per methodology given in PTC 12.2, the tube cleanliness factor corresponding to the same shall be appropriately assessed considering the aspect of actual tube cleaning prior to conducting the test

h) Test Reports

The Contractor shall prepare test reports for Efficiency Test, Capacity Test and the Emissions test, in which the methods followed, instrument readings, graphs, observations, final results obtained, etc., shall be recorded.

SECTION - 5

QUALITY ASSURANCE PLAN

1.0. GENERAL REQUIREMENTS

a) Shop Tests

Shop tests shall include all tests to be carried out at Contractor's works, at works of his sub-contractor and at works where raw material supplied from manufacture of equipment is manufactured. Testing requirement of major equipment over and above the respective code / standard requirements are given for ST & Aux. including Condenser, HP Bypass System & Vibration Isolating System.

b) Site Tests

The Contractor shall prepare and submit detailed field quality plans by setting out the quality practice and procedures to be adopted by him for assuring quality for each equipment of material at this specification from the receipt of material at site, during storage erection, precommissioning to final commissioning of the plant. These procedures shall necessarily include all checks/tests conducted at site for preservation, assembly, alignment, positioning of the equipment, foundation preparation, welding/bolting heat treatment, non-destructive examination, hydraulic test, running test, performance test etc. The Contractor shall also furnish detailed quality procedure proposed by him for storage, preservation, painting, acid cleaning, alkali boil out, steam blowing, hydraulic test air/gas tightness test etc. to the Employer. The same shall be discussed and finalised with the Employer and six numbers of such finalised copies shall be submitted.

2.0. STEAM TURBINE AND ASSOCIATED EQUIPMENT

2.1. High Pressure & Intermediate Enclosure

High pressure Cast Steel Enclosures (for example High pressure and Intermediate Pressure Inner and Outer Cylinders, Steam Chests and liner, Steam Inlet Pipes, nozzle boxes).

1) Test pieces fully representative of the material and condition of the casting shall be provided to enable the properties of material to be determined.

   Creep requirements:

   a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

   b) Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's approval.

   c) Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's approval.

   d) Unspecified alloying elements shall be controlled as per the applicable standard.

2) Each casting shall be subjected to magnetic particle examination on the entire inner and outer surfaces after heat treatment.

3) Each casting shall be subjected to a 100% examination for internal flaws by ultrasonic/ radiographic method after heat treatment and suitable preparation.

4) Cast enclosure shall be subjected to a hydraulic pressure test based on established practice of manufacturer. Bidder to furnish their practice in this regard for Employer's approval.

5) Excavated area of all the defects shall be subjected to MPI to ensure excavation up to sound area. All the areas repaired/upgraded by welding shall be examined by UT, RT (to confirm findings of UT wherever required) and MPI. Sketches/reports of location of repair and reports of NDT carried out on repaired areas shall be submitted alongwith certificates. Hardness survey shall be carried out on the repaired area.

6) Where stub pipes and transition pieces are welded to the main body of an enclosure the following shall be carried out:

   i. Radiographic examination and Magnetic particle or dye penetrant examination of weld preparation.

   ii. Magnetic particle examination of finished welds after stress relief.

   iii. Radiographic or ultrasonic examination of finished welds.

   iv. Before despatch to site, the site weld preparations on the stub pipes and transition pieces shall be subjected to 100% RT/UT and magnetic particle examination.

   v. Hardness survey on the weld joint, HAZ and parent material.

7) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting shall be carried out.

8) Colour matching of castings by putting two halves together and feeler gauge tightness check from both sides, i.e. inside and outside to ensure required contact area and joint tightness shall be carried out.

2.2. Low Pressure Enclosure (Fabricated)

a) Where welds are made by chipping and grinding back to the first side weld before completing the weld from second side, a magnetic particle or dye penetrant examination of the chipped area shall be carried out.

b) Bidder to furnish their practice regarding stress relieving of the fabricated enclosures for Employer's approval.

c) Bidder to furnish their standard practice regarding NDT on welds for Employer's approval, however following are minimum NDT requirements:

Butt welds	10% RT or UT and 10% MPE/DP test
Fillet welds	10% MPE/DPT
Nozzle welds	10% MPE/DPT
Lifting lug & other load bearing fillet welds	100% MPE/DPT
Site weld edge preparations	10% MPE/DPT

d) Bidder to furnish his proven practice for hydraulic pressure tests. If it is not their practice, the justification for not carrying out hydraulic test shall be furnished for Employer's approval.

e) Feeler gauge tightness check from inside and outside to ensure required joint tightness shall be carried out.

2.3. Rotors

a) Forgings

Rotor forgings (monoblock and/or discs), Impulse Wheel & Nozzle Box and coupling forgings :

1) Fully representative tangential, radial and axial test pieces shall be provided at each end of the body, at each shaft end and from the trepanned core (when a core is trepanned) to determine mechanical properties including impact, brinell hardness etc. and tests for notch toughness i.e. FATT / NDTT (both transition temperature and room temperature impact values).

2) Creep requirements:

   a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

   b) Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's approval.

   c) Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience or adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's approval.

   d) Unspecified alloying elements shall be controlled as per the applicable standard.

3) Heat treatment should be carried out in such a way so as to ensure minimum residual stress in the rotor. Residual stress measurement will be carried out.

4) Each forging shall be subjected to a 100% ultrasonic examination. Normal probes and angular probes with different probe angles shall be used for thorough examination to ensure complete soundness of the forging. Supplier should furnish the proposal, alongwith scanning plan and probe angles to be used, for Employer's approval.

5) Each rotor shall be subjected to a 100% magnetic particle examination after final machining on journal areas and before gashing on other areas.

6) When a rotor forging is bored, a visual and magnetic particle examination of the bore shall be carried out.

7) Thermal stability tests shall be carried out on HP and IP rotor forgings to ensure the thermal stability of the rotors in service and at overspeed.

8) Following tests shall be carried out on the rotor welds:

   i. Ultrasonic examination with normal and angular probes of the weld to ensure complete coverage and freedom from harmful defects.

   ii. Run out of rotor before and after welding

   iii. MPE on finish welds.

   iv. Hardness survey on the welds

   v. Stress relieve annealing.

vi. Test reports of filler material used.

vii. Dimensional record of weld preparation.

9) Dimensional Examination of the rotor blade grooves and other important dimensions to be carried out to ensure the conformance to drawing dimensions, Log sheets/records shall be prepared for all important dimensions.

b) Complete Rotors

1) Axial & radial run-outs and surface finish checks shall be carried out before and after blading and after overspeed tests. Run out examination will be carried out at blade shrouds also.

2) Check for clearance between rotor groove and blade at the root.

3) Rotors shall be dynamically balanced at rated speed.

4) An overspeed test shall be carried out during which the rotor shall withstand an overspeed of 120% for five continuous minutes. If bidder's practice is different from as stated above, then same shall be furnished to Employer's approval. During this test vibration measurement and analysis shall be carried out.

5) After blading and again after overspeed testing, rotor stages with blades over 225 mm of active length are to be given standing vibration tests to determine natural frequencies in various vibration modes to ensure that the ranges are outside operating frequencies. The modes to be tested are: Bucket group tangentials, wheel axials and group axials.

6) In case, impulse stage and or blade discs are fitted on the rotor, fit up between such disc and rotor to be checked up before and after overspeed.

7) Lock blade lift after the overspeed shall be checked and record for same shall be maintained.

2.4. Stator & Rotor Blades and Shroud Bands

a) Fully representative test pieces shall be provided to enable mechanical properties of the material to be determined. In case of blades machined from bar stock, mechanical tests shall be carried out on the hardest and softest specimens of each heat treatment batch. Hardness test will be carried out on 100% basis.

b) Each bar stock for machining blades and forging shall be subjected to 100% ultrasonic examination.

c) When erosion shielded, the erosion shield and blade joint shall be radiographed.

d) Dye penetrant checks shall be made on the erosion shield and blade joint in manufacture prior to fitting to the wheel and after overspeed tests.

e) Magnetic particle inspection or dye-penetrant examination (when MPI is not applicable) shall be carried out on finish machined blade profile, roots and shrouds.

f) All moving blades of over 225 mm active length are to be moment weighed and assembled on shaft in a prescribed sequence to ensure optimum balancing of rotor.

g) Natural frequencies of the L.P. Turbine blades shall be determined before mounting on rotors to ensure that the same are outside operating frequency range.

h) Shroud bands after punching and after rivet-ting shall be subjected to 100% DPT to ensure freedom from harmful surface defects.

i) In case of cast blades, following testing shall be done:-

1. Chemical analysis/Mechanical testing per heat/heat treatment batch.

2. Rough machined and finish machined blade shall be subjected to MPI.

3. RT on blades.

4. Before starting mass productions, following technological tests shall be carried out on the first lot of 10 to 15 blades :-

   i. 100% radiography and 100% MPI on blades

   ii. 100% hardness testing.

   iii. Mechanical testing and metallurgical testing.

   iv. Weld repair shall not be permitted unless prior approval of Employer is obtained.

   In case of repair is allowed, manufacturer shall submit WPS/PQR and defectogram for Employer's approval before welding. After weld repair, RT shall be carried out on repaired area.

2.5. Diaphragms

a) Welded and fabricated Diaphragms

1) Concentricity checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades.

2) 10% Ultrasonic examination and 100% magnetic particle examination shall be carried out on finished, stress relieved and machined welds.

b) Cast/Forged/Machined Diaphragms

1) Details of the results of the tests conducted to determine mechanical properties together with chemical analysis, metallographic/ metallurgical examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.

2) Concentricity, flatness, blade drop and area checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades and port wall. Finish shall be to employer’s approval.

3) A 100% ultrasonic examination shall be carried out on diaphragm materials. Blade junction areas with the side walls shall be checked by magnetic particle or dye penetrant testing.

c) Colour matching of all the diaphragms by putting two halves together, and feeler gauge tightness check shall be carried out.

2.6. Stop, Control and bypass valves, actuators/servo-motors and steam strainers

a) Test pieces shall be provided to enable the mechanical properties of valve bodies, bonnets, valve disc and seat, and valve spindle material to be determined.

Test Creep requirements:

i. Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

ii. Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's approval.

iii. Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's approval.

iv. Unspecified alloying elements shall be controlled as per the applicable standard.

b) Dye penetrant checks shall be carried out on stellited / nitrided areas of components and stellite components in the finish ground or honed condition. Hardness check shall be carried out to ensure required hardness.

c) Valve body and bonnet castings/forgings shall be subjected to 100% radiography or 100% ultrasonic examination. Body and bonnet shall also be subjected to 100% magnetic particle examination on entire surface. All pressure containing welds in body and bonnet shall be subjected to 100% RT/UT and MPI examination.

d) Wall thickness of the body and bonnet after finish machining shall be measured by ultrasonic method and valve seat bore shall be checked for size and concentricity.

e) Bar stock for valve stem shall be subjected to ultrasonic examination and finish machined stem shall be subjected to magnetic particle/Dye penetrant examination.

f) Each valve body and bonnet shall be hydraulically tested at minimum 1.5 times the maximum working pressure after applying temperature corrections.

g) All the actuating cylinders/servomotors shall be performance tested.

h) Performance testing shall be carried out on valve operators/ actuators to check functional requirements like trip closing and opening time, valve lift and hysterisis.

i) Colour matching of the valve disc and seat to ensure the required contact area is to be carried out.

2.7. Cast and Forged Steel Components such as LP casing, in case of cast design, inlet & extraction / exhaust connections, shaft seal covers and rings, governor shaft, breach nut, threaded ring, angle ring, U-ring, servomotor parts such as body, piston, cover, yokes; turning gear casing and other items which are not specifically covered elsewhere

Results of tests conducted to determine mechanical properties, chemical analysis, metallurgical/ metallographic examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.

Each pressure containing enclosure shall be subjected to a hydraulic pressure test at 1.5 times the design pressure.

Each casting/forging shall be subjected to suitable non-destructive examination by Radiographic or ultrasonic and magnetic particle or dye penetrant examination methods to ensure freedom from harmful defects.

2.8. Bolts and nuts for pressure Retaining enclosures and Rotor Couplings

a) Bar stock for bolts shall be subjected to ultra- sonic examination.

b) Finish machined bolts shall be subjected to magnetic particle examination for surface defect examination.

c) Coupling bolts and nuts shall be suitably identified after weight control checks.

2.9. Governing and Protection System Equipment such as Electro-hydraulic Controller, Hydraulic Amplifier, Hydraulic Controller, Electro hydraulic Convertors, Hydraulic Convertors, Hydraulic Speed Governor, Trip Devices etc.

a) All pressure retaining parts shall be subjected to hydraulic testing.

b) All the major castings/forgings shall be subjected to suitable NDT methods depending upon their application and criticality to ensure the freedom from harmful defects.

c) All the main assemblies and sub-assemblies shall be subjected to functional test.

d) All butt welds shall be subjected to minimum 10% RT/UT and all fillet and corner welds shall be subjected to MPI/DPT.

e) All control equipment shall be subjected to rig testing, if it is not possible to test it on the steam turbine light run. The purpose of rig testing shall be as far as practical to prove that the functioning of the control equipment is in accordance with the approved design.

f) Nitrided and stellited components will be subjected to DPT and hardness check.

2.10. Inspection of Completed Turbine

The steam turbine shall be assembled in the manufacturer's works to such an extent that a thorough inspection can be carried out. The purpose of this inspection will be to ensure that the fit between mating components is correct and that all clearances are in accordance with the design requirement. Contractor will prepare the checklist in this regard and submit the same for Employer's approval. However, minimum clearances which are required to be checked and records to be maintained during assembly of Inner Casing - Rotor, Inner Casing - Outer Casing, Rotor - Outer Casing, Gland Steam Housing - Shaft - Casing etc. are shroud diameters, axial distances for shroud bands for casings, clearance between shaft seal casings and shaft seal rings, radial and axial blade clearance in blading section, axial and radial alignment of rotor in respect of shaft seals, alignment of overspeed governor etc. This is indicative check only. However, the details shall be finalised during QP finalisation stage.

These check lists shall be designed so that a comparison can be made between the design clearances, the clearances measured during works assembly, and those measured during the site turbine build. The vendor shall state, in his proposal, whether or not it is his practice to carry out no load works running tests on the steam turbine. (To this end the vendor shall give details of their normal works practice. In order to prove the compliance with design of the steam turbine control and emergency control equipment, functional tests shall be carried out in the manufacturer's works).

These tests shall be:

a) Part of a no-load run under steam and / or

b) By approved rig tests.

3.0. AUXILIARIES OF STEAM TURBINE

3.1. Bearing Pedestals and Bearings

a) Cast Pedestals & Housing

Leakage tests shall be conducted on pedestals.

b) Fabricated Pedestals & Housing

1) Leakage test shall be conducted on pedestals.

2) 10% weld shall be checked after stress relieving by magnetic particle test and minimum 10% of the butt welds will be checked by RT or UT.

c) Bearings shell

1) The shell and castings \ forgings shall be subjected to suitable non destructive examination like RT\UT & MPI as applicable.

2) Colour matching of the shells by putting two halves together and feeler gauge tightness checks from inside and outside to ensure required contact area and joint tightness shall be carried out.

3) The shell shall be subjected to hydraulic pressure test.

4) Chemical analysis of white metal shall be carried out. The effectiveness of the white metal adhesion shall be checked by ultrasonic or other approved method and the exposed edges of the white metal shall be subjected to a dye penetrant examination.

3.2. Cross around pipes

a) Weld edge preparation of shop and site welds shall be checked by magnetic particle examination

b) All butt welds shall be subjected to 100% Radiographic examination.

c) Magnetic particle examination shall be carried out on all welds.

3.3. LUBRICATING OIL, JACKING OIL AND CONTROL OIL SYSTEMS

a) Pumps

1) Main oil pump shaft shall be subjected to ultrasonic examination. Butt welds shall be subjected to RT/UT.

2) Pump impeller shall be subjected to suitable NDT method like MPI/DPT for surface defect examination. Impeller of main oil pumps shall also be subjected to an over speed test at 120% of rated speed for 5 minutes.

3) Pump casing shall be subjected to hydraulic pressure test at 2 times the working pressure or 1.5 times the pump shut off head whichever is higher. Rotor assemblies shall be dynamically balanced.

4) All pumps shall be performance tested at the manufacturer's works. Test shall include check for vibration and noise levels also. Procedure for performance testing shall be submitted to Employer for approval.

b) Oil purifiers.

1) All pressure parts will be subjected to hydraulic pressure test.

2) Components/parts of the equipment shall be subjected to suitable NDT depending upon the criticality of the application to ensure freedom from surface and sub surface defects.

3) All rotating parts like bowl assembly etc, shall be subjected to static and dynamic balancing test.

4) The complete purifier shall be tested at manufacturer's works for capacity, mechanical running sequential operation and interlocks, moisture content, vapour tightness, vibration, noise level, quality improvements etc. Sample shall be drawn from inlet and outlet of purifier after works test and shall be tested for moisture content, chemical tests and particle size of impurities.

c) Refer relevant clauses of the specification for other items such as piping, heat exchangers, valves, filters, blowers / exhausters etc in this system.

4.0. STEAM SURFACE CONDENSERS FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

4.1. SHELL, HOTWELL, WATER BOXES, DOORS AND TUBESHEETS

a) All welds shall be visually examined. Radiographic examination of 10% of butt welds shall be carried out. However, for vacuum containing welds, R.T on atleast 10% of each butt weld shall be carried out. Surface defect examination by magnetic particle inspection or equivalent test method shall be carried out for minimum 10% weldments. This shall apply to site welds also.

b) All edge preparations shall be examined for surface defects. Edge preparation for welds to be carried out at site shall be checked by magnetic particle inspection method before dispatch.

c) In case of fabricated flanges, welds shall be checked by 100% radiographic/ ultrasonic and 100% magnetic particle inspection methods to ensure freedom from internal and surface defects.

d) To ensure dimensional control of condenser, parts\sub assemblies shall be trial assembled at shop. BIDDER shall furnish his proposal in this regard, which will be subject to Employer's approval. Trial insertion of a few tubes through main tube plates and support plates shall be carried out to ensure alignment of tube plates and proper fitting and matching of parts\sub-assemblies.

e) Bidder to furnish his practice regarding stress relieving of the water boxes and water chambers.

4.2. Condenser Tubes shall be tested as per the requirements of relevant codes and standards.

4.3. Steam Throw Off Device

a) Edge preparations shall be examined for surface defects by MPI/DPT. 10% radiographic or ultrasonic examination shall be carried out for all weldments.

b) Welds shall be subjected to surface defect examination by 10% magnetic particle\dye penetrant examination.

4.4. SPRING ASSEMBLY

a) Static load testing of the springs shall be carried out and spring characteristics shall be drawn and verified.

b) Surface defect test shall be carried out on all the springs after coiling and heat treatment.

c) Surface cleaning shall be checked prior to painting and check for thickness of painting shall be carried out.

5.0. Condenser air evacuation system for main turbine condenser and drive turbine condenser (if offered)

5.1. Pumps

a) Vacuum pump shafts shall be subjected to ultrasonic test. After finish machining, shaft shall be subjected to magnetic particle examination/dye penetration test.

b) Pump casings and impellers shall be subjected to magnetic particle/dye penetration test. Finished pump rotor shall be subjected to dynamic balancing.

c) Pump casings shall be subjected to hydraulic test at 1.5 times the shut off pressure or twice the maximum operating pressure, whichever is higher.

d) Each pump shall be tested at supplier's works at full speed and load conditions to demonstrate successful operation and performance in accordance with the design requirements.

e) Supplier shall demonstrate by carrying out visual cavitation test that pump will be operating under all operating condition including blank off condition without cavitation.

f) Refer relevant clauses of the specification for other items such as heat exchangers, filters, piping, valves, etc. in this system.

5.2. The complete package shall be subjected to hydraulic pressure and leakage test and shop tested to check interlocks and functional requirements. The one complete unit shall also be subjected to demonstrate successful operation and performance testing, with saturated air conditions at condenser design vacuum point as well as vacuum pump design point with total minimum three points The test should be conducted with the respective motors to be supplied. The test shall include check for vibration and noise level.

6.0. FEED WATER HEATER, DRAIN COOLERS, GLAND STEAM CONDNSER, HEAT EXCHANGERS & PRESSURE VESSELS / STORAGE TANKS

6.1. All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.

6.2. Material for Tube plates shall be ultrasonically tested. Finished plates shall be subjected to suitable NDT. For cladded plates, bonding shall be checked by UT. Vendor shall furnish their practice regarding manufacturing & NDT for supply of cladded plates for Employer's review. Drilled Tube plates shall be checked for ovality of holes, ligaments, surface finish etc.

6.3. Dished ends shall be subjected to 100% MPI and RT/UT on welded joints. Knuckle portion shall be checked by MPI for surface defects and thinning shall be checked by UT.

6.4. Butt Welded / Full penetration joints shall be checked by suitable RT / UT. Fillet welds shall be checked by MPI / DPT.

6.5. Tubes shall be tested as per the relevant codes / specification / standards.

6.6. Before tubes expansion in the tube sheets, the mockup test for expansions shall be carried out, in case not done earlier. Torque setting of expander shall be based on mock up tests. Joints shall be checked for tube thinning.

6.7. Completed assemblies shall be pressure tested with working-fluid/ hydraulically/ pneumatically. The heat exchangers shall be tested on both tube side and shell side. After hydrotest, the heat exchangers shall be suitably dried and nitrogen capped. Atmospheric tanks shall be tested for leakage by water fill test for atleast 12 hrs.

7.0. PIPING, BELLOWS AND THERMAL INSULATION FOR TURBINE & AUX SYSTEMS

7.1. Piping and Fittings

a) All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.

b) All pipe lengths shall be subjected to 100% ultrasonic examination or hydraulic tests and UT/RT on longitudinal welds at the tube mill.

c) All mother pipes used for fittings shall be subjected to a hydraulic test or an ultrasonic test at the tube mill. Raw material of all forged fittings shall be ultrasonically tested. Forged fittings shall be ultrasonically tested.

d) Welded and cast fittings, if any, shall be subjected to suitable NDT as per applicable standards. However, as a minimum 100% RT shall be carried out on all alloy steel fittings and on carbon steel fittings for use above 71 bar design conditions.

e) The edge preparation for shop and site welds shall be checked by MPI/LPI however edge preparation in stainless steel alloy/ steel shall be subjected to a Dye penetrant check.

f) Thickness of pipe bends shall be checked by ultrasonic or other acceptable methods on sample basis for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination / LPI.

g) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

h) Non-Destructive Examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met (except for oil piping). Further statutory requirement, wherever applicable shall also be complied with

1) Temperature > 400^0C and / or pressure exceeding 71 bar.

   i. 100% RT/UT on butt welds and full penetration branch welds.

   ii. 100% MPE.

2) Temperature > 1750C up to 4000C and / or pressure exceeding 17 bar and up to 71 bar.

   i. 100% RT / UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.

   ii. 10% RT / UT on butt welds and full penetration branch welds for pipe dia up to 100 NB.

   iii. 100% MPE.

3) Wherever SR/PWHT is envisaged, above NDTs shall be after SR/PWHT.

4) For all other pipes not covered above (except oil piping), shall be subjected 100% MPE / DPT in case of under ground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

5) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping. (100% Hardness survey of welds on P91, X20 & X22 material grade pipings).

6) For welds in P91, X20 & X22 materials, only induction type of heating shall be deployed for heat treatment.

i) Oil piping shall be subjected to following NDT.

1) Butt welds of Oil piping shall be subjected to 10% RT and 10% DP Test. For Jacking oil lines 100% RT & 100% DPT shall be carried out on butt welds.

2) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.

j) Rubber lined pipes shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:

1) Adhesion test

2) Check for resistance to bleeding

3) Measurement of thickness

4) Shore hardness test

5) Visual examination and spark test at 5 kv/mm of thickness.

7.2. Metallic Expansion Bellows

a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

c) All welds shall be subjected to 100% magnetic particle/dye pentrant check and butt welds shall be subjected to 100% radiographic testing.

d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype / expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). In case these tests have already been accepted by employer on a prototype expansion bellow, as defined in Sec.D Clause 3.2 of Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

7.3. Rubber Expansion Joint

a) Rubber compound test slab after valcanising shall be tested for tensile strength, elongation and shore hardness. Tests on rubber compound shall also include hydrostability test as per ASTM D-3137 and ozone resistance test as per ASTM D- 380.

b) Fabric strength of synthetic fibre for reinforcement shall be checked, and test for rubber to fabric adhesion as per IS:3400/ASTM D- 413, rubber to metal adhesion as per IS 3100/ASTM D-429 shall be carried out.

c) All expansion joints in assembled condition shall be subjected to vacuum test at 730 mm Hg under conditions to ensure its suitability to withstand deflection in each axial transverse and longitudinal direction. Duration of test shall be of minimum 10 minutes.

d) All bare bellows shall be subjected to hydraulic pressure test in normal condition at twice the design pressure for a duration of 30 minutes.

e) Additionally, all bare bellows shall be subjected to deflection tests under pressure, pressure being raised from zero to the design value in regular steps and deflection measured at each step.

f) All expansion joints in assembled condition alongwith control rod assembly shall be subjected to deflection test under design pressure. The details of test procedure shall be subjected to approval by employer.

g) Either during the hydraulic test or during the vacuum test, change in circumference at the top position of the arch shall not exceed 1.5% of measured circumference at normal position.

h) Twenty Four (24) hours after the above tests, the permanent set (variation in dimensions with respect to its original dimension) shall be measured and recorded. The permanent set shall not be more than 0.5%.

i) Life cycle test and burst test shall be carried out on bellows of each type, design and size. In case these test have already been accepted by employer in earlier projects for the same type / size /design, test certificate for the same may be furnished for approval of Employer.

7.4. THERMAL INSULATION

a) For mineral wool insulation, testing shall be carried out as per IS:3144.

b) For sprayed mineral wool, testing shall be carried out as per IS:9724.

c) Thermal conductivity (k value) shall generally be measured in line with IS:3346.

7.5. Hangers and Supports

a) Forged components such as clevis, turnbuckle, eye- bolts, coupling etc. will be subjected to material testing, hardness, MPE, proof load test etc.

b) Dampers with viscous fluids will be checked for viscosity of liquid used, damping resistance of the damper, stiffness of the damper etc.

c) Springs used for variable constant load and spring hangers shall be checked for chemical, mechanical and spring rate tests.

d) Complete variable and constant load spring cage will be subjected to performance test and load/deflection test.

e) Complete hanger will be subjected to performance test and load test.

8.0. VALVES

8.1. Inspection and testing requirements for valves other than extraction line valves and butterfly valves shall be as follows:-

a) Pressure retaining parts of valves shall be subjected to NDT as per Table 1.

b) Bar stock/forging above 40mm diameter for valve trim shall be subjected to UT

c) Hardened / stellitted valve disc and seat are to be subjected to LPI and hardness check.

d) Colour matching of valve disc/plug and seat shall be carried out to ensure contact.

e) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34.

f) Air seat leak test shall be carried out as per applicable Standards/Codes.

g) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet:

1) Smooth operation

2) Valve travel, closing and opening time.

3) Current drawn by actuators..

h) Springs for safety valves shall be tested with suitable NDT and for spring rate.

i) Safety and safety relief valves shall be tested for performance.

TABLE-1

NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

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

Note:

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

ii. Weld Edge Preparation shall be subjected to MPI/LPI

8.2. Extraction Line Valves

a) Surface crack examination and hardness check shall be carried out on all hard faced/stellieted surfaces, if any.

b) As a minimum requirement of castings for all valves on cold reheat and extraction lines shall be subjected to 100% MPI on all areas and RT on Butt Weld ends and change of Section. For forgings minimum requirement shall be 100% UT and 100% MPI.

c) Bar stock for valves stem shall be subjected to UT. Finish machined valve stem shall be subjected to magnetic particle examination/dye penetration test.

d) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting/forging shall be carried out.

e) Colour matching of the valve disc and seat to ensure required contact area shall be carried out.

f) Hydraulic pressure tests shall be carried out on each valve to check body and bonnet strength. Seat leakage and back seat leakage test (wherever applicable) shall be carried out. Air seat leakage test shall also be carried out. Minimum test requirements of pressure shall be as per ANSI B 16.34.

g) Functional testing shall be carried out on each valve to check for freedom of movement, adherence to clearance, opening/ closing etc. Type tests for discharge co-efficient and pressure drop co-efficient, shall be carried out. In case the type tests have been carried out in the past and documents generated, the same shall be furnished to the Employer for approval.

8.3. Butterfly valves

a) Valve disc shall be checked for surface and sub-surface defects by magnetic particle examination.

b) Stubs and driving shafts shall be tested for internal defects by ultrasonic method.

c) Dye penetration test shall be carried out on shafts, seat rings etc.

d) Test samples for rubber seal shall be subjected to tensile and hardness test for vulcanising and after ageing. Hydraulic stability test and ozone crack reistance tests also be carried out.

e) Valve shall be subjected to hydraulic pressure test for body and air seat leakage tests as per AWWA-C504

f) Proof of design tests for valves and actuator shall be carried out as per AWWA-C504. In case the test has already been carried out on previous supplies, the contractor may submit the test certification of same for approval of employer.

g) After complete assembly each valve with actuator will be subjected to performance test by opening and closing the valve from fully closed to fully open position and the reverse, under no flow for at least 25 cycles to check.

1) Smooth uninterrupted movement of valve.

2) Closing and opening time.

3) Current drawn by actuator.

4) Operation of tripping switch and position indicator.

h) After assembly, one valve of each size with respective actuator shall be shop operated over the full range of movement in both the directions, with the body subjected to the full hydrostatic pressure conditions, to demonstrate that the unit is in working order without any leakage through the joints and torque switches/clutches, limit switches are operating satisfactorily. During the test, hand wheel operation, opening/closing time and current drawn shall also be

checked. The test shall be conducted for three consecutive cycles with valve shaft both in vertical and horizontal planes.

9.0. MISC. ITEMS / EQUIPMENTS

9.1. FILTERS / STRAINERS

a) Filters / strainers shall be tested as per the requirements of relevant codes / standards.

b) Filters / strainer shall be performance tested for pressure drop, flow, particle size. If performance test is earlier established, then records shall be reviewed.

9.2. **BLOWERS/ EXHAUSTERS**

a) Rotors shall be dynamically balanced. Leakage tests (if applicable) shall be carried out.

b) Performance tests including noise and vibration tests shall be carried out as per relevant standards / codes.

9.3. LP CHEMICAL DOSING SYSTEM

a) Pumps of chemical doing system shall be performance tested as per relevant international codes.

b) In case of diaphragm type of pumps, the life cycle test shall be done on pumps. If this test is already conducted for same model in earlier projects of TANGEDCO, then TCs for same shall be reviewed.

c) Dosing skid shall be subjected to leakage test and functional test.

10.0. Electrical and Control & Instrumentation:

Refer Electrical and Control & Instrumentation Sections.

11.0. SITE TEST:

Quality requirements for site activities shall be as a minimum, those specified for corresponding shop activities.

11.1. Hydraulic Test of Pressure Parts :

On completion of erection of pressure parts of each steam turbine generator, the unit with its fittings and mountings in position shall be subjected to hydraulic test pressure in accordance with requirement of Indian Boiler Regulations. Water used for hydraulic test shall be made alkaline by addition of suitable chemical. After the test, all parts shall be drained and suitably preserved.

11.2. Condenser Assembly :

a) If the condenser sections calls for site assembly, care shall be taken in assembly of sections and correctness of alignment and fit up shall be checked. Site welding shall be carried out as per the procedure approved by the employer.

b) All weld seams shall be subjected to magnetic particle examination. At least 10% of butt welds shall be subjected to radiographic examination.

c) All welds between condenser neck and LP turbine shall be subjected to 100% radiographic and magnetic particle examination.

d) Condenser tubes shall be visually examined for dents, mechanical damages or any other defects prior to insertion. Both tube ends shall be thoroughly cleaned to a length of 100mm to remove oil, grease etc. and shall be checked for freedom from burrs prior to insertion.

e) Tube expansion shall be carried out by electronic automatic torque control expanding unit, which shall be calibrated before use. Tube wall thinning and length of expansion shall be controlled and recorded.

f) Hydrostatic testing of condenser steam space shall be carried out after connecting all the pipes with the condenser along with condenser vacuum systems by filling the steam space with water upto the tip of the last stages of blades of LP cylinder.

g) Condenser water boxes shall be tested hydraulically at a minimum test pressure of 1.5 times the design pressure.

11.3. TURBINE ASSEMBLY

Bidder shall clearly indicate the extent of assembly to be carried out at site. Accordingly, bidder shall submit elaborate erection and assembly inspection programme of turbine for Employer's approval.

12.0. CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

General Requirements

12.1. Ball Recirculation Pump

a) All rotating parts shall be dynamically balanced.

b) Pump casing shall be subjected to hydraulic test at 1.5 times the shut off head or twice the maximum working pressure whichever is higher.

c) Complete pump assembly shall be subjected to shop performance test at supplier's works.

12.2. Ball Sorter / Fabricated Body (housing)

a) In the case of fabricated design, all butt welds shall be subjected to 10% radiographic/ultrasonic examination. All welds shall be examined by 10% magnetic particle testing method to ensure freedom from surface and subsurface defects.

b) Body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.

c) Performance test shall be carried out on ball sorter assembly.

12.3. Strainer

a) Strainer mesh shall be checked for chemical composition and mesh size.

b) Strainer body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.

c) Strainer assembly shall be checked for its function.

12.4. The complete system and the individual equipment shall be subjected to performance testing at Site to demonstrate successful operation and performance to meet the design conditions. The tests shall also include hydraulic test, function test, check for interlocks and sequential

operation. Site test shall also include test to establish pressure drop across the strainer section, proper functioning of DELTA-P system.

12.5. Piping and Fittings

Piping and fabricated fittings shall be subjected to following NDT.

a) Butt welds of piping shall be subjected to 10% RT and 10% DP Test. Butt welds of Segmental flanges shall be checked by 100% RT and DPT.

b) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.

Wrought/ forged fittings shall be tested as per relevant code/ specification/ standard.

12.6. Coating / lining

12.7. Coating shall be checked for DFT and adhesion. Further, Contractor shall furnish his practice for testing of coating to ensure the uniformity and freedom from pinholes.

12.8. Rubber lined items shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:

a) Adhesion test

b) Check for resistance to bleeding

c) Measurement of thickness

d) Shore hardness test

e) Visual examination and spark test at 5 kv/mm of thickness.

12.9. VALVES

Conventional gate/ globe/ check/ ball valves shall be tested as per relevant standard.

13.0. CONDENSATE EXTRACTION PUMPS AND DRIP PUMPS (IF OFFERED)

CONDENSATE EXTRACTION PUMP

INPROCESS TEST												**FINAL TESTS**					
TEST **ITEM DESCRIPTION**	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	Hyd. Test	Inclusion Rating	Pressure Drop Test	Performance test	NPSH Test	Vibration	Noise	Strip Down Test
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Pump Casing	Y	Y①	-	-	-	-	Y	-	-	Y	-						
Suction Bell	Y	Y①	-	-	-	-	Y	-	-		-						
Shaft	Y	Y①	Y	Y	Y	-	Y	Y	-		Y						
Impeller	Y	Y①	Y	-	-	-	Y	-	Y		-						
Rotor	-	-	-	Y	-	-	-	-	Y		-						

INPROCESS TEST												**FINAL TESTS**					
TEST **ITEM DESCRIPTION**	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	Hyd. Test	Inclusion Rating	Pressure Drop Test	Performance test	NPSH Test	Vibration	Noise	Strip Down Test
Fabricated Items	Y	Y①	-	-	-	Y②	Y	-	-	Y③							
CEP													Y④	Y⑤	Y⑥	Y⑦	Y⑧
Strainer																	
a) Body	Y	Y	-	-	-	-	Y*	-	-	Y	-						
b) Assembly											Y**						

① Chemical/ Mechanical shall be one per heat/HT batch.

② 10% Random on Butt Welds

③ Pressure Containing Parts.

④ Performance Test on each Condensate Extraction Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%,25%, 50%,65%, 80%, 100% and 125% of design flow with cold water.

⑤ NPSH (R) test shall be carried out on one Condensate Extraction Pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1 % and 3% head break by Suction Throttling Procedure.

⑥ Vibration on all Condensate Extraction Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.

⑦ Noise Level on each Condensate Extraction pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.

⑧ One Condensate Extraction Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

Note:
1) Quantum of In-Process Checks/ Tests is 100% until & unless specified otherwise.

2) Shop tests shall be conducted with soften Quality Water.

3) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.

4) Tests shall be done in accordance with latest edition of Hydraulic Instiute standard.

5) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	+ 5% of design head (Under 152.4 meter) +3 % of design head (for 152.4 meter and above)

* In case of fabricated construction
** One per type and size.
Results must show no minus tolerance with regard to flow and head.
No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed

14.0. POWER CYCLE HEATERS AND DEAERATOR

14.1. Deaerator

Sl. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	HT	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQR/App. Performance test	Mock up Test
1.	Shell & Dished End	Y	Y	Y				Y[a]		Y[g]				Y[a]				Y[e]		
2.	Fabrication/ Welding													Y				Y		
a)	Edge Preparation/ Fillet Weld									Y[b]	Y[b]									
b)	Butt Joints/ Branch Welding							Y[c]	Y[c]	Y	Y			Y				Y[d]	Y	
3.	Complete Deaerator															Y		Y		
4.	Safety & Safety Relief Valve & other valves	Y	Y					Y[f]	Y[f]	Y[f]	Y[f]					Y		Y[h]		

14.2. Heaters

Sl. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	HT	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQR/App. Performance test	Mock up Test
1.	**Tube Sheet**																			Y
a)	Forging	Y	Y					Y		Y					Y			$Y^{(l)}$		
b)	Plates	Y	Y	Y				Y			Y							$Y^{(l)}$		
c)	Cladding							Y			Y			Y		Y		$Y^{(j)}$		
2.	Shell Plates	Y	Y	Y				Y												
3.	Feed Nozzle Manhole forging	Y	Y			$Y^{(k)}$		$Y^{(l)}$				$Y^{(k)}$		$Y^{(l)}$				Y		
4.	**Welding / Fabrication**																			
a)	Weld Edge Preparation									$Y^{(b)}$	$Y^{(b)}$									
b)	Back Chipping									$Y^{(b)}$	$Y^{(b)}$									
c)	Weld Joints																			
i.	Butt							$Y^{(c)}$	$Y^{(c)}$	Y	Y				Y		Y	Y		
ii.	Fillet									Y	Y				Y		Y	Y		
iii.	Nozzle / Branch							$Y^{(c)}$	$Y^{(c)}$	Y	Y				Y		Y	Y		
iv.	Tube to tube sheet										Y		Y			Y				
5.	Dished End & Hemi Head	Y	Y	Y				$Y^{(a)}$		$Y^{(b)}$	$Y^{(b)}$			Y			$Y^{(e)}$			
6.	Tubes	Y	Y			$Y^{(q)}$	$Y^{(q)}$					Y			$Y^{(n)}$	Y		Y		
7.	Tube expansion in tube sheet																	$Y^{(o)}$		
8.	Complete Heater															$Y^{(p)}$	Y			

14.3. REMARKS FOR DEAERATORS AND HEATERS

a) After forming of plates. For dished end and Hemi head.

b) DPT may be used as an alternate to MPI.

c) UT/RT to be decided according to configuration/accessibility.

d) (i) For plates
(ii) For welding
(iii) For wall thickness

e) Including wall thickness

f) (i) 100% RT/UT shall be carried out on bodies, bonnets, nozzle and stem of valves of HP heater.
(ii) 100% DPT/MPI on machined surfaces of valve body, bonnet, stem, disc & springs.

g) Outer surface (Dished end Knuckle Portion)

h) Including - Seat leakage
- Relieving

Capacity-popping test at set and blow down pressure

i) Include ovality of holes, surface finish and size of holes.

j) For cladding bond and cladding thickness during bond check and after drilling

k) For feed nozzle (pipes)

l) For forgings

m) After bending also

n) Dimension to include wall thinning

o) Both tube and shell side. After Hydro test drying and nitrogen filling to be done.

p) As per the code.

q) For HP Heater & Gland steam coolers the statutory requirements as per IBR to be ensured and to be certification original to be furnished as per IBR statutory requirements.

Note:

1) Quantum of Checks shall be 100% unless otherwise specified.

2) Chem./Mech. shall be One/ per heat or HT batch.

15.0. BOILER FEED PUMPS & DRIVE TURBINE

BFP + BOOSTER PUMP + TURBINE																
INPROCESS TESTS																
Sl.No.	**TESTS** **ITEM/ DESCRIPTION**	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	F.A.T.T.	Hyd. Test	Inclusion Rating	Pr. Drop	Dimensions	Remark
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A.	**BFP+BOOSTER PUMP**															①Chemical/Mechanical Shall be one per heat / HT batch. # On BFP Impeller as per ASTME 446 level 2 *** In case of Fabricated Construction. ②One per type and size. + Type of NDE & quantum of check shall be as per relevant code & pressure class. ++ Include body & seat leakage test and functional test
i.	Barrel Casing	Y	Y①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
ii.	Discharge Branch	Y	Y①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iii.	Casing Cover	Y	Y①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iv.	Suction Branch	Y	Y①	Y	-	-	-	Y	-	-	-	Y	-	-	-	
v.	Diffuser	Y	Y①	Y	-	-	-	Y	-	-	-	-	-	-	-	
vi.	Ring Section	Y	Y①	Y	-	Y	-	Y	-	-	-	-	-	-	-	
vii.	Impeller	Y	Y①	Y	-	-	Y#	Y	-	Y	-	-	-	-	-	
viii.	Shaft	Y	Y①	Y	-	Y	-	Y	Y	-	-	-	Y	-	-	
ix.	Rotor	-	-	-	Y	-	-	-	-	Y	-	-	-	-	-	
B.	**STRAINER**															
i.	Body	Y	Y	-	-	-	-	Y***	-	-	-	Y	-	-	-	
ii.	Assembly	-	-	-	-	-	-	-	-	-	-	-	-	Y②	-	
C.	**GEAR BOX AND HYDRAULIC COUPLING**															
i.	Gear	Y	Y①	Y	-	Y	-	Y	Y	-	-	-	-	-	-	
ii.	Pinions	Y	Y①	Y	-	Y	-	Y	Y	-	-	-	-	-	-	
iii.	Shaft	Y	Y①	Y	-	Y	-	Y	Y	-	-	-	-	-	-	
iv.	Casing	Y	Y①	-	-		-	-	-	-	-	Y	-	-	-	

v.	Wheels	Y	Y①	Y	-	Y	-	Y	Y	-	-	-	-	-	-
vi.	Assembled Rotating Component	-	-	-	-	-	-	-	-	Y	-	-	-	-	Y
D.	**RECIRCULATION VALVE**	Y	Y①	Y	-	Y+	-	Y+	Y+	-	-	Y++	-	-	Y
E.	**DRIVE TURBINE**	Tests as per relevant portion of specification													

Note: Quantum of Checks/ Tests is 100% until & unless specified otherwise.

Final Test													
TESTS **ITEM/ DESCRIPTION**	Performance Test	NPSH Test	Vibration	Noise	Pressure Pulsation	Axial thrust	Dry Running	Thermal Shock	Visual Cavitation	Strip Down Test	Mech. Run test	Other Tests	Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
BFP	Y①	Y②	Y③ (a)	Y③ (b)	Y③ (c)	Y③ (c)	Y④	Y③ (d)	Y⑤	Y⑦	Y	Y⑥	
Booster Pump	Y①	Y②	Y③ (a)	Y③ (b)	-	-	Y④	-	-	Y⑦	-	Y⑥	
Gear Box	Y⑧	-			-	-	-	-	-	-	Y⑧	-	
HYD Coupling	-	-	-	-	-	-	-	-	-	-	Y⑨	Y⑥	
Drive Turbine	Tests as per relevant portion of specification												
Elect Items	Tests as per relevant portion of specification												

A (a) Performance Tests on each Boiler Feed Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure compliance with design requirements specified in the specification. Measurement shall be carried out at 10%, 25%, 50%, 65%, 80%, 100% & 125% of Design Flow with loop water at design temperature. Performance Test at other specified Conditions shall be carried out on all Boiler Feed Pumps at their respective Speeds at design temperature.

(b) Performance Test on each Booster Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%, 25%, 50%, 65%, 80%, 100% and 125% of design flow with cold water.

② NPSH (R) test shall be carried out on one Boiler Feed Pump and one booster pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1 % and 3% head break by Suction Throttling Procedure.

③ (a) Vibration on all Boiler Feed Pumps and Booster Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.
(b) Noise Level on each Boiler Feed Pump and Booster Pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.

(c) Pressure Pulsation and Axial Thrust Measurement shall be carried out on one Boiler Feed Pump at all measuring points. Pressure Pulsation shall be measured at suction as well as at discharge in the operating range.

④ Dry running withstand capability shall be demonstrated and established on one Boiler Feed Pump and its corresponding booster pump. Feed pump shall be capable of accepting complete loss of water and must be capable of being shut down in a controlled manner and brought down to rest after being tripped from design condition with simultaneous closure of suction valve. To demonstrate the capability during shop testing, suction valve actuation should be fast in order to ensure operation during vapour phase. Pump shall then be restarted and bring it back to design condition.

⑤ Visual Cavitation Test on one first stage production impeller of Boiler Feed Pump shall be carried out to demonstrate absence of Cavitation at test speed in Cold Water. The test will establish the cavitation characteristic of one production first stage impeller to confirm that the cavity length under dynamically scaled site conditions corresponding to test point will not exceed an agreed size. This test shall be carried out at 25%, 50%,65%,80%,100% and 125% of Design Flow

⑥ String Test:- Operational Test of One Motor Driven Boiler Feed Pump assembly using contract Booster Pump, Drive Motor, Hydraulic Coupling and Main Boiler Feed Pump to include test as specified at 1 & 3 (a) & (b). Dry Run Test shall preferably be carried out during String Test.

⑦ Complete Strip Down of Boiler Feed Pump which under goes Performance Test, NPSH Test, Dry Run Test, etc. shall be done in order to check problems like Internal Rubbing Damage, Excessive Wear etc. One Booster Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

⑧ Full load full speed/back to back locked rotor torque test for one gearbox.

⑨ Smooth operation, vibration, noise and temperature rise check on all equipment.

Note:

1) Shop tests shall be conducted with soften Quality Water.

2) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.

3) Tests shall be done in accordance with latest edition of Hydraulic Institute Standard, USA.

4) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	5% of design head (Under 152.4 meter) + 3% of design head (for 152.4 meter and above)

Results must show no minus tolerance with regard to flow and head.

No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

16.0. LOW PRESSURE PIPING

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
1)	Pipes & Fittings and Metered Bends	Y[a]	Y[b]		Y		Y									
2)	Diaphragm Valves	Y[a]					Y[5]			Y				Y[6]		
3)	Butterfly Valves (Low Pressure)															
a)	Casted Butterfly Valves															
(i)	Body (Cast)	Y[a]	Y[b]				Y		Y	Y	Y		Y[7]			
(ii)	Disc (Cast)	Y[a]	Y[b]													
(iii)	Shaft	Y[a]	Y	Y[c]												
b)	Fabricated Butterfly Valves															Ref. Note14
4)	Gate / Globe / Swing Check Valves	Y[a]	Y[b]	Y[c]			Y[5]	Y	Y				Y[8]			
5)	Dual Plate Check Valves	Y[a]	Y[b]	Y[c]			Y	Y	Y				Y[4]			
6)	Rolled & Welded Pipes	Y[a]	Y[3]		Y		Y[1]			Y						
7)	Coating & Wrapping of Pipes	Y[2]											Y[2]			
8)	Tanks & Vessels	Y[a]	Y[b]		Y		Y									
9)	Strainers	Y[a]	Y[b]				Y						Y[11]			

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
10)	Rubber Expansion Joints	Y[a]					Y[12]		Y				Y[13]			
11)	Rubber Lining of Pipes	Y[a]	Y[b]		Y		Y			Y				Y[9]	Y	
12)	Hangers & Supports	Y[a]						Y								
13)	Fastners	Y[a]		Y[b]				Y								
14)	Site Welding		Y[1]		Y		Y									

Notes:

1. Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91
3. DPT on route run and after back gouging and on finish welds.
4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test..
5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.
6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.
7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Employer's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.

8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes 9.

9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material

10. 2% of welds shall be subjected to DPT.

11. Pressure drop across the strainer for each type and size as a special test shall be carried out

12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.

13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.

14. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc and post weld heat treatment as per ASME, Section-VIII, Division- I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.

    a) One per heat/heat treatment batch/lot.

    b) On machined surfaces only for castings and on finished butt welds.

    For shaft/spindles > or = 50 m

17.0 POWER CYCLE PIPING

17.1 H.P. PIPING FOR TURBINE AND AUX.

1. Piping & Fittings

a) All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.

b) Raw material of all forged/formed fittings shall be ultrasonically tested. All mother pipes used for fitting shall either be ultrasonically tested or hydraulic tested. Forged fittings shall be ultrasonically tested and formed fittings shall be MPI tested.

c) All pipe lengths shall be subjected to 100 % ultrasonic examination or hydraulic tests and UT/RT on longitudinal welds at the tube mill.

d) Welded and cast fittings if any shall be subjected to suitable NDT as per applicable standards. However, 100 % RT shall be carried out on alloy steel fittings and on carbon steel fittings for use above 71 bar design conditions.

e) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrate check

f) Thickness of pipe bend shall be checked by ultrasonic or other acceptable methods on sample basis for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination/LPI.

g) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

h) For welds in P91, X20 & X22 materials, induction type of heating shall be deployed for heat treatment, or heat treatment can be carried out in furnace.

i) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with.

   a) Temperature > 400 Deg, C and / or pressure exceeding 71 bar

      i. 100% RT/UT on butt welds and full penetration branch welds.

      ii. 100% MPE.

   b) Temperature > 175 Deg, C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar

      i. 100% RT/UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.

      ii. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.

      iii. 100% MPE.

   c) 100% UT & 100% MPI on all butt welds of P 91 and X22 UT shall be carried out by digital recorded type.

      Wherever SR/PWHT is envisaged, above NDTs shall be after SR/PWHT.

j) For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of underground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

k) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping (100% Hardness survey of welds on P91, X20 & X22 material grade piping) and 3% hardness survey on welds of other alloy steel.

2. Hangers & Supports

a) All raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test.

3. Thermal Insulation & Lagging, Cladding

a) Light resign bound mineral wool:

LRB mattresses of Rockwool/Glasswool from approved manufacturing sources confirming to 8183, tested as per relevant clauses of IS 3144. Wire mesh of diameter 0.71mm (min.) shall only be used.

b) Lagging & Cladding

Aluminium sheeting confirming to ASTM B-203-1060 temper H14 from reputed manufacturer.

4. Valves

a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table 2.

b) Hardened / stellitted valve disc and seat are to be subjected to LPI and hardness check.

c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/ IBR.

e) Air seat leak test shall be carried out as per applicable Standards/Codes.

f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet

i. Smooth operation

ii. Valve travel, closing and opening time.

iii. Current drawn by actuators.

g) Springs for safety valves shall be tested with suitable NDT and for spring rate.

h) Safety and safety relief valves shall be tested for performance.

TABLE-2

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

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

SECTION - 6

MANDATORY SPARES

1.0. SPARES

The Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spares is given below:-

1.1. MANDATORY SPARES

a) The list of mandatory spares considered essential by the Employer is indicated in this chapter. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Employer to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid Forms and Price Schedules. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.

b) The Employer reserves the right to buy any or all the mandatory spares parts.

c) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.

d) All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipments.

e) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.

f) For list of Mandatory Spares referVOL – II (Schedule K)

1.2. RECOMMENDED SPARES

a) In addition to the spare parts mentioned above, the contractor shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and total prices in relevant schedule of the Bid Form and Price Schedules. This list shall take into consideration the mandatory spares specified in this section & should be independent of the list of the mandatory spare. The Employer reserves the right to buy any or all of the recommended spares. The recommended spares shall be delivered at project site at least two months before the scheduled date of initial operation of first unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

b) Price of recommended spares will not be used for evaluation of the bids. The price of these spars will remain valid upto 6 months after placement of Notification of Award for the main equipment. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the Employer.

1.3. START-UP & COMMISSIONING SPARES

Start-up and commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the employer shall come under this category. The Contractor shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and

commissioning. They must be available at site before the equipments are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Contractor.

1.4. The Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spars is given below.

2.0. The Contractor shall indicate the service expectancy period for the spares parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

3.0. All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.

4.0. All the spares (both recommended and mandatory) shall be manufactured alongwith the main equipment components as a continuous operation as per same specification and quality plan.

5.0. The contractor will provide Employer with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Employer to identify and finalise order for recommended spares.

6.0. Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

7.0. All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Employer.

8.0. The contractor will provide the Employer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipments covered under the contract and will further ensure with his vendors that the Employer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

9.0. The Contractor shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.

10.0. In addition to the recommended spares listed by the contractor, if the employer further identifies certain particular items of spares, the contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request with a validity period of 6 months for consideration by the Employer and placement of order for additional spares if the Employer so desires.

The Contractor shall guarantee the long term availability of spares to the Employer for the full life of the equipment covered under the contract. The Contractor shall guarantee that before going out of production of spares parts of the equipment covered under the Contract, he shall give the Employer atleast 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub contractors, Contractor will provide the Employers, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/procurement of such items.

CHAPTER 3

3.0 SEA WATER INTAKE SYSTEM

3.1 The water required for the condenser cooling water system make up, feed to RO stage I and electrochlorination plant for the proposed 2 x 660 MW units and 1x660 MW future unit shall be drawn from the the cooling water forebay of existing NCTPS Phase II. Necessary modification will have to be carried out in the cooling tower forebay of existing NCTPS Phase II. The sea water intake forebay will be located within the premises of NCTPS Phase II. The intake pumps shall be located in the sea water intake pump house located adjacent to the forebay near the cooling water forebay of NCTPS Phase II. The pipe routing from the sea water intake pump house to the plant shall be as indicated in the Plot plan (approx distance 5.5 to 6 kms). However exact distance shall be aceratined by the bidders themselves.

3.2 The sea water in- take shall be designed for the total make up for the proposed 2x 660 MW units and 1x660 MW future unit (CT Make up & other process make up as needed and specified) plus water for elctrochlorinatrion plant.

3.3 The drawing of existing cooling water forebay of NCTPS Phase II is enclosed in volume VII. Bidder shall carry out the necessary modification in the existing forebay accordingly. Bidder may also visit site to ascertain/ acquaint with the quantum of modification accordingly.

3.4 The sea water intake system shall be designed to cater to an intake requirement equal to the sum total of CT make up plus water required for elctrochlorination plus RO feed required to feed RO Stage I for the proposed 2 x 660 MW units and 1x660 MW future unit. The above in-take quantity is estimated as stated hereunder:

CT make-up requirement for proposed 2x660 MW units: 11120 cum/hr

CT make-up requirement for 1x660 MW future unit: 5560 cum/hr

Process make-up requirement to feed RO stage-I for proposed 2x660 MW units (including Electro-chlorination requirement) : 1830 cum/hr

Process make-up requirement to feed RO stage-I for future 1x660 MW unit (including Electro-chlorination requirement) : 915 cum/hr

In consideration to the above total intake water requirement is estimated as: 19425 cum/hr.

The water quantities indicated above are only tentative and bidder has to work out the exact quantity during detailed engineering and establish the same through calculations which will be reviewed and approved by owner. However the RO permeate quantities indicated in the specification are the minimum quantities which will have to be complied with.

3.5 Sea water piping shall be as per Chapter 13, Volume II. 2x50 % pipes shall carry the entire water requirement as stated above from the in-take pumphouse at NCTPS stage-II to the site of the power plant. Sea Water Intake piping, CT Make up piping and desalination plant (RO Stage I) piping after bifurcation of CT make up shall be designed for future unit also and thus be designed to carry flow of three units. Tap off with isolation

valve shall be provided in the CT make Up and desalination make up pipe for interconnection to futire unit at later date.

3.6 There shall be 4(2W+2S) sea water in-take pumps installed in the sea water in-take pumphouse to cater to the entire requirement of make up water to the cooling towers, make water to the sea water Treatment plant to generate process water alongwith water required for electrochlorination as detailed under sl. No. 3.4 for the proposed 2x660 MW units and 1x660 MW future unit. Two of the four pumps shall be working to suffice to the water requirement of the proposed 2x660 MW units.

Refer composite water scheme & flow diagrams enclosed in Vol VII for tentative flow scheme. However the water quantities shall be worked out by the contractor and equipment sizing shall be done accordingly.However bidder to note that the required permeate from RO Stage I for the proposed 2x660 MW plant is minimum 560 cum/hr. All the pumps shall be installed in individual sumps provided with stop-log gates followed by removable type trash rack (of clear opening 25 mmx 25mm) and travelling water screen (of 50 sq. mm. clear opening).

3.7 The pumps shall be provided with quick closing electrically operated actuator butterfly valves and expansion joints at the discharge side and the material of the delivery parts of equipment, valves and piping shall be compatible for sea water use.

3.8 Adequate handling and hoisting facilities shall be provided for the equipment such as valves, stop logs, trash racks, travelling water screens etc. including crane for handling the pumps and their motors depending upon the system requirements. Adequate air conditioning for the PLC /control rooms and 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. Getting flexibility analysis done for the entire sea water piping is included in the scope. Pump and sump model tests are to be conducted at any reputed and approved institution for the sea water intake system leading pipes, fore-bay and sump.

3.9 The scope of Sea Water Intake System includes, but not limited to the following:

- Modification of cooling water forebay of NCTPS Stage II.
- In-take stop log gate
- In-take trash rack of clear opening 50 mmx 50 mm
- Intake Forebay
- Sea Water Pumphouse
- 4(3W +1S) Sea Water Intake pumps
- Sea water intake piping (overground) comprising of 2x50% GRP pipes from sea water intake PH (at NCTPS stage-II) upto the proposed plant boundary (Ennore SEZ)
- CT make up piping (buried) upto to cooling tower forebay within the proposed 2x660 MW plant site
- Process make-up piping (buried) upto PT plant/clarifier in the proposed 2x660 MW plant site
- Stop log gates at inlet of each pump sump
- Trash rack for each pump sump of clear opening 25 mmx 25mm
- Travelling Water Screens for each pump sump of 50 sq. mm. clear opening

- 2 x 100% screen wash pumps.
- Valves and specialities
- Handling facilities
- Reciculation line shall be provided at pump discharge with motorized valve to recirculate 30% of flow of each pump.

3.10 All pumps shall have 10% margin on capacity and 10% margin on friction head over the actual requirement.

3.10 **Forebay**

3.10.1 The sea water intake system shall be designed to cater to the requirement equal to the sum total of CT make up plus water required for elctrochlorination plus RO feed required to feed RO Stage- I for the proposed 2 x 660 MW units and 1x660 MW future unit.

3.10.2 All RCC works shall conform to Volume VI.

3.10.3 Modification of existing fiorebay of NCTPS Stage II including demolition of existing buildings/structures is included in the scope of work.Necessary coffer dam etc shall be constructed by bidder for carrying out the same. Care shall be taken while carrying out the modificatrion works such that the running of the plant at NCTPS Stage II is not affected.

One no. stop log gate followed by removable type trash rack of clear opening 50 mm by 50 mm shall be provided at intake.Material of construction shall be as detailed in the resprctive data sheets. Lifting arrangement and storage/maintenance bay for stop log gate and trash rack shall be provided.

3.10.4 The forebay shall be located near the fore bay of NCTPS Stage II. The tentative location of forebay is shown in the enclosed drawings.

3.10.5 Proper care should be taken during construction of Forebay to avoid contamination of groundwater with the saline water.

3.10.6 Forebay shall be provided with cage ladder at four corners constructed of epoxy painted steel. Top of the forebay shall be kept 500mm above grade level and hand rail of epoxy painted M.S. pipes shall be provided on the entire length on either sides.

3.10.7 Chlorination shall be done in the forebay from the existing chlorination plant at NCTPS stage-II. Chlorination lines shall be supplied by the Contractor from the existing chlorination plant.

3.11 **Sea Water Pumphouse**

3.11.1 Sea Water pump house shall house 4 nos. Sea water in-take pumps of adequate capacity. Floor shall be cast in the entire pumphouse. All pumps shall be installed in individual sumps with partitions.

3.11.2 The intake pumps shall be located suitably near the cooling tower forebay of NCTPS stage-II and chlorination for the forebay shall be extended from the exsting NCTPS stage-II chlorination plant. All required chlorination lines from the chlorination plant shall be provided by the Contractor.

3.11.3 The depth of the forebay shall be decided based on the submergence requirement of the pumps at the lowest water level in the sump.

3.11.4 Provision of stop log gate shall be followed by removable type trash rack of clear opening 25 mm x 25 mm. After the trash rack, travelling water screen (TWS) of 50 sq. mm. clear opening shall be installed. Material of construction shall be as specified in the data sheets.

3.11.5 2 x 100% screen wash pumps shall be installed in the pumphouse for cleaning & flushing the travelling water screens.

3.11.6 Each pump shall have an individual sump with proper isolation. Dimension of the pump sump shall be decided as per Mechanical requirements. Sump shall be provided with stainless steel (SS316 L) groove for inserting stop logs, trash rack and TWS. Pump house floor shall have openings for lowering and lifting of stop logs, trash rack and TWSs.

3.11.7 EOT crane of adequate capacity shall be provided for maintenance of the pumps and other auxiliary equipment.

3.11.8 All the openings shall be covered with galvanized mild steel gratings when the stop logs/trash rack/TWSs are placed in position. Grooves for stop logs/trash rack/TWSs shall be covered with epoxy painted mild steel gratings. Handling arrangement for stop logs/trash rack/TWSs shall be provided. Sufficient paved space shall be provided to place stop log /trash rack/TWSs when not in use and also for their maintenance. Each individual pump sump shall be provided with a drain sump to empty the sump for attending to the maintenance of the pump.

3.11.9 Sea Water pump house shall accommodate switchgear and control room with cable vault below and toilet block. Control room shall have false ceiling /false flooring and shall be air-conditioned. Necessary Office room for plinth area of 1000 sq ft shall be provided in the proposed pump house. The entire pump house shall be constructed in line with the requirements stipulated in Vol-VI of the specification.

3.11.10 All doors shall be of Aluminum. For switch gear room, the main entrance door shall be of adequate size to facilitate movement of panels. All windows shall be Aluminum glazed side hung.

3.11.11 Rolling shutter shall be provided as required.

3.14.0 **Discharge Pipe from Sea Water Pumphouse**

3.14.1 Sea water intake from the sea water intake pump house at NCTPS stage-II upto the proposed plant boundary shall be thru' 2x50%GRP pipes run overground along the route of coal pipe conveyor and preferably on pedestals. The two equally sized intake pipes shall be sized for a cumulative flow of 22640 cum/hr (approx) as detailed before. The pipes shall run on the pipe conveyor trestle at canal crossing, railway crossing & road crossings and statutory clearances as required shall be maintained for the same.

Inside the proposed plant area and after necessary bifurcation for the respective facilities, process make-up water pipe(s) to sea water Treatment plant and CT make-up pipe(s) to cooling tower forebay shall be laid underground. Pipe material shall conform to stipulations under chapter-13 of this volume.

3.14.2 A drawing showing the tentative route of pipe lines is enclosed for reference in the plot plan. All necessary Permission /Clearances for crossing Railway and High way enrouting pipelines shall be obtained by the contractor. All the works including crossing

Railway line, Highways and local bodies etc., and construction of culverts/ casing pipes as may be required by the respective agencies etc.,are included in the scope of work. TANGEDCO will assist in the matter. Statutory fees to be paid to the Govt agencies shall be paid by the Contractor.

3.14.3 Suitable anchor blocks and thrust blocks shall be provided.

3.15.0 PAINTING

All paints, painting materials and accessories for the painting shall be supplied by the contractor.

Painting shall be as indicated in Volume II

3.15.1 PAINTING OF STRUCTURAL STEEL

Refer Volume II & Volume VI.

3.16.0 Electrical equipment and system shall conform to the requirement specified in Volume IV - Electrical Works. HT/LT supply is required for the pumps. The HT/LT supply will be provided by the owner at the incoming end in the switchger room. The switchgear, room and other fcilites beyond this shall be provided by the contractor.

DATA SHEET FOR SEA WATER INTAKE PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	4 (3 working + 1 stand by) for the proposed 2x660 MW plant +1x660 MW future plant operation, out of which 2 pumps shall meet the total make up water requirements of proposed 2x660 MW plant operation (Ennore SEZ)
2.	Pump capacity	M^3/ hr	By Bidder (pump shall have 10% margin on capacity over actual requirement)
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 Turbine Pumps
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Sea 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		Bidder to indicate.
14.	Recirculation capacity		Minimum 30 % of the rated flow
15.	Materials of construction		
a.	Casing		Duplex SS 2205 UNS 31803
	Column Pipe		Duplex SS 2205 UNS 31803
c.	Impeller		Duplex SS 2205 UNS 31803
d.	Shaft		Duplex SS 2205 UNS 31803
e.	Line shaft coupling		Duplex SS 2205 UNS 31803
f.	Line shaft bearing		Duplex SS 2205 UNS 31803
g.	All hardware under water		AISI SS 316L
h.	Wearing Ring		Duplex SS 2205 UNS 31803
i.	Shaft sleeve		Duplex SS 2205 UNS 31803
j.	Thrust bearing cooling system pipes and valves		SS 316
k.	Thrust Pads		Carbon steel with white metal lining
l.	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating inside
m.	Gland Packing		Impregnated Teflon
n.	Stuffing Box Housing		SS 316L

DATASHEET FOR STOP LOG GATES & TRASH RACK

Material of Construction Stoplog Gates

a.	Guides/ Anchors	:	SS 316L
b.	Gate leaf & lifting beam	:	SS 316L
c.	Rubber seals	:	As per Appendix-B of IS: 4622
d.	Lifting Beam	:	SS 316L
e.	Frame	:	SS 316L
f.	Fastners	:	SS 316L

Material of Construction Trash rack

S. No.	**Component**	**Materials**
1.	Screen Wire	SS 316L
2.	Clear opening size	25mm x 25mm (at individual pump sump) 50mmx50mm (at intake channel)
3.	Side guide-cum-track	SS 316L
4.	Frame	SS 316L
5.	Mechanical fasteners	SS 316 L

All the codes and specifications mentioned shall be of latest edition.

DATASHEET FOR TRAVELLING WATER SCREENS

Material of Construction

a.	Guides/ Anchors	:	SS 316L
b.	Frame	:	SS 316L
c.	Rubber seals	:	As per Appendix-B of IS: 4622
d.	Screens	:	SS 316 L with 50 mm sq. clear opening
e.	Sprocket	:	SS 316 L
f.	Wheels	:	SS 316 L
g.	Shaft	:	SS 316 L
h.	Fastners	;	SS 316 L
i.	Nozzles	:	SS 316 L
j.	Pipes	;	SS 316 L

All the codes and specifications mentioned shall be of latest edition.

DATA SHEET FOR SCREEN WASH PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	2 (1 working + 1 stand by)
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
6.	Location		Indoor
7.	Type of internal element		
8.	Liquid handled		Sea 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		Bidder to indicate
14.	Materials of construction		
a.	Casing		Duplex SS 2205 UNS 31803
c.	Impeller		Duplex SS 2205 UNS 31803
d.	Shaft		Duplex SS 2205 UNS 31803
e.	Line shaft coupling		Duplex SS 2205 UNS 31803
f.	Line shaft bearing		Duplex SS 2205 UNS 31803
g.	All hardware under water		AISI SS 316L
h.	Wearing Ring		Duplex SS 2205 UNS 31803
i.	Shaft sleeve		Duplex SS 2205 UNS 31803
j.	Thrust bearing cooling system pipes and valves		SS 316
k.	Thrust Pads		Carbon steel with white metal lining
l.	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating inside
m.	Gland Packing		Impregnated Teflon
n.	Stuffing Box Housing		SS 316L

CHAPTER 4

4.0 SEA WATER TREATMENT PLANT

4.1 The sea water intake pumps shall supply sea water to the sea water treatment plant dedicated for the proposed 2x660 MW plant and located in the proposed plant site through adequately sized pipeline, control station and cascade aerator.

Refer composite water scheme enclosed in Vol VII for this system. However the water quantites indicated are only tentative. The exact quantities will have to be worked out by the contractor.

4.2 Sea water analysis is enclosed in this chapter.

4.3 **Pretreament & Filtration Plant**

a) Flow control station upstream of cascade aerator consisting of a throttling type motorized butterfly valve with isolation valves and by pass valve.

b) One (1) Cascade type aerator to oxidize ferrous to ferric and to remove dissolved carbon dioxide

c) One (1) stilling chamber with retention time of min. 1 minute.Drainage to be connected with sludge sump.

d) One (1) flow measuring element (Parshall flume) and 2 nos. flow transmitter, one at the inlet channel to flash mixer and the other at the outlet channel of clarifier.

e) One (1) flash mixer with retention time of min. 1 minute and slow speed agitator or baffles, isolation gates etc. Drainage to be connected with the sludge sump.

f) Two (2) clariflocculators (over ground), complete with rake mechanism, flocculator mechanism alongwith drive and drive motors, telescopic type continuous sludge discharge arrangement, intermittent timer operated by- pass sludge disposal system, flushing arrangement etc.

g) Coagulant (Alum) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.

h) Coagulant aid (Polyelectrolyte) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.

i) Lime dozing system consisting of 2 nos. dozing tanks and 2 x 100% capacity dosing pumps complete with associated piping and valves.

i) Clarified water storage tank (above ground) of RCC construction and effective capacity 5000 m^3, with two compartments and a common sump and a pumphouse. This tank shall be covered.

j) The Clarified water pumphouse shall house3 x 50 % Filter feed Pumps.

k) 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.)
iv)	Chlorine for Pre- Treatment	:	5 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.

l) One (1) complete sludge handling system consisting of reject sump of 2000 cum. effective capacity, three(3) nos. vertical sludge pumps (2Working+1Stand-by) , each of 1000 cum/hr capacity , sludge flushing arrangement etc.

m) One(1) no. platform dial type weighing scale of 0-500 kg capacity and an electric hoist of suitable capacity in the chemical house.

n) All RCC channels/ ducts and hume pipes as required for sea water PT plant.

o) All pipe, or RCC channels/ ducts and hume pipes required for sludge disposal drain/ filter backwash water shall be led to sludge/ reject sump.

p) Necessary flushing arrangement for the sludge pipes and filter back wash water disposal pipes.

q) Two nos. (1W+1S) twin section dual media filters with inlet channels, flow controller, filter media, internals complete with associated piping and valves.

r) Seven nos (6W+1S) Ultra filter modules complete with filter media, internals complete with associated piping and valves. Backwash provision of the UF shall consist of UF backwash pumps 2(1W+1S), dozing skids with dedicated pumps 2(1W+1S). Filter backwash from the filter outlet shall also be led to guard pond.

s) One (1) no. RCC UF Permeate Water Storage tank of effective capacity 2000 cum in two compartments. Tank shall be covered.

t) Seven (6W +1S) Cartiridge filters.

u) 3 x 50% Cartridge Filter Feed Pumps.

v) 2 x 100% UF Backwash Pumps

w) Other civil works as specified.

x) Isolating gates and shutters as detailed below:

i. Isolation gates with hand wheel at inlet to clariflocculator
ii. Isolation gates with hand wheel at outlet of clariflocculator

4.4 REVERSE OSMOSIS PLANT

4.4.1 RO STAGE-I

a) Three nos. (2W +1S) RO Stage I high pressure pumps taking suction from ouitlet of cartridge filters with associated piping and valves. Each pump shall be supplied with suitable energy recovery device (ERT/ turbo charger/ pressure exchanger) with all associated instruments and controls.

b) Sea Water RO antiscalant dosing system consisting of 2 x 100 % dosing pumps and 2 nos. solution dosing tanks complete with associated piping, valves and instrumentation.

c) Sea Water RO acid dosing system consisting of 2 x 100 % dosing pumps and 2 nos. acid dosing tanks complete with associated piping, valves and instrumentation.

d) Sea Water RO sodium meta bi sulphite dosing system consisting of 2 x 100 % dosing pumps and 2 nos. solution dosing tanks complete with associated piping, valves and instrumentation.

e) 2 (2W + 0S) degasser towers located on RO Stage I Permeate Tank.

f) One (1) no. micron cartridge filter for each dozing system.

g) Automatic pH correction system in RO stage I Permeate tank consisting of tank and 2 (1W+1S) dosing pumps interlocked with pH analyzer mounted in the RO stage I permeate tank. System shall be completely automatic.

h) 3 x 50% capacity RO Stage I modules (with 35% recovery) with associated feed, permeate and reject piping with all valves and fittings etc. The permeate of RO Stage I shall be minimum 560 cum/hr.

i) Permeate from RO stage I shall be stored in Filtered Water Storage Tank (RO Stage I Permeate) / fire water tank. This tank shall be in two compartments and covered. The effective capacity of the tank shall be 12000 cum or of 24 hrs consumptive water requirement whichever is higher. The common sump in which all the pumps including fire water pumps are installed shall have dedicated storage for fire water as per TAC norms. However this dedicated storage for fire water in the common suction sump shall not be less than 3500 cum. The tank shall be overground and of RCC construction. Pumps shall be installed in this tank as indicated in Chapter 12 & 25.

j) The tank shall be overground and of RCC construction with lining/ painting as indicated in Vol VI.

k) Two (1W+1S) RO Stage I permeate supply pumps taking suction from RO stage-I permeate tank.

l) RO modules chemical cleaning system consisting of one chemical cleaning tank for stage-I, 2x100% chemical cleaning pumps for stage-I RO and 2x100% micron cartridge filters for stage-I.

m) RO Stage I Reject shall be led to the guard pond.

4.4.2 RO STAGE II

a) Two (1W+1S) RO stage-II high pressure supply pumps taking suction from Filtered water storage tank.

b) 2 x 50% RO Stage II modules (with 70% recovery) with associated feed, permeate and reject piping with all valves and fittings etc.

c) One no. RO Stage II permeate tank of 1200 cum capacity.

d) RO antiscalant dosing system consisting of 2 x 100 % dosing pumps and 2 nos. solution dosing tanks complete with associated piping, valves and instrumentation.

e) RO acid dosing system consisting of 2 x 100 % dosing pumps and 2 nos. acid dosing tanks complete with associated piping, valves and instrumentation.

f) RO sodium meta bi sulphite dosing system consisting of 2 x 100 % dosing pumps and 2 nos. solution dosing tanks complete with associated piping, valves and instrumentation.
g) Three (2W+1S) micron cartridge filters upstream of RO Stage II.
h) RO modules chemical cleaning system consisting of one chemical cleaning tank for stage-II and 2x100% chemical cleaning pumps for stage-II RO and 2x100% micron cartridge filters for stage-II.
i) Complete interconnecting piping with fittings, valves, specialties and instrumentation with all pipe support. Also pedestals, pipe racks, hangers, expansion joints etc. (wherever necessary) for pipe lines including air piping, valves shall also be included.
j) Mandatory spares as specified.
k) First fill of lubricants.
l) Safety shower (whole body shower) and eye wash station.
m) Control & instrumentation as specified.
n) Electrical system as per requirement.
o) All platforms, walkway platform, approach ladders, hand rails as required for approach, installation, removal and maintenance of various equipment.
p) All equipment foundations.

4.5 DM PLANT

4.5.1 DM plant consists of chain of SAC, SBA followed by MB to treat RO Stage- II outlet water to reduce the loading to MB during any abnormal variation in sea water quality.

a) Three (2W+1S) RO Stage II permeate water pumps.
b) Two (2) DM water storage tanks, each of 1000 cum capacity.
c) 2 x 100% CST make Up/ DM Water transfer pumps
d) Two (2) Condensate storage tanks, each of 750 cum capacity.
e) 2 x 100% Hotwell make up pumps for unit # 1.
f) 2 x 100% Hotwell make up pumps for unit # 2.
g) 2 x 100% Boiler Fill pumps
h) 2x 50% SAC Units with piping and valves to take care of any extra load from RO stage-II in the long run. Each SAC shall be sized for 20 hours operation and generate the DM water requirement for one unit. The feed to the SAC shall be RO Stage II permeate.
i) 2 x 50% SBA units with piping & valves to take care of any extra load from RO stage-II in the long run. Each SBA shall be sized for 20 hours operation and generate the DM water requirement of one unit. . The feed to the SBA shall be SAC permeate.
j) A bypass line with valve shall be provided to bypass the SAC & SBA system to feed RO stage-II permeate directly to MB.
k) Three (2W+1S) capacity MB Units with piping & valves directly from RO stage-II through the by-pass line or from the outlet of SBA (during extra load from RO Stage-II). Each MB shall be sized for 140 hours operation and generate the DM water requirement of one unit. . The feed to the MB shall be normally from RO stage-II or from SBA permeate during abnormal variation in sea water quality.
l) 3 x 50% (2W + 1S) regeneration water pumps.

The regeneration system shall be common for CPU & MB. However in case common regeneration system is not possible then bidder shall provide two independent regeneration systems. However in case of common regeneration system for CPU & DM only the bulk tanks, unloading pumps and N Pit with disposal pumps shall be common. Everything else shall be separate

m) Necessary instrumentation and PLC systems for fully automatic controls.
n) Flow meter shall be provided before condensate storage tank.

o) All interconnecting piping, fittings, valves, specialty & instruments necessary for smooth operation of the system.

p) All acid/ alkali pipes, valves & fittings shall be of CPVC PN 10 grade only.

q) Acid/ Alkali regeneration system for conventional DM chain (SBA, SAC, MB) (sized to hold 120% of one regeneration) consisting of:

- Two (2) nos acid measuring tank, one each for SAC & MB (at SBA outlet).
- Two (2) nos alkali measuring tank, one each for SBA & MB (at SBA outlet) with dissolving basket & motorized agitator.
- 2 x 100% acid metering pumps or ejectors for each system (SAC & MB (at SBA outlet))
- 2 x 100% alkali metering pumps or ejectors for each system (SAC & MB (at SBA outlet))

r) Acid regeneration system for CPU (sized to hold 120% of one regeneration) consisting of:

- One acid measuring tank
- 2 x 100% acid metering pumps or ejectors

s) Alkali regeneration system for CPU (sized to hold 120% of one regeneration) consisting of:

- One alkali preparation cum measuring tank with dissolving basket & motorized agitator.
- 2 x 100% acid metering pumps or ejectors

t) 2 x 100% capacity air blowers for mixed bed units (at SBA Outlet), complete with all accessories

4.6 The quality of DM water at the outlet of MB units at design flow rate shall be guaranteed under correction as follows :

Conductivity at the outlet	:	not greater than 0.1µmho/cm @25^{0}C
pH	:	6.8-7.2
Total Silica (reactive + colloidal)	:	not to exceed 0.01 ppm as SiO_2
TOC	:	< 300 ppb

The load on mixed bed shall not be more than 25 ppm.

4.7 Acid/Alkali storage system consists of the following :

(i) Two nos (1W+1S) acid unloading pumps
(ii) Two nos (1W+1S) alkali unloading pumps
(iii) Two (2) nos. bulk acid tank (cumulatively sized for 15 days storage for DM plant/ MB & CPU) or 20 cum capacity each, whichever is higher.
(iv) Two (2) nos. bulk alkali tank (cumulatively sized for 15 days storage for DM plant/ MB & CPU) or 20 cum capacity each, whichever is higher.

4.8 **NEUTRALIZATION SYSTEM**

i. One no. each alkali/ acid measuring tank for N pit.
ii. 2 x 100% acid metering pumps or ejectors
iii. 2 x 100% neutralized waste disposal cum recirculation pumps.
iv. Two nos. eye wash/ safety shower.
v. Neutralizing pit in two compartments with suitable acid/ alkali resistant lining. Each section to hold minimum 1.2 times the waste quantity generated during one regeneration of CATION & ANION resins, MB & CPU
vi. Instrumentation & controls.

Note : if CPU regeneration system is located near DM plant the acid/ alkali unloading pumps, bulk acid/ alkali tanks and neutralization pit with all accessories shall be common for DM & CPU.

4.9 **LAYOUT REQUIREMENTS**

4.9.1 RO Stage II plant and DM equipment shall be located in an RCC building with a chemical laboratory located on the first floor. Necessary drain trench (with suitable lining) for carrying regeneration/ backwash effluents and pipe/ cable racks shall also be provided.

4.9.2 The UF Building, chemical house, RO Stage-I plant, Cartridge filters, RO Stage-I Permeate pumphouse, UF Permeate pumphouse and Laboratory shall be RCC building with necessary drain trenches, lining for carrying regeneration/ backwash effluents and pipe/ cable racks.

4.9.3 Chemical house shall be a complete building to house the following:

a) NaOCl dosing equipment for clarifiers.
b) Coagulant dosing equipment for clarifiers.
c) Coagulant aid dosing equipment for clarifiers.
d) Electric hoist for handling PT chemicals to be located inside the chemical house.
e) Chemical storage for PT plant chemicals.

Chemicals that need to be dosed at the pretreatment plant will be stored in a chemical house for a storage period of 30 days. The chemical house will be located near the pre treatment plant and will be designed for proper ventilation, lighting and chemical protection. The chemical house will have sufficient unloading space, wide corridors, toilets etc. The chemical house will be of two floors. All chemical preparation tanks and dosing pumps will be located in the first floor. Suitable walkways, handrails, platforms shall be provided.

f) Handling of chemicals

The chemical house shall have suitable handling arrangement for the housed equipment and chemicals. Monorail with chain pulley block shall be provided for the same. The coagulant stocking area (floor and wall upto the height of stocking) will be lined with acid resistant tiles. For coagulant solution preparation, a 2 m^3 potable water overhead tank of RCC construction is envisaged.

g) All chemical handling pipes, valves & fittings shall be of CPVC PN 10 grade only

4.9.4 All access platforms and stairways necessary for the operation & maintenance of equipment supplied under this contract shall be provided by the bidder.

4.9.5 Bidder shall furnish the general arrangement drawing as proposed by him clearly indicating the dimensions of various equipment, pipe routing, maintenance space etc. The pipelines and valves shall be laid out in such a way that they are easily accessible for any maintenance or repair. Bidder to propose and optimize layout ensuring adequate space for operation and maintenance of equipment.

4.10 DESIGN REQUIREMENT

4.10.1 SPECIAL MECHANICAL REQUIREMENT

a) The analysis of sea water for design is detailed in this chapter. Bidder shall furnish detailed analysis of treated water from RO stage I & Stage II clearly identifying the constituents (as $CaCO_3$ equivalent) that are expected with the rate of dosing of various chemicals considered by them for the RO plant offered. The offer for RO

stage I shall be based on a recovery of 35% and RO stage II shall be based on a recovery of 70%. If recovery more than the above is offered, proof of installation and working of such systems satisfactorily for at least 3 years shall be furnished in the bid.

b) The water analysis furnished is only indicative. It is the responsibility of the vendor to establish the correct design analysis through analysis of water samples collected at least 3 times a day over a period of I year and analysis for all constituents that are critical for the performance of the RO plant.

c) Bidder shall furnish necessary curves for the membranes which show the variation in permeate quality (I and II stage) with respect to variation in feed water and TDS levels.

d) The sludge from the clarifiers shall continuously be removed through a telescopic pipe arrangement with which continuous sludge removal rate can be adjusted. Apart from continuous sludge bleed off through the telescopic pipe arrangement, provision shall also be made to intermittently blow off the bottom sludge of the clarifier through a manually operated sludge blow off and drain valve. Air blowing facility shall be provided in the common sludge disposal sump.

e) Adequate instrumentation as required shall be provided for monitoring performance, protection and operation of various components of the plant. The operation philosophy and instrument details shall be clearly highlighted in the bid.

f) RO plant shall be designed for 24 hours operation.

g) An optimum energy recovery device shall be provided for the RO plant high pressure pumps. Bidder shall provide all technical details of such system offered. Proof of installation and satisfactory operation of the system for at least 2 years as on date of bid opening shall be included in the bid.

In case ERT (Energy recovery turbine) is proposed as an energy recovery device for each RO plant high pressure pump, the rating of the motors for these pumps shall be based on the power requirement to run these pumps without energy recovery device. In case the energy recovery device is other than ERT, then the required motor rating shall be indicated separately in the motor list and the method of start up of the high pressure pumps with such energy recovery devices shall be clearly indicated in the bid.

h) The quality of treated water from RO stage I & II shall be guaranteed over the ranges of TDS. Bidder shall guarantee the power consumption of RO high pressure pumps and indicate the corresponding temperature at which the power consumption is guaranteed.

i) Bidder to note that acid dosing system is not proposed and all requirements for RO membranes in terms of pH etc. shall be ensured by the bidder with dosing systems specified. Bidder to confirm suitability of the above scheme to meet the system requirements.

j) Chemicals required for one month operation of PT & RO Stage I outlet shall also be provided by the bidder. Space required for the same shall be clearly identified on the GA drawing to be furnished alongwith the bid.

k) Bidder to note that separate lines from each stream of RO Stage I outlet shall be provided with valving arrangement so that permeate water of inferior quality (below desirable limits) will not be allowed to feed RO Stage II. Instrumentation and control to achieve the above shall be provided.

l) Each SA, SBA & MB shall be sized to generate total DM Make up for 2 units in 20 hours. The input quality of water to SAC & SBA shall be RO Stage II Permeate.

m) Painting as specified in Vol II.

4.11.0 **PLANT WATER SYSTEM**

4.11.1 Plant Water system shall consist of the following :

(i) Service water system
(ii) Potable water system
(iii) FGD make-up
(iv) AHP seal water make-up
(v) HVAC make-up
(vi) CHP DFDS
(vii) RO stage-II make-up, etc. as detailed in Chapter 25, 26 & 27 and schematically depicted in the composite water scheme enclosed in Vol VII.

4.12.0 **CONTROLS**

4.12.1 **R**efer clause 5.00 of Annexure 'C' volume V Instrumentation and Control works.

SEA WATER ANALYSIS

S.No.	Parameter	Unit	Value (Range)
1	**General**		
a	pH		7.94-8
b	Conductivity	millisiemens/cm	43.8-44.1
c	Temperature	Deg C	25-32
d	Turbidity	NTU	20-40
e	Total Organic carbon (total/ dissolved)	PPM of C	2.4-2.84
f	CO_2	Mg/l	<2
g	TDS	Mg/l	39600-39740
h	BOD	Mg/l	10-12
i	COD	Mg/l	88-96
j	Oil & Grease	Mg/l	<10
k	Phenols	Mg/l	0.08-0.09
l	Free Residual Chlorine	Mg/l	<0.2
2	**Cations**		
a	Cacium	Mg/l	459-478
b	Magnesium	Mg/l	1510-1516
c	Sodium	Mg/l	10100-12000
d	Potassium	Mg/l	358-450
e	Ammonia	Mg/l	4.43-5.42
f	Stontium	Mg/l	12.9-12.4
g	Barium	Mg/l	1.55-1.58
h	Aluminum Total	Mg/l	1-1.8
i	Aluminum Dossolved	Mg/l	0.8-1.0
j	Manganese Total	Micro g/l	0.2-0.6
k	Manganese Dissolved	Micro g/l	0.1-0.2
l	Iron total	Micro g/l	220-260
m	Iron Dissolved	Micro g/l	Below detectable limit (detectable Limit : 10)
3	**Anions**		
a	Chloride	Mg/l	18994-19194
b	Sulphate	Mg/l	3710-3949
c	Nitrate	Mg/l	136-152
d	Nitrite	Mg/l	0.46-0.62
e	Bicarbonate	Mg/l	144-148
f	Carbonate	Mg/l	Nil
g	Fluoride	Mg/l	2.64-2.8
h	Boron	Mg/l	0.14-0.17
i	Phosphate	Micro g/l	240-380
j	Sulphide	Micro g/l	Below detectable limit (detectable Limit : 100)
k	Silica Dissolved	Micro g/l as SiO_2	200-250
4	**Heavy Metals**		
A	Arsenic	Micro g/l	Below detectable limit (detectable Limit : 2)
B	Mercury	Micro g/l	Below detectable limit (detectable Limit : 1)
C	Cadmium	Micro g/l	120-130
D	Copper	Micro g/l	200-220
E	Nickel	Micro g/l	470-490
F	Molybdenum	Micro g/l	Below detectable limit (detectable Limit : 100)

5	**Suspended Particle Size Range**		
A	10 micron & above	Mg/l	Below detectable limit (detectable Limit : 10)
B	5 micron to 10 micron	Mg/l	Below detectable limit (detectable Limit : 10)
C	1 micron to 5 micron	Mg/l	Below detectable limit (detectable Limit : 10)
D	0.1 micron to 1 micron	Mg/l	20-26
6	**Colloidal Particle Size Range**		
A	SDI (10 Minutes)	-	10-20
B	SDI (5 Minutes)	-	20-40
7	**Density of sea water**	Kg/ cum	1030

Note : Unless otherwise indicated all elements shall be expressed in respective ionic form only.

DATA SHEET – SEA WATER TREATMENT PLANT

S. No.	Description	Units	Parameter
1.0	**Sea Water Inlet Pipe and Valves**		
a.	Size of inlet pipe	Mm	By bidder as per specification criteria
b.	Material of Construction of Pipe		Refer Chapter 13
c.	Inlet valves		
	i) Type		Electric motor actuated type butterfly valve long body as per AWWA–C-504.
	ii) Size	Mm	By bidder
	iii) Isolating & By pass valve		
	ii) Type		Butterfly valve with suitable gear boxes.
	iii) Size	mm	By bidder
d.	Ends		Flanged, flat serrated faced as per ANSI B - 16.5 class 150
e.	Material of construction		
	i) Body & disc		ASTM A 182 F 316L
	ii) Shaft		ASTM A 182 F 316L
	iii) Bearing & Gland packing		Teflon
	iv) Valve seat		SS 316L
	v) Disc seat		Renewable Nitrile rubber 70 to 75A shore hardness.
	vi) Seal retaining ring		ASTM A 182 F 316L
	vii) Bolts and nuts		ASTM A 182 F 316L
	viii) Gear casing		ASTM A 182 F 316L
	ix) Gears		Phosphor Bronze
	x) Pinions		Nickel molybdenum steel.
	xi) Pinion screw hardware		ASTM A 182 F 316L
2.0	**Cascade Aerator**		
	a. Number required	No.	One (1)
	b. Number of steps		Min. 7
	c. Surface loading	$m^2/m^3/hr$	0.045
	d. Material of construction		R.C.C
	e. Time	sec.	2
	f. Riser	mm	> 250
	g. Tread	mm	< 400
3.0	**Stilling Chamber**		
	a. Number required	No.	One (1)
	b. Construction		RCC
	c. Capacity	Cum	75
	d. Detention time	Sec.	Sixty (60)
4.0	**Parshall Flume**		
	a. Number required		One (1)
	b. Construction		RCC
	c. Capacity	Cum/hr.	1.2 times of clariflocculator
5.0	**Flash mixer**		
	a. Number required	No.	One (1)
	b. Construction		Radial, RCC
	c. Capacity	Cum	75 (min)
	d. Detention time (approx.)	Sec.	Sixty (60)

S. No.	Description	Units	Parameter		
	e. Free-board	Mm	Minimum 500		
	f. Agitator		Centrifugal type ac electric motor operated thru reduction gear, MOC : SS-316L		
	g. Protective cover of GI construction for motors and gear drives.		Required – protection for motors – IPW-55 (outdoor duty)		
6.0	**Clariflocculator**				
	a. MOC of inlet pipe		MS internally coated with Corrocoat/ Polyures/ GRP – please refer chapter 13. Pipe shall be selected for 10 Kg/cm^2(g) Pressure Class		
	b. Number required	No.	Two (2) nos 50% duty		
	c. Type & Construction		Radial, RCC		
	d. Rated Effluent Capacity	Cum/hr	By bidder		
	e. Effluent quality	NTU	<10		
	f. Detention period:				
	i.Flocculation zone	minutes	Thirty (30) (minimum)		
	ii.Clarifier zone	minutes	One hundred fifty (150) (min.)		
	g. Rise rate	$Cu.M/hr/m^2$	1.2		
	h. Surface flow rate of clarifier zone	$cum/hr/ m^2$	Not more than 1.2		
	i. Velocity in launder	m/sec.	Not more that 0.4		
	j. Platform with railing		1 M wide all along clarifloculator		
	k. Rake bridge :				
	i. Material		MS IS: 2062 Corrocoated or FRP coated.		
	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 of the clarifier	ϕ M x SWDM	By bidder		
	n. Flocculation Agitator		Vertical Slow speed motor driven thru reduction gear , MS Corrocoated/ FRP coated		
7.0	**Chemical House**				
	a. Number	No	One		
	b. Type		Two (2) storeyed building		
	c. Ground Floor		Chemical storage for PT Plant for 30 days (min.).		
	d. First Floor		Location of Chemical Tanks EL Approx. 5.0m with dozing pumps.		
	e. Handling Facility		Electrically operated Mono-rail with chain pulley block.		
8.0	**Dosing System**		**Coagulant Tank**	**Poly Electrolyte tank**	**Lime Tank**
	a. Numbers required		Three(3)	Two (2)	Two (2)
	b. Construction		RCC	RCC	RCC
	c. Internal lining		FRP/ PP Lining		

S. No.	Description	Units	Parameter		
	d. Minimum Capacity (effective)	Cum.	Each tank sized to hold 12 hours requirement		
	e. Solution strength	%	10	0.5	5
	f. Agitator – type		Vertical	Vertical	Horizontal
	MOC		SS	SS	MS
	g. Dissolving basket		In SS 316L Construction with 10 mm Φ holes on 50mm triangular pitch.		
	h. M.O.C. for piping valves, & fittings		CPVC PN 10		
	i. Solution dosing system - Coagulant - Polyelectrolyte		2x2000 lph (min) each diaphragm / plunger type with stroke adjustment metering pumps. 2 x 1000 lph (min)		
	j. Lime dosing system		2 x 1000 lph (min) screw type dosing pumps.		
9.0	**Reject Sump**		**Sludge**		
	a. Number	No.	One		
	b. MOC & Type		RCC with lining, Under ground, Outdoor location		
	c. Capacity (Effective)	Cu.m	2000 (min.)		
	d. Instruments		Level switch with indication on panel		
	e. Inside Protection		FRP/ PP Lining		
10.0	**Sludge Disposal Pumps**		Sludge		
	a. Numbers	No.	3 (2 W + 1 S)		
	b. Type		Vertical, non-clog		
	c. Capacity rate	Cum/hr	Minimum 1000		
	d. Head	Mwc	By bidder		
	e. Type of lubrication		Self lubrication		
	f. Material of Construction				
	i. Casing		Duplex SS 2205 UNS 31803		
	ii. Impeller		Duplex SS 2205 UNS 31803		
	iii. Shaft		Duplex SS 2205 UNS 31803		
	iv. Shat sleeves		Duplex SS 2205 UNS 31803		
	vi. Packing		Braided Impregnated Teflon		
	vii. Flexible coupling		Duplex SS 2205 UNS 31803		
	viii. Bolts & Nuts		SS-316L		
	g. Electric supply		415V, 3 phase, 50 Hz.		
	h. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55		
	i. Speed of pump motor	Rpm	1450		
11.0	**Clarified Water Storage tank**				
	a. Number	No.	One (1) (in two sections)		
	b. Effective capacity	m^3	5000		
	c. MOC		RCC		
	d. Type of tank		Above ground, fully covered (in RCC), RCC tank.		
	e. Level Indicator		Electro – mechanical		

S. No.	Description	Units	Parameter
	f. Inside protection		FRP/ Corrocoat lining/ as per Civil Spec
12.0	**DMF Feed Pumps**		
	a. Numbers		Three (2W+1S)
	b. Type		Vertical
	c. Capacity rate		By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		
	i. Casing		Duplex SS 2205 UNS 31803
	ii. Impeller		Duplex SS 2205 UNS 31803
	iii. Shaft		Duplex SS 2205 UNS 31803
	iv. Shat sleeves		Duplex SS 2205 UNS 31803
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		Duplex SS 2205 UNS 31803
	viii. Bolts & Nuts		SS-316L
	ix. Column Pipe		Duplex SS 2205 UNS 31803
	g. Electric supply		3.3Kv/ 415V, 3 phase, 50 Hz.
	h. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	i. Speed of pump motor rating		1450
13.0	**Dual Media Filter**		
A	No. of Modules		2(1W + 1S)
B	Type		Vertical
C	Capacity	Cum/hr	Min 1800 (approx)
D	Required total permeate		
E	Back Wash pumps		
	a. Numbers		Two (1W+1S)
	b. Type		Horizontal
	c. Capacity rate		By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		

S. No.	Description	Units	Parameter
	i. Casing		Duplex SS 2205 UNS 31803
	ii. Impeller		Duplex SS 2205 UNS 31803
	iii. Shaft		Duplex SS 2205 UNS 31803
	iv. Shat sleeves		Duplex SS 2205 UNS 31803
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		Duplex SS 2205 UNS 31803
	viii. Bolts & Nuts		SS-316L
	g. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	h. Speed of pump motor rating		1450
F	DMF backwash Tank		
	Quantity		One No.
	Effective Capacity	Cum	
	Type		Overhead Rectangular
	Material of Construction		RCC internally coated with coating as indicated in Volume VI for sea water structures
G	Air Blowers		Two (1W+1S)
H	Alum dosing tanks		21No.
I	Alum dozing pumps		2 (1W+1S)
J	Material of Construction		
	Frame and support legs		SS 316 L
	Filter media		Sand & anthracite
	Piping		CPVC
	Flanges		**CPVC**
	Bolts and Nuts		**CPVC**
14.0	**Ultra-filtration module**		
A	No. of Modules		7 (6W + 1S)
B	Recovery		90%
C	Required total permeate	Cum/hr	Minimum 1600
D	Back Wash		By 2 x 100% pumps
E	Material of Construction		
	Frame and support legs		SS 316L

S. No.	Description	Units	Parameter
	UF Modfule		Polyehthersulfone membrane
	Piping		CPVC
	Flanges		**CPVC**
	Bolts & Nuts		**CPVC**
F	UF Backwash Pumps		
	a. Numbers		Two (1W+1S)
	b. Type		Horizontal
	c. Capacity rate		By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		
	i. Casing		Duplex SS 2205 UNS 31803
	ii. Impeller		Duplex SS 2205 UNS 31803
	iii. Shaft		Duplex SS 2205 UNS 31803
	iv. Shat sleeves		Duplex SS 2205 UNS 31803
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		Duplex SS 2205 UNS 31803
	viii. Bolts & Nuts		SS-316L
	g. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	h. Speed of pump motor rating		1450
G	**UF Permeate Tank**		
	Quantity		One No.
	Effective Capacity	Cum	2000 in two compartments and covered
	Type		Rectangular
	Material of Construction		RCC internally coated with coating as indicated in Volume VI for sea water structures
15.0	**Cartridge FIlter Feed Pumps**		
	a. Numbers		Three (2W+1S)
	b. Type		Horizontal
	c. Capacity rate		By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		
	i. Casing		Duplex SS 2205 UNS 31803
	ii. Impeller		Duplex SS 2205 UNS 31803
	iii. Shaft		Duplex SS 2205 UNS 31803
	iv. Shat sleeves		Duplex SS 2205 UNS 31803
	vi. Packing		Braided Impregnated Teflon

S. No.	Description	Units	Parameter
	vii. Flexible coupling		Duplex SS 2205 UNS 31803
	viii. Bolts & Nuts		SS-316L
	g. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	h. Speed of pump motor rating		1450
16.0	**Micron Cartridge Filter at outlet of UF**		
A	Quantity		7 (6W + 1S)
B	Mesh Size	Microns	To suit RO membranes
C	Material of construction		
	i. Cartridges		5 micron nominal 90% efficient rating POLYPROPYLENE
	ii. Body and Cover		SS 316L
D	Operating parameters		By bidder
E	Accessories		Differential pressure switch, drain/ vent cock and foundation bolts.
17.0	**RO stage-I High Pressure Feed PUMPS**		
	a. Numbers		Three(3W+1S)
	b. Type		Horizontal
	c. Capacity	Cum/hr	By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		
	i. Casing		Duplex SS 2205 UNS 31803
	ii. Impeller		Duplex SS 2205 UNS 31803
	iii. Shaft		Duplex SS 2205 UNS 31803
	iv. Shat sleeves		Duplex SS 2205 UNS 31803
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		Duplex SS 2205 UNS 31803
	viii. Bolts & Nuts		Duplex SS 2205 UNS 31803
	Ix. Seal		Mechanical
	g. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	h. Speed of pump motor rating		1450

S. No.	Description	Units	Parameter
18.0	**Reverse Osmosis Plant**		
18.1	**Sodium Meta Bi Sulphite System**		Each system comprising of 2 x 100% capacity dosing pumps with PP wetted parts, reciprocating type, 2 nos. solution preparation cum measuring tanks each of capacity to store one day's requirement of all the streams with motorized agitators with 20% margin. This shall be supplied independently & separately for both RO Stage I & RO Stage II.
18.1.2	**Antiscalant dosing system**		Each system comprising of 2 x 100% capacity dosing pumps with PP wetted parts, reciprocating type, 2 nos. solution preparation cum measuring tanks each of capacity to store one day's requirement of all the streams with motorized agitators with 20% margin. This shall be supplied independently & separately for both RO Stage I & RO Stage II.
18.1.3	**Acid dosing system**		Each system comprising of 2 x 100% capacity dosing pumps with PP wetted parts, reciprocating type, 2 nos. solution preparation cum measuring tanks each of capacity to store one day's requirement of all the streams with motorized agitators with 20% margin. This shall be supplied independently & separately for both RO Stage I & RO Stage II.
18.2	**RO module Stage I & II**		
A	Membrane material		Thin film polyamide
B	Membrane make		DOW/ TORAY/ KOCH/ GE/ HYDRONAUTICS
C	Material of construction		
	i. Pressure tube		FRP/ SS 316L
	ii. Product or feed tube of RO element		SS 316L
	iii. End plate / segemented ring		SS 316L
D	Salt rejection		99%(min)
E	Overall recovery		35% (min) for Stage I RO 70% (min) for Stage II RO
F	No. of Streams		3 x 50% for Stage I RO 2 x 50% for Stage II RO
G	Output required at RO outlet	Cum/hr	Stage I – by bidder (min. 560 cum/hr) Stage II – by bidder (min.114 cum/hr) (tentative values indicated in composite water scheme)
H	Suck back arrangement for membrane protection during emergency shutdown or stop		Yes

S. No.	Description	Units	Parameter
I	Any other protection system required for satisfactory performance of RO plant arrangement		Yes, to be decided suitably by the bidder.
J	Membrane Life		Not less than 3 years from date of handing over of plant after PG test
18.3	**Chemical cleaning System**		
A	Chemical cleaning tank		One for Stage I RO One for Stage II RO
B	Capacity	Cum	By bidder
C	Material of construction		MSRL
D	Accessories		SS 316 dissolving basket
E	Chemical cleaning pumps		2 x 100% for Stage I RO of SS 316 construction 2 x 100% for Stage II RO of SS 316 construction
F	Micron cartridge filter		2 x 100% for Stage I RO (MOC similar as specified elsewhere) 2 x 100 % for stage II RO (MOC similar as specified elsewhere)
19.0	**Degasser Tower**		
A	Quantity	Nos.	2(2W+0S) located on RO Stage I Permeate Tank
B	Capacity		By Bidder
C	Material of construction		MSRL
D	Packing		PP
20.0	**Degasser Blower**		
A	Quantity	Nos.	Three (2W +1S)
B	Capacity		As per process requirement
C	Material of Construction		CI with suitable painting
21.0	**Filtered Water Storage Tank (RO Stage I Permeate)**		
A	Quantity	Nos.	1
B	Capacity (Effective)	Cum	**12000 or 24 hrs consumptive water requirement whichever is higher.** The common sump in which all the pumps including fire water pumps are installed shall have dedicated storage for fire water as per TAC norms. However this dedicated storage for fire water in the common suction sump shall not be less than 3500 cum.

S. No.	Description	Units	Parameter
C	Type		Above ground in two compartments and covered.
D	Material of construction		RCC with suitable internal & external painting/ coating to withstand saline atmosphere as specified in Volume VI.
22.0	**RO stage-II Supply High Pressure Pumps**		
	a. Numbers		Two (1W+1S)
	b. Type		Horizontal
	c. Capacity	Cum/hr	By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		
	i. Casing		SS 316
	ii. Impeller		SS 316
	iii. Shaft		SS 316
	iv. Shat sleeves		SS 316
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		SS 316
	viii. Bolts & Nuts		SS 316
	Ix. Seal		Mechanical
	g. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	h. Speed of pump motor rating		1450
23.0	**RO Stage II Permeate tank**		
A	Quantity	1	
B	Capacity (Effective)	Cum	1200
C	Type		Above ground
D	Material of construction		MS Epoxy (internal) with suitable external painting (PU) to withstand saline atmosphere. Three Coats of high build epoxy internally having DFT of 150 microns. External PU coating having DFt of 300 microns.
26.0	**Strong Acid Cation Exchanger**		
26.1	Number of streams		Two (2) 50 % capacity streams

S. No.	Description	Units	Parameter
26.2	Service		Down flow
26.3	Design flow per stream (net)	m^3 / hr	Each SAC sized to produce make up of one unit in 20 hours (min 40 cum/hr).
26.4	Vessel Size	M	By Bidder
26.5	Vessel MOC		
	Shell		IS 2062 Gr B
	Dished End		IS : 2002 GR - 2A / SA - 515 - GR - 70
	Internal Lining		4.5 mm thk rubber lining in 3 layers as per IS 4682 Part I shore hardness 65 ± 5^0
26.6	Cycle time	Hrs.	20
26.7	Regeneration time	Hrs.	4
26.8	Regeneration Level	gm/L	By Bidder
26.9	Resin		ROHM & HASS/ BAYER/ PUROLITE/ DOW
26.10	Instruments required at each SAC Outlet		- Conductivity Analyser at oulet of each SAC & 100 mm above bed. - Sodium Analyser at outlet of each SAC
27.0	**Strong Base Anion Exchanger**		
27.1	Number of streams		Two (2) 50% capacity streams
27.2	Service		Down flow
27.3	Design flow per stream (net)	m^3 / hr	Each SBA sized to produce make up of one unit in 20 hours (min 40 cum/hr).
27.4	Vessel Size	M	By Bidder
27.5	Vessel MOC		
	Shell		IS 2062 Gr B
	Dished End		IS : 2002 GR - 2A / SA - 515 - GR - 70
	Internal Lining		4.5 mm thk rubber lining in 3 layers as per IS 4682 Part I shore hardness 65 ± 5^0
27.6	Cycle time	Hrs.	20
27.7	Regeneration time	Hrs.	4
27.8	Regeneration Level	gm/L	By Bidder
27.9	Resin		ROHM & HASS/ BAYER/ PUROLITE/ DOW
27.10	Instruments required at eachSBA Outlet		- pH Analyser - Conductivity Analyser - Silica Analyser

S. No.	Description	Units	Parameter
29.0	**Mixed Bed Units at outlet of RO Stage II/ SBA Exchanger**		
29.1	Number of streams		Three (3) (2W + 1S)
29.2	Service		Down flow
29.3	Design flow per stream (net)	m^3 / hr	Each MB sized to produce make up of one unit (min 40).
29.4	Vessel Size	M	By Bidder
29.5	Vessel MOC		MSRL
29.6	Cycle time	Hrs.	140
29.7	Regeneration time	Hrs.	4
29.8	Regeneration Level	gm/L	By Bidder
29.9	Resin		ROHM & HASS/ BAYER/ PUROLITE
29.10	Instruments required at MB Outlet		- pH Analyser - Conductivity Analyser -- Silica Analyser - Chloride Analyser - TOC Analyser
30.0	**DM Water Storage Tanks**		
30.1	Number	Nos.	Two (2)
30.2	Capacity of each tank	m^3	1000
30.3	Material of Construction	-	M.S. with solvent free epoxy coated DFT 500 microns (inside) and chlorionated rubber painting DFT 500 microns (outside)
30.4	Protection against atmospheric air	-	3 Layers of floating PP balls to be provided in DM Tank to prevent contact with atmospheric air. This shall be in addition to Co_2 breather
31.0	**CONDENSATE Storage Tanks**		
31.1	Number	Nos.	Two (2)
31.2	Capacity of each tank	m^3	750
31.3	Material of Construction	-	M.S. with solvent free epoxy painting DFT 500 microns (inside) and chlorinated rubber painting DFT 500 microns (outside)
31.4	Protection against atmospheric air	-	3 Layers of floating PP balls to be provided in DM Tank to prevent contact with atmospheric air. This shall be in addition to Co_2 breather

S. No.	Description	Units	Parameter
32.0	**RO STAGE-II Permeate Water Pumps**		
	a. Numbers		Three (2W+1S)
	b. Type		Horizontal
	c. Capacity rate		By Bidder
	d. Head		By Bidder
	e. Type of lubrication		Self lubrication
	f. Material of Construction		
	i. Casing		SS 316
	ii. Impeller		SS 316
	iii. Shaft		SS 316
	iv. Shat sleeves		SS 316
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		SS 316
	viii. Bolts & Nuts		SS 316
	g. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
	h. Speed of pump motor rating		1450
33.0	**MICRON CARTRIDGE FILTER AT INLET OF RO STAGE II**		
A	Quantity		2W + 1S
B	Mesh Size	Microns	To suit RO Stage II membranes
C	Material of construction		
	i. Cartridges		5 micron nominal 90% efficient rating POLYPROPYLENE
	ii. Body and Cover		SS 316L
D	Operating parameters		By bidder
E	Accessories		Differential pressure switch, drain/ vent cock and foundation bolts.

DATASHEET FOR REGENERATION SYSTEM

S. No.	Description	Unit	DESCRIPTION	
1.0	**Regeneration System**			
1.1	Acid/Alkali Unloading Pumps			
1.1.1	Number required	Nos.	Two (2x100%) for acid/alkali each	
1.1.2	Type	-	Horizontal centrifugal	
1.1.3	Location	-	Outdoor	
1.1.4	Service	-	Intermittent	
1.1.5	Capacity and head	M^3/hr, MWC	Cap. – 10 (min) Head – 15 (min)	
1.1.6	Material of Construction	-	Acid	Alkali
1.1.7	Liquid to be handled	%	HCL – 33.0%	NaOH – 45% to 48%
1.1.8	Material of construction			
	-Casing	-	Polypropylene	Polypropylene
	-Impeller	-	Polypropylene	Polypropylene
	-Shaft	-	BS-970 Hardened Steel EN8	BS-970 Hardened Steel EN8
	-Shaft Sleeves	-	Ceramic	SS 316
	-Types of shaft sealing	-	Mechanical	
1.1.9	Pump speed	Rpm	1450	
1.1.10	Drive motor	-	415V, 3Φ, 50 HZ TEFC.	
1.1.11	Accessories required between motor and pump	-	Coupling guard, drain plug, vent valve etc.	
1.1.12	Type of coupling between motor and pump	-	Flexible coupling	
1.1.13	Reinforced rubber house with coupling and isolation valve	Nos.	One (1) each, minimum 20 meter, Reinforced Chemical Resistant Rubber.	
2.0	MOC for piping, valves & fittings in acid/alkali handling		**CPVC PN10/Sch. 40**	
3.0	**Storage Tank**		**Acid**	**Alkali**
3.1	Numbers required (in case regeneration facility is separate for MB & CPU then the complete regebneration system shall be duplicated from what has been indicated in this datasheet)	Nos.	Two(2)	Two (2)
3.2	Location	-	Outdoor	
3.3	Total Useful capacity of each tank (indicated capacity or cumulative 15 days storage whichever is higher)	M^3	Min 20	Min 20
3.4	Type of Pressure class	-	Horizontal Cylindrical with Dished ends, Atmospheric.	
3.5	Material of Construction	-	FRP	Carbon Steel
3.6	Protection – Inside	-	-	4.5 mm thk rubber lining

S. No.	Description	Unit	DESCRIPTION	
3.7	Protection – Outside	-	-	Chlorinated rubber paint DFT 500 microns.
3.8	Concentration	%	33	48
3.9	Vent, overflow, Drain, fume absorber and sample connection pipe M.O.C.	-	Required, pipe, flange & valves CPVC PN 10/Sch.40	
3.10	Manhole, staircase, platform	-	Required	
4.0	**Metering Pumps**			
1.1	Acid/Alkali Metering Pumps			
1.1.1	Number required	Nos.	2 x 100 % acid for MB (RO Stage II Permeate/SBA permeate) 2 x 100 % alkali for MB (RO Stage II Permeate/SBA permeate) 2x 100 % acid for SAC 2x 100 % alkali for SBA 2x 100 % acid for CPU 2x 100 % alkali for CPU 2 x 100 % acid for N Pit 2 x 100 % alkali for N Pit	
4.1.2	Type	-	Horizontal centrifugal	
4.1.3	Location	-	Outdoor	
4.1.4	Service	-	Intermittent	
4.1.5	Capacity and head	M^3/hr, MWC	By Bidder	
4.1.6	Material of Construction	-	Polypropylene	Polypropylene
4.1.7	Liquid to be handled	%	Acid	Alkali
4.1.8	Material of construction		HCL – 33.0%	NaOH – 45% to 48%
	-Casing	-	Polypropylene	Polypropylene
	-Impeller	-	Polypropylene	Polypropylene
	-Shaft	-	BS-970 Hardened Steel EN8	BS 970 Hardened Steel EN8
	-Shaft Sleeves	-	Ceramic	SS 316
	-Types of shaft sealing	-	Mechanical	
4.1.9	Pump speed	Rpm	1450	
4.1.10	Drive motor	-	415V, 3Φ, 50 HZ TEFC.	
4.1.11	Accessories required between motor and pump	-	Coupling guard, drain plug, vent valve etc.	
4.1.12	Type of coupling between motor and pump	-	Flexible coupling	
5.0	**Concentration Density Meter**		**Acid**	**Alkali**
5.1	Number	Nos.	One (1) at each mixing tee outlet	
5.2	Type	-	Density indicator (Hydrometer type)	
5.3	Indication	-	Local	
5.4	Location	-	Diluted Acid / Alkali line	

S. No.	Description	Unit	DESCRIPTION	
6.0	**Neutralising System**			
6.1	**Neutralisation Pit**			
6.1.1	Number	Nos.	One (1) in two sections	
6.1.2	Material of construction	-	RCC with acid / alkali proof lining bricks	
6.1.3	Effective capacity	-	Each section to hold minimum 1.2 times the waste quantity generated during one regeneration of CATION & ANION resins, MB & CPU	
6.2	**Neutralised Waste Disposal cum recirculation Pumps**			
6.2.1	Number	:	Two (2) (1w+1s)	
6.2.2	Type	:	Horizontal, Centrifugal Single stage with priming system	
6.2.3	Capacity and total head of each pump	m^3/hr, MWC	Cap. – by bidder Head – by bidder	
6.2.4	Duty	-	Intermittent	
6.2.5	Pump Speed	rpm	1450	
6.2.6	Drive motor	-	Induction motor 415V, 3 phase 50Hz, TEFC	
6.2.7	Suction condition	-	Negative, with priming chamber	
6.2.8	Material of Construction			
	- Casing	-	2.5% Ni Cast Iron IS210 Gr. FG	
	- Impeller	-	Stainless Steel CF 8M	
	- Shaft	-	Stainless Steel SS 304	
	- Shaft coupling	-	Stainless Steel SS303	
	- Shaft sleeve	-	SS 316	
7.0	**Flow Indicator**			
7.1	Number	-	One in each water line	One in each water line
7.2	Type	-	Rotameter	Rotameter

S. No.	Description	Unit	DESCRIPTION	
7.3	Flow Switch	-	One in each water line, vane actuated type or DP bellows type	
8.0	**Measuring Tanks**		**Acid**	**Alkali**
8.1	Numbers required (in case regeneration facility is separate for MB & CPU then the complete regeneration system shall be duplicated from what has been indicated in this datasheet)	Nos.	• One for MB (RO Stage II Permeate/ SBA permeate) • One for SAC • One for N- Pit • One (1) for CPU	• One for MB (RO Stage II Permeate/ SBA permeate) with motorized SS 316 agitator & dissolving basket • One for SBA with motorized SS 316 agitator & dissolving basket • One for N Pit with motorized SS 316 agitator & dissolving basket • One for CPU motorized SS 316 agitator & dissolving basket
8.2	Location	-	Indoor	
8.3	Total Useful capacity of each tank (indicated capacity or cumulative 15 days storage whichever is higher)	M^3	By Bidder (sized to hold 120% of one regeneration)	By Bidder (sized to hold 120% of one regeneration)
8.4	Type of Pressure class	-	Vertical Cylindrical with Dished ends, Atmospheric.	
8.5	Material of Construction	-	FRP	Carbon Steel
8.6	Protection – Inside	-	-	4.5 mm thk rubber lining
8.7	Protection – Outside	-	-	Chlorinated rubber paint DFT 500 microns.
8.8	Concentration	%	33	48

S. No.	Description	Unit	DESCRIPTION
8.9	Vent, overflow, Drain, fume absorber and sample connection pipe M.O.C.	-	Required, pipe, flange & valves CPVC PN 10/Sch.40

CHAPTER 5

5.0 ELECTROCHLORINATION

5.1 To prevent microbiological fouling in the Sea Water Intake system,circulating water system and pretreatment system, an efficient chlorination plant shall be provided. The chlorine dosing shall be done in the Sea water intake sump & forebay, CW Pump suction pits and pretreatment plant on a continuous basis. The cooling tower shall operate at 1.3 COC.

CW Chemical Treatment

The CW Chemical treatment shall includes the following facilities:

a) Chlorine dosing system
- CW System – 1 ppm continuously for 22.5 hrs, shock dozing @ 2 ppm for 30 min 3 times a day
- Pretreatment Plant – 5 ppm continuous & Potable – 2 ppm continuous
- Sea Water Intake System – 1 ppm continuous
- Sewage treatment plant – 2 ppm continuous dozing

5.2 Electrochlorination shall be adopted to dose the requisite dosage of chlorine to the areas listed above. The chlorination system for CW System & PT shall be installed in a separate buildings which shall be located close to the circulating water pumphouse. The chlorination shall be designed for continuous operation.

Electrochlorination for the sea water intake system shall be provided from the existing electrochlorination system of NCTPS Stage II. The terminal point for same shall be from the existing electrochlorination building of NCTPS Stage II

The electrochlorination system delivers hypochlorite solution obtained by sea water electrolysis process.

5.3 **Scope of Supply**

A. **Electrochlorination for CW System and Preatreament plant**

a) 2 x 100% capacity sea water booster pumps
b) 2 x 100 % capacity automatic self cleaning sea water filters
c) 2 x 100 % transformer rectifiers for providing DC current
d) 2 x 100% Sodium Hypochlorite Generators.
e) Two (2) nos. Sodium Hypochlorite Storage Tanks, each of capacity 15 m^3 (min.).
f) 2 x 100% dilution air blowers for each sodium hypochlorite tank for hydrogen dilution.
g) 2 x 100% sodium hypochlorite dosing pumps for continuous dosing in CW system
h) 2 x 100% sodium hypochlorite dosing pumps for shock dosing in CW system
i) 2 x 100% sodium hypochlorite dosing pumps for continuous dosing in PT Plant
j) One (1) Sodium hypochloriote staorge tank for dosing in PT Area.
k) One (1) HCL circulation tank and 2 x 100% HCL circulation pumps for electrolyser cleaning.
l) PLC based control panel
m) UPS for PLC panel
n) MCC panel

B. Electrochlorination for Sea Water Intake System

Electrochlorination for the sea water intake system shall be provided from the existing electrochlorination system of NCTPS Stage II. The terminal point for same shall be from the existing electrochlorination building of NCTPS Stage II. However necessary equipment as listed below shall be supplied by the bidder for completing the chlorination dosing of sea water intake pumphouse.Necessary extension of dosing piping, supports, booster pumps, if required,

a) One (1) no. Sodium Hypochlorite Storage Tank of adequate capacity (min 2 cum).
b) 2 x 100% dilution air blowers for each sodium hypochlorite tank for hydrogen dilution.
c) 2 x 100% sodium hypochlorite dosing pumps for continuous dosing in Sea water intake sump.
d) PLC based control panel
e) UPS for PLC panel
f) MCC panel

5.4 All the pumps shall have 10% margin on capacity and frictional head over the actualrequirement.

5.5 Electrochlorination

The sea water shall be fed to the electrochlorination plant from the CW Sump from the ACW pump discharge header for CW system by means of 2 x 100% sea water booster pumps for each dosing system.

A flow transmitter along with flow control valve shall be provided at the inlet of each electrolyzer to regulate the flow of sea water according to generation rate of NaOCl.

The filtered sea water shall be fed to the electrolyzer unit The active hypochlorite solution shall be collected in the sodium hypochlorite storage degassing tank where the liberated hydrogen shall be vented out with air dilution.

Level transmitters shall be provided in the sodium hypochlorite degassing tank for controlling level in the tank.

The sodium hypochlorite solution shall be pumped to the CW/ Pretreatment plant by means of 2 x 100% continuous centrifugal pumps for each area.

The hydrogen generated with the hypochlorite in the sodium hypochlorite tank and 2 x 100% blowers for each tank dilute the hydrogen steam with air.

All piping valves & fittings shall be CPVC.

The electrolyser units, sea water booster pumps, TR sets will be located indoors.

MCC room and Control room shall be indoor.

Road access shall be available to chemical storage area for unloading.

The chlorination system shall be PLC controlled.

For controls refer clause 11.0.00 of Annexure ‘C’ volume V Instrumentation and Control works.

DATA SHEET - ELECTROCHLORINATION

S. No.	Item	Units	Description	
			CW System/ PT Plant	**Sea Water Intake System**
	ELECTROCHLORINATION			
1.0	**Automatic Self Cleaning basket strainer**			
1.1	Quantity		2 x 100%	
1.2	Mesh Screen Size	µ	500	
1.3	Material of Construction			
	Body		SS 316L	
	Screen		SS 316L	
2.0	**Sea Water Booster Pumps**			
2.1	Number required	Nos.	2 x 100%	
2.2	Type		Vertical/ Horizontal	
2.3	Capacity		By bidder	
2.4	TDH		By bidder	
2.4	Materials of construction:			
	Casing		Duplex SS 2205 UNS 31803	
	Impeller		Duplex SS 2205 UNS 31803	
	Shaft		Duplex SS 2205 UNS 31803	
	Shaft Sleeves		Duplex SS 2205 UNS 31803	
	Bolts & Nuts		SS 316L	
3.0	**Electrolysers**			
3.1	Quantity		2 x 100%	
3.2	Available Cl_2 content @ outlet	Ppm	2000	
3.3	Life of electrodes	Years	5	
3.4	Range of operation		10% to 100%	
3.5	Material of construction			
	Anode		Titanium with MMO coating	
	Cathode		Titanium	
	Shell		PVC lined with FRP	
	Gaskets		Titanium impregnated ebonite	
	Design pressure		1.5 times of sea water booster pump shut of head	
4.0	**Hypochlorite Dosing Pumps**			
4.1	Number required	Nos.	2 x 100 % for continuous dosing in CW system 2 x 100% for shock dosing in cw system 2 x 100% for continuous dosing in pretreatment plant	2 x 100% for continuous dosing in sea water intake sump
4.2	Capacity		By Bidder	By Bidder
4.3	TDH		By Bidder	By Bidder
4.4	Material of Construction			

S. No.	Item	Units	Description	
			CW System/ PT Plant	**Sea Water Intake System**
	Casing		Duplex SS 2205 UNS 31803	Duplex SS 2205 UNS 31803
	Impeller		Duplex SS 2205 UNS 31803	Duplex SS 2205 UNS 31803
	Shaft		Duplex SS 2205 UNS 31803	Duplex SS 2205 UNS 31803
5.0	**Dilute Hydrochloric Acid Tank**			
5.1	Number required		One (1)	One (1)
5.2	Capacity of each tank	M^3	20 or one tanker load whichever is higher	Min 2 cum
5.3	Material of Construction		FRP	FRP
6.0	**Hydrochloric Acid Circulation Pumps**			
6.1	Quantity		2 x 100%	2 x 100%
6.2	Capacity		By Bidder	By Bidder
6.3	TDH		By Bidder	By Bidder
6.4	Material of Construction			
6.5	Casing		PP	PP
	Impeller		PP	PP
	Shaft		PP	PP
7.0	**Hypochlorite Storage Tank**			
7.1	Capacity	M^3	15 each	15
7.2	Number required		Two	One
7.3	Type		Vertical Cylinder with dished top & bottom	Vertical Cylinder with dished top & bottom
7.4	Material of Construction		FRP	FRP
8.0	**H_2 Dilution Air Blowers**			
8.1	Number		2 x 100% for each hypochlorite tank	2 x 100% for each hypochlorite tank
8.2	Type		Horizontal, centrifugal	Horizontal, centrifugal
8.3	Location		Outdoor	Outdoor
8.4	Duty		Continuous	Continuous
8.5	Capacity		By Bidder	By Bidder
8.6	Head		By Bidder	By Bidder
8.7	Material of Construction			
	Casing		SS 316	SS 316
	Impeller		SS 316	SS 316
	Shaft		SS 316	SS 316
9.0	Transformer Rectifiers			
	Quantity		2 x 100%	
	Method of control		Thyristor	
	Output DC Current		By Bidder	
	Output DC Voltage		By Bidder	
	Cooling Type		Air Cooled	

CHAPTER 6

6.0 CONDENSATE POLISHING SYSTEM

6.1 DESIGN CRITERIA

6.1.1 There will be three (3) (2W+1S) vessels for each 660 MW unit, each polishing vessel of capacity 50% of Condensate flow corresponding to maximum :

- VWO (Valve Wide Open) condition at 1% make-up

OR

- HP / LP bypass charge condition

OR

- All HP heaters out of service

6.1.2 Operating pressure shall be normal operating pressure of condensate extraction pump.

6.1.3 (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 50 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.

6.1.4 The total pressure drop across condenser polisher units under dirty conditions shall be restricted to 3.5 bar (g).

6.1.5 The bed cross section of CPU service vessels shall be such that the average velocity of condensate through it shall not exceed 2 meter / sec. at design flow rate.

6.1.6 The effective depth of the mixed resin bed in the condensate service vessels shall not be less than 1100 mm.

6.1.7 The inlet and outlet quality for design of CPU exchanger shall be as under :

Sl. No.	Parameter	Unit	Normal Condition		Start-up or Condender Leak	
			I/L	O/L	I/L	O/L

Sl. 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		

6.1.8 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.

6.1.9 The regeneration process shall be of proven design and shall give resin – separation compatible with the desired effluent quality.

6.1.10 External Regeneration Facility shall be located in DM Plant area as shown in layout of DM Plant/CPU regeneration area.

6.2.0 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 connecting the external regeneration facilities to the condensate polisher vessels.

(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 foolproof 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 or acceptable equivalent international standard.

(x) All pressure vessels shall be fabricated from carbon steel plates as per SA-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 regenerant distributor

Hub and internals diffuser splash plate or header and perforated laterals. Material of construction shall be SS-316.

Under Drains

Same as above with screened laterals with internal perforated pipes and rubber lined flat bottom. For resin separation/ regeneration/ mixed resin vessels, it may have fully screened bottom (NEVA – clog type with pora septanurese screen, fully supported by subway grid or equal)/Fasteners

All internal fasteners shall be of SS-316 and heavy duty locknuts shall be used throughout.

(xviii) **Resin Traps**

Outlet of each condensate polisher vessel, activated carbon filter shall be provided with a resin trap. Pressure drop at design flow through a clean resin trap shall not exceed 0.35 kg/sq.cm. Resin trap shall be of steel construction and internals shall be of SS-316 construction. Resin traps of process effluent line shall have screen opening not exceeding 120 percent of associated process vessel under drain screen Opening. Other resin traps shall have screen opening of 60 mesh. Manual back flushing shall be provided for all resin traps.

(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) per unit oil free type air blowers with electric motor drive for supplying air required for mixing the resins in serice vessels.

(xvi) Adequate resins for each condensate polisher service vessels along with one (1) spare change of resin in the mixed resin storge tank. Two (2) spare charge of resins during commissioning and one (1) spare charge of resins as mandatory spares. Total charges twelve (12).

6.3.0 Emergency Bypass System

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.

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 vessel/one vessel/no vessel is in operation.

Either 2 x 50% or 100% capacity control valve shall be provided to achieve proper control under all operating conditions.

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.

The isolation valve shall be provided with geared operator for manual operation and shall be located at a height which can be easily operatable.

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.

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.

6.4.0 Exchange Resins

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.

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 systems are as follows:

1.0 Duolite.
2.0 Rohm and Hass
3.0 Dowex
4.0 Purolite.

The CPU Grade resin shall be of uniform particle size quality.

6.5.0 External Regeneration Facility

Bidder can propose a common regeneration system for the ROMB Plant & CPU. In case this is not feasible then separate regeneration facility shall be created for both ROMB & CPU. In case of common regeneration only the bulk tanks, unloading pumps & N Pit shall be common.

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 suppliers process requirement.

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) nos. 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.

6.5.1 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.

(vi) All the equipment, piping etc. shall be assembled on two structural steel skids one for acid and one alkali dosing equipment.

(vii) One (1) no. activated carbon filter for alkali rated flow of the filter shall not be less than the design capacity of the alkali unloading pump, and the maximum velocity through the filter for this flow shall not exceed 12 meters/hour: Depth of the filter materials shall not be less than 1 meter.

(viii) All instrumentation and controls as required.

6.5.2 Bulk acid and alkali storage tanks

DM Plant Bulk acid / alkali storage tanks shall be used for regenetaion of CPU veseels. In case common regeneration facility with DM plant is not feasible then separate regeneration facility shall be provided. In such case bulk acid alkali storage as listed below shall be provided.

Storage tanks shall be horizontal, dished ends, cylindrical type as per BS-2594 or equivalent and shall be located outdoor near the regeneration plant. This tank shall be made of mild steel as per relevant codes. The inside surface of caustic tanks shall be rubber lined (4.5 mm thick) and the out side surface shall be applied with chlorinated rubber paint. Acid tank shall be of FRP.Vessels should be complete with vent, overflow, sample connection manhole, staircase, and platform level indicator, fume absorber, overflow seal pot etc. along with two (2) nos (1W+1S) acid/alkali unloading pumps for each chemicals.

6.5.3 DM Water for regeneration

DM water required shall be drawn from DM Water Storage Tanks. In case separate DM Water Storage tank is required for CPU same shall be provided. The separate DM (CPU) tank, if required, tank shall be of mild steel construction with epoxy coating and necessary DM tank accessories like CO_2 absorber, polypropylene ball layer etc.

6.5.4 Effluent Disposal System

DM Plant neutralizing pit shall be used.

However in case it is not feasible to use the DM N Pit then separate N pit for CPU shall be provided. In such case neutralising pit shall be in two (2) sections of RCC construction lined with acid/ alkali resistant lining. Each section shall have a holding capacity of 1.5 times the waste effluent from one regeneration. Two (2 x 100%) capacity Waste Recirculation / Disposal pumps of horizontal centrifugal type with priming arrangement shall be supplied for waste recirculation and disposal Effluent Treatment Plant. The pump shall be designed to pump the total volume of one section of the pit in 2 hours. Proven agitation system like air agitation, venture mixing etc shall be provided in addition to recirculation from pumps. Provision for dosing acid/ alkali in the Neutralising pit from Bulk storage tanks to neutralize effluent before disposal shall be made.

Note: All Piping, Valves & Fitings in Regeneration Area and DM Water Area shall be of CPVC PN10/SCH 40 Only.

6.5.5 Operation

6.5.1 **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 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.

Please refer Volume V Annexure 'A' for additional details of controls.All the process valves & drive are to automated from DDCMIS.

Bidder to also refer clause 7.00 of Annexure 'C' volume V Instrumentation and Control works and clause 5.00 of volume V for DPU instructions.

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) The condensate-polishing unit shall be controlled from the PLC system, located near the service vessel. This system shall be suitably interlocked with the regeneration system control panel.

(ii) 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.

(iii) 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.

6.5.2 **Condensate Polisher Control System**

(i) The controls for CPU System shall be realized in PLC based Control System.

(ii) The requirements of PLC given are to be read in conjunction with Volume V.

(iii) In addition to the PLC based system, a control desk shall be provided to locate 2 No. of OWS (1 OWS & 1 OEWS), printer in regeneration area and 1 OWS in service area.

(iv) Plant schematic for monitoring & operation shall be available on OWS, bidder to further submit list of important signal 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 PLC with master clock system is to be carried out. Necessary hardware/software for same to be provided.

(vii) PLC shall be connected to DCS through OFC with Modbus/OPC protocol for monitoring.

(viii) Each PLC has to be accompanied by LIU (Light Interface Unit/Fibre Patch- Chord) which has multi mode SC coupler / adapters.

(ix) All bidirectional dirves are with integral starter, typical Hook up diagram of drives is attached for reference.

(x) 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..

(xi) Smart positioners shall be provided for pneumatically controlled valves

Each condensate polishing system shall be provided with a programmable logic control based local panel that will clearly show the status of each service vessel. From this panel it shall be possible to initiate any of the following operating modes. This panel shall be located near the respective condensate polishing vessels.

The following requirements of the control system shall be included:

i) Rinse Recycle

The rinse recycle shall be manually initiated in full automatic sequence. This sequence shall include the rinse down step using condensate at the rate of 0.4 to 0.6 cu.m/min/sq.m until the unit effluent quality is acceptable for boiler feed water. The effluent quality shall be determined by conductivity monitoring of the rinse water outlet which is returned to the condenser hotwell for recycle. A panel mounted cation conductivity indicator shall be interlocked to prevent advancing of the automatic sequence until the rinse down is complete.

ii) Service Mode

Service flow rate for each polishing vessel shall be monitored by panel mounted flow indicators. During periods of low condensate flow the operator may select to remove one of the vessels from service by a manually initiated automatic sequence. A differential pressure switch installed between the influent and effluent headers will on a high signal cause an annunciator alarm. By observing the individual vessel flow indicators, or conductivity at vessel outlet the operator can determine which vessel is contributing most to the pressure drop and is in need of resin cleaning.

Panel mounted cation conductivity indicators shall monitor the polishing system influent and effluent streams as well as the discharge of each service vessel. A high influent conductivity annunciator alarm will alert the plant operator that a problem condition such as air or condenser cooling water leakage has occurred. This conductivity analyser shall also provide contacts for an alarm at the power station main control room. A high effluent header or service vessel conductivity annunciator alarm will alert the operator to the need for regeneration of a polishing vessel.

iii) The sequence 'Resin Transfer from CPU Vessel to Regeneration plant' and Resin Transfer from Regeneration plant to CPU Vessel' shall be initiated from the condensate polishing unit control panel but shall be controlled by the programmable logic controller in the Regeneration Control Panel.

6.5.3 External Regeneration System

i) One external regeneration system shall be provided to serve the condensate polishing for the unit.

This system shall be designed for physical cleaning and chemical regeneration of the resin system will consist of required number of resin separation and regeneration vessels, a mixed resin storage vessel, the tank for introducing the required regeneration solutions and means for adding make-up resin. It will have acid, alkali, ammonia (if required) dosing system and alkali preparation facilities.

ii) Regeneration Control System

a) A manually initiated automatic sequence for physical cleaning and chemical regeneration of the resin shall be provided. Control for chemical dosing system and alkali preparation facility shall also be provided in it.

b) Demineralized water shall be used throughout the regeneration process for backwashing, regenerant diluent, rinsing and resin transfer.

c) A conical bottom hopper having a water ejector will be used for resin make-up.

d) The bidder shall submit with the proposal the complete detail of the system offered by him like the extent of automation offered, operation of the complete system, logic/flow diagrams, type and details of the presentation of information, the type and details of the presentation of information, the type of mimic, hardware details etc. along with detailed circuit descriptions.

iii) Resin Transfer

Manually initiated automatic sequences shall be provided for transferring resin from a vessel to the remote common facility for physical cleaning and chemical regeneration and for returning fresh resin to that vessel.

The transfer of resin from the service vessel shall include isolation of the service vessel, hydraulic transfer of the resin to the external regeneration system (resin separation vessel) and the complete drain down of the service vessel to the hot well.

iv) The complete control and operation of the Regeneration Plant shall be through Programmable Logic Controller.

v) It shall be possible to operate the Regeneration Plant in Auto/Semi-Auto/Manual mode.

vi) Following operations shall be possible from the Regeneration Control Panel.

a) Complete Regeneration.
b) Resin Transfer from CPU vessel to Regeneration Plant.
c) Resin Transfer from Regeneration Plant to CPU vessel.

vii) Operation (a) shall be initiated from the Regeneration Control panel whereas operation (b) & (c) shall be initiated from the CPU control panel.

viii) In 'Auto' mode, once the sequence has been initiated, it shall proceed from step to step automatically.

ix) In 'Manual' mode complete operation shall be by the operator by operation of the Control switches on the panel.

x) 'Close-Auto-Open' control switches shall be provided on the panel for the various drives. In 'Auto' position, the drives shall receive stop/start command from the PLC.

xi) 'Start-Auto-Start' Control switches shall be provided on the panel from the various drives. In 'Auto' position, the valves shall receive close/open command from the PLC.

xii) On PLC failure, it shall be possible to operate the valves by means of manual operation of solenoid valves too.

xiii) It shall be possible to switch mode of operation from one to the other at any moment and the operation shall proceed on the newly selected mode from that time.

xiv) For steps which require frequent time adjustment, it shall be possible to change the time setting from the front of the panel. For all other steps it shall be possible to adjust the time setting from inside the panel.

xv) For all sequences, the current step number, set time of the step, elapsed time of the step and the total elapsed time of the sequence shall be indicated on the front of the panel.

xvi) A mimic diagram of the Regeneration system shall be provided on the front of the panel. The status of various drives and valves shall be indicated by LED on the mimic diagram.

xvii) The system shall incorporate the necessary safety features. During automatic sequential operation, if any pre-requisite criteria is not fulfilled or missing for a pre determined time interval, the steps should not proceed further, the Alarm shall be provided. Missing criteria, sequence which is under hold up etc. shall be displayed on the panel.

xviii) The safety system for any sequence/step shall check the opening of the required valves and closure of the remaining valves of the plant to avoid mal-operation.

xix) Wherever standby equipments are provided, it shall be possible to select each of the drive on 'standby' duty.

xx) Start, progress and stop of each of the sequence shall be annunciated in all the control panels.

xxi) At any time only one of the sequence shall be in progress.

6.5.4 Interlocks

All interlocks for safe operation of the plant shall be provided. They shall specifically include the following as minimum requirement.

i) Service vessels can be back in service, only after they have been pressurized.

ii) Service vessels can be taken up for resin transfer only after they have been completely isolated from the condensate system and depressurised.

iii) Resin can be transferred to and from only one service vessel at a time.

iv) Resin transfer between the service and the regeneration skids shall be permitted only when the receiving vessel is initially empty.

v) Wherever possible, completion of all timed steps in the regeneration and resin transfer process shall be physically verified by effluent conductivity etc. as applicable. The automatic sequence shall be prevented from advancing to next step, till these required physical conditions are achieved, and at the same time this delay shall be annunciated in the control panel, to draw the attention of the operator. The automatic sequence of operations shall be interruptive at any time by the operator and he shall be able to take over the control to manual from that step onwards. Further operator should be able to over ride sequence, if required. It shall be possible for the operator to extend the timing of the particular step by isolating the timer for the duration. The timer will restart once the operator puts back the system on 'auto' and the other steps will then follow as programmed.

vi) The regeneration sequence shall be prevented from advancing further in the event of tripping of a running motor or other fault condition which do not permit the various desired parameter of this step to be achieved. A manual override for this shall also be provided.

vii) Annunciation logic shall be carefully designed so that the alarms are activated only under abnormal conditions. As for example, low flow of diluent water is only relevant when the chemical dosing is in progress. All other times, when no diluent water flow is required, this annunciation should be blocked. In general, Normal and trouble free operation of the plant shall not activate any of these alarms.

viii) Adequate diluent water flow shall be established before starting of the ejectors for acid and alkali regeneration.

ix) The immersion heater in the hot water tank can be put on only when there is adequate water level in the tank.

DATASHEET - CONDENSATE POLISHING UNIT

S. No.	**DESCRIPTION**	**VALUE**
2.0	**CONDENSATE POLISHER SERVICE VESSELS :**	
(i)	No. of condensate polisher service vessel	Three (3) (3 x 50%) Full flow condensate polishing for each unit – Total six vessels/
(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	By Bidder
(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%) per unit
(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

S. No.	**DESCRIPTION**		**VALUE**
(v)	Pressure gauge		One per blower
(vi)	Location		Indoor
(vii)	Material of construction		Cast Iron
(viii)	Drive 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 Vessel		One (1)
(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)	One (1)

S. No.	**DESCRIPTION**		**VALUE**
(ii)	Type	---------- Vertical Cylindrical Atmospheric with dished bottom and cover at 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 Gr. A/B	FRP
(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 – 1 as per IS : 12615	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%)

S. No.	**DESCRIPTION**		**VALUE**
(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	

S. No.	**DESCRIPTION**	**VALUE**	
(c)	**Concentration Density Meter**	**Acid**	**Alkali**
	Number	One (1) at each mixing tee outlet	
	Type	Density indicator (Hydrometer type)	
	Indication	Local	
(d)	Location	Diluted Acid / Alkali line	
	Flow Indicator		
	Number	One in each water line	One in each water line
	Type	Rotameter	Rotameter
	Flow Switch	One in each water line, vane actuated type or DP bellows type	
3.3	**ALKALI DILLUENT 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	

S. No.	**DESCRIPTION**	**VALUE**
		lugs (4 Nos. minimum) etc.
3.4	**CPU REGENERATRION 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)	Drive 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

S. No.	**DESCRIPTION**	**VALUE**
(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
(viii)	Drive 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. 40 only
(viii)	Acid / Alkali Transfer piping (Diaphragm Valves)	
(ix)	Instrument Air piping (Full Port Ball Valves)	IS 1239 Galvanized

S. No.	**DESCRIPTION**	**VALUE**
(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 Cl.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 standard : 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

S. No.	**DESCRIPTION**	**VALUE**
		d)Compressor : Stainless Steel e)Stem and Bush : Stainless Steel For Acid and Alkali services the valve shall be CPVC PN10/Sch 40 only.
(xii)	**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

DATASHEET - CONDENSATE POLISHING UNIT REGENERATION (INCASE COMMON FACILITY WITH ROMB IS NOT FEASIBLE)

S. No.	Description	Unit	DESCRIPTION	
1.0	**External Regeneration System**			
1.1	Acid/Alkali Unloading Pumps			
1.1.1	Number required	Nos.	Two (2x100%) for acid/alkali each	
1.1.2	Type	-	Horizontal centrifugal	
1.1.3	Location	-	Outdoor	
1.1.4	Service	-	Intermittent	
1.1.5	Capacity and head	M^3/hr, MWC	Cap. – 10 Head – 15	
1.1.6	Material of Construction	-	Acid	Alkali
1.1.7	Liquid to be handled	%	HCL – 33.0%	NaOH – 45% to 48%
1.1.8	Material of construction			
	-Casing	-	Polypropylene	Polypropylene
	-Impeller	-	Polypropylene	Polypropylene
	-Shaft	-	BS-970 Hardened Steel EN8	BS 970 Hardened Steel EN8
	-Shaft Sleeves	-	Ceramic	Alloy 20
	-Types of shaft sealing	-	Mechanical	
1.1.9	Pump speed	Rpm	1450	
1.1.10	Drive motor	-	415V, 3Φ, 50 HZ TEFC.	
1.1.11	Accessories required between motor and pump	-	Coupling guard, drain plug, vent valve etc.	
1.1.12	Type of coupling between motor and pump	-	Flexible coupling	
1.1.13	Reinforced rubber house with coupling and isolation valve	Nos.	One (1) each, minimum 20 meter, Reinforced Chemical Resistant Rubber.	
2.0	MOC for piping, valves & fittings in acid/alkali handling		**CPVC PN10/Sch. 40**	
3.0	**Storage Tank**		**Acid**	**Alkali**
3.1	Numbers required (in case regeneration facility is seaparety for MB & CPU then the complete regeneration system shall be duplicated from what has been indiucated in this datasheet)	Nos.	Two(2)	Two (2)
3.2	Location	-	Outdoor	
3.3	Total Useful capacity of each tank (indicated capacity or cumulative 15 days storage whichever is higher)	M^3	20	20
3.4	Type of Pressure class	-	Horizontal Cylindrical with Dished ends, Atmospheric.	
3.5	Material of Construction	-	FRP	Carbon Steel
3.6	Protection – Inside	-	-	4.5 mm thk rubber lining

S. No.	Description	Unit	DESCRIPTION	
3.7	Protection – Outside	-	-	Chlorinated rubber paint DFT 500 microns.
3.8	Concentration	%	33	48
3.9	Vent, overflow, Drain, fume absorber and sample connection pipe M.O.C.	-	Required, pipe, flange & valves CPVC PN 10/Sch.40	
3.10	Manhole, staircase, platform	-	Required	
4.0	**Neutralising System**			
4.1	**Neutralisation Pit**			
4.1.1	Number	Nos.	One (1) in two sections	
4.1.2	Material of construction	-	RCC with acid / alkali proof lining bricks	
4.1.3	Effective capacity	-	Each section to hold minimum 1.5 times the waste quantity generated during one regeneration of CATION & ANION resins.	
4.2	**Neutralised Waste Disposal cum recirculation Pumps**			
4.2.1	Number	:	Two (2) (1w+1s)	
4.2.2	Type	:	Horizontal, Centrifugal Single stage with priming system	
4.2.3	Capacity and total head of each pump	m^3/hr, MWC	Cap. – by bidder Head – by bidder	
4.2.4	Duty	-	Intermittent	
4.2.5	Pump Speed	rpm	1450	
4.2.6	Drive motor	-	Induction motor 415V, 3 phase 50Hz, TEFC	
4.2.7	Suction condition	-	Negative, with priming chamber	
4.2.8	Material of Construction			
	- Casing	-	2.5% Ni Cast Iron IS210 Gr. FG	
	- Impeller	-	Stainless Steel CF 8M	
	- Shaft	-	Stainless Steel SS 304	

S. No.	Description	Unit	DESCRIPTION
	- Shaft coupling	-	Stainless Steel SS303
	- Shaft sleeve	-	SS 316

CHAPTER 7

7.0 CIRCULATING WATER SYSTEM

7.1 System Description

The Circulating Water (CW) system envisaged for the unit is open re-circulating type with natural draught cooling tower. The system shall be designed to operate at 1.3 cycles of concentration (CoC).

7.2 Scope

The Circulating Water System shall include, but not limited to, the following:

- Six (2 working for each unit and 1 standby for each unit) - Circulating Water Pumps with drive motors, base frame, foundation bolts, etc.
- Three (2 working and 1 standby) - Blowdown Pumps with drive motors, base frame, foundation bolts, etc.
- Electric actuator operated Butterfly valves at the discharge of each CW pump, blow down pump, cooling water inlet / outlet connections to the Condensers.
- Rubber expansion joints at the discharge of each CW pump, blowdown pump and at any other locations as may be required based on the layout of CW piping.
- Piping as specified in Chapter 13, Volume III 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.
- 2 x 100 % debris filters in the unit CW discharge header of each unit. These debris filters shall be installed above ground level outside of TG building before the inlet of condenser of each unit.
- Blowdown piping upto sea and within plant with all associated flanges, gaskets, man-holes, instrument tapings with root valves / thermo wells, pipe supports, clamps, thrust blocks and other accessories.
- The sumps with partition walls for these pumps along with grooves for inserting stop-log gates & screens shall also be provided. All the sumps shall be isolated by stop log gates..
- The CW channel from CT to forebay, forebay, pump house shall be designed for the 2x660 MW plant. Space to be provided for additional channel,forebay and pump house adjacent to the proposed one for the future 660 MW unit. The proposed circulating water pump house shall accommodate 6x50 % circulating water pumps, 4x100% Auxiliary Cooling Water pumps and 3x50% Blow down pumps.
- Vents, air-release valves and drain valves as per the system layout requirements.
- Two sets (2) of Stop log gates for isolating CW sumps.
- One (1) set of Stop Log gate for isolating Blow down pump sump
- Six (6) sets of coarse screens for CW pump sumps.
- Three (3) sets of coarse screens for Blow down pump sumps.

- One storage rack for storing CW pump stop log gate.
- One storage rack for storing blowdown pump stop log gate.
- EOT crane for handling pumps, motors and other equipment in the CW pump house.
- Electric hoists for handling stoplog gates and coarse screens.
- Recirculation line from each unit CW header & blowdown header with motorized isolation valve sized for recurculating 30% of total unit CW flow back to forebay & blowdown respectively.
- The protection, control and monitoring of the CW system including the CW pumps, Butterfly Valves, blowdown pumps 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 pumps/ blowdown pumps and its auxiliaries sequentially and should also be able to operate and control them individually from the operator stations from central control room.
- Model tests and Flow tests for CW pumps and CW in-take channel/sump for selection of optimum layout for the system.
- Condenser onload tube cleaning system.
- Surge analysis (hydraulic transient analysis of CW/ ACW & blowdown piping to establish the quantity & sizing of air release valves.
- The blowdown piping shall be sized for furure unit and thus shall cater to the total flow of three units. Interconnection with isolation valve shall be provided on the blowdown header near CW pumphouse for interconnection to future unit later.
- The pumphouses shall also accommodate the following equipment facilities
    - All auxiliary equipment related to pumpsets such as discharge piping complete with valves and specialties, electric motors etc.
    - Ventilation system for pumphouse.
    - Separate bays for unloading and maintenance.
    - Cranes and hoists as specified in Vol III, Chapter 17.
    - Gates & screens located suitably.
    - Necessary toilet with basin & mirror and operator's cabin with drinking water facility.

7.3 Circulating Water Pumps

7.3.1 Six (6) (2 working for each unit + 1 stand by for each unit) Circulating Water (CW) pumps shall be provided to cater the cooling water requirement of condensers of the two 660 MW steam turbines. These pumps shall be installed in the Circulating Water Pump House.

7.3.2 The shaft bearings shall be self water lubricated type.

7.3.3 The circulating water pump shall be concrete volute type pumps suitable for sea water application. Shaft selection shall be based on maximum torque the shaft is subjected to.

7.3.4 Replaceable wearing rings/casing liners shall be provided for impeller and casing as per manufacturer's standard practice.

7.3.5 The CW pump discharge piping shall be provided with rubber expansion joints, butterfly valves and other fittings. The piping supports and pump foundation bolts shall be designed to withstand thrust generated particularly under shut off condition. The CW pump and motor shall be capable to withstand reverse rotation.

7.3.6 CW pumps shall be concrete volute type, constant speed, mixed flow design with single stage impeller suitable for continuous operation. The pumps shall be designed to have best efficiency point at design duty point.

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.
- Friction drop 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.
- Pressure drop across debris filter.

7.3.7 The design, construction and speed of the pumps shall be such as to minimise cavitation and ensure long and trouble free operation.

7.3.8 The pump shall have stable head capacity characteristics continuously rising towards shut off conditions.

7.3.9 The design shall ensure equal load sharing among the pumps operating in parallel.

7.3.10 The pumps shall operate satisfactorily without cavitation or deleterious effects or under vibration or noise at all water levels from minimum to maximum. The impeller shall be of non over loading type. Pumps shall be able to operate satisfactorily and continuously at run out capacity conditions.The vendor shall generate the system resistance curves with parallel operation of the [pumps.

7.3.11 The suction specific speed of the pump shall be calculated with NPSH available with consideration of the minimum water level. Net positive suction head required shall be less than Net positive suction head available during all operating conditions including run out condition.

7.3.12 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 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.

7.3.13 Suitable staircases and platforms shall be provided for access and maintenance of all equipment in the pumphouse.

7.3.14 All drive motors shall be as per relevant sub-section of electrical specification.

7.3.15 The pump shafts shall be designed such that the critical speed of the shaft is sufficiently away from the pump operating speed and in no case shall be between 80% and 130 % of the rated speed. Also first critical speed shall be more than reverse run away speed.

7.3.16 Pump design with single thrust bearing at motor top or separate thrust bearings at pump and motor (as per manufacturer's standard practice) is acceptable. 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.

7.3.17 The pump and motor (complete assembly) shall be designed to withstand the run away speed attained with reverse rotation caused by reverse flow, continuously, when the other pump(s) is in operation. Necessary speed switches to detect reverse rotation shall be provided to prevent motor switching "ON" while rotating in reverse direction. The indication and alarm in DCS shall be provided for reverse rotation.

7.3.18 Each CW Pump and Blowdown Pump shall be installed in an individual sump with suitable partitions.

7.3.19 Please refer Volume V Annexure A for control details.

7.3.20 Refer clause 1 of Annexure 'C' volume V Instrumentation and Control

7.4 **Model Tests**

7.4.1 Model test for the offered pumps shall be conducted. The performance guarantee test shall be done as per JIS-B-8327, IEC P 497 or BSS 599 class A in the presence of Purchaser's representative.

7.4.2 The model test shall include generation of pump performance curves, NPSH tests and cavitation tests.

7.4.3 Model test shall also be conducted for the complete intake channel, forebay and pump chambers to arrive at proper geometry for intake and ensure satisfactory flow condition under any permutation of pump operation and under all predictable water level combinations. The scale for the model shall not be more than 1:12.

7.5 **Stoplog Gates & CoarseScreens**

7.5.1 **Scope**

7.5.1.1 Stop log gate assembly {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.

7.5.1.2 Coarse screen assemblies {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.

7.5.1.3 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. The lifting beam shall be supplied separately for each size & type of gate.

7.5.1.4 One (1) set of guide bar and sills for gates and screens for guiding them to operate in the center of the slot.

7.5.1.5 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.

7.5.2 **Stop Log Gates**

7.5.2.1 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 as identical interchangeable units as 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.

7.5.2.2 Permissible stresses in various components shall not exceed those specified under Appendix-B of IS: 5620 for wet conditions (accessible) column and those mentioned in these specifications.

7.5.2.3 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.

7.5.2.4 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.

7.5.2.5 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.

7.5.2.6 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.

7.5.2.7 The stop log unit shall be required to be raised/lowered at a speed of 1 to 2 meters per minute.

7.5.2.8 In closed position, the stop log assembly units shall be completely water tight with the design water head.

7.5.2.9 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.

7.5.3 **Arrangement of Stop Log**

7.5.3.1 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.

7.5.3.2 The side seals shall be music note rubber seals with solid bulbs and bottom seal shall be wedge type.

7.5.3.3 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.

7.5.3.4 The side and bottom seals should have perfect leak proof jointing, and the side seal bulbs should be in a true vertical plane.

7.5.3.5 The end vertical girders shall have suitable inclined cut at bottom, so that only skin plate and bottom seal rest on bottom seal set.

7.5.3.6 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.

7.5.4 **Design Criteria**

7.5.4.1 This stop log assembly units and guiding parts shall consist of the following component parts and shall involve the design of these components:

a. Stop log unit leak consisting of skin plate, horizontal and vertical girders/ plates; end vertical girders; lifting points; guide stems; guide shoes; bearing pads.

b. Seals and accessories e.g., clamp plates, nuts and bolts etc.

c. Guides (Rails/tee sections)

d. Track, bottom and side seal seat assemblies.

7.5.4.2 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.

7.5.4.3 Carbon steel construction suitable bearing pads shall be provided and the bearing surface shall be machined.

7.5.5 **Seals**

7.5.5.1 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.

7.5.5.2 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.

7.5.5.3 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/cm^2.

7.5.5.4 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.

7.5.6 **Construction Materials**

a.	Guides/ Anchors	:	SS 316L
b.	Gate leaf & lifting beam	:	SS 316L
c.	Rubber seals	:	As per Appendix-B of IS: 4622
d.	Storage Rack	:	SS 316L

All the codes and specifications mentioned shall be of latest edition.

7.5.7 **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.

7.5.8 **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.

7.5.9 **Lifting Beam for Stop log Gate/Coarse Screen**

7.5.9.1 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.

7.5.9.2 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.

7.5.9.3 It should be assembled in shop and its operation specially that of automatic engaging and disengaging hook shall be checked for its correct operation.

7.5.9.4 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.

7.5.10 **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.

7.5.11 **Design Considerations & Operating Requirements**

7.5.11.1 The coarse screen shall be designed for 50 percent choking condition.

7.5.11.2 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.

7.5.11.3 The screens shall always remain in position, under water, to stop objectionable large debris and floating matter.

7.5.11.4 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.

7.5.11.5 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.

7.5.12 **Arrangement of Screens Parts**

7.5.12.1 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.

7.5.12.2 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.

7.5.12.3 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

7.5.13 **Design Criteria for Screens**

7.5.13.1 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.

7.5.14 **Material of Construction**

S. No.	Component	Materials
1.	Screen Wire	SS 316L
2.	Side guide-cum-track	SS 316L
3.	Frame	SS 316L
4.	Mechanical fasteners	SS 316 L

All the codes and specifications mentioned shall be of latest edition.

7.5.15 **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 with due consideration given to the special nature of the parts and corresponding accuracy required to secure proper operations.

7.6 **Condenser Onload Tube Cleaning System**

Condenser onload tube cleaning system complete with cleaning balls, ball injector, ball collector, ball strainer, ball recirculating pumps and all other auxiliaries shall be provided.

7.7 **Circulating Water Pipework**

1) The thickness of CW pipe shall conform to the provisions of AWWA M-11; however the minimum thickness should not be less than the value specified in Chapter 13, Volume III.

2) The discharge header to condenser and return line from condenser to cooling tower shall be of material as indicated in Chapter 13, Volume III.

7.8 **Cooling Tower Blowdown System**

7.8.1 CT Blowdown shall be provided from the CW sump and for this following shall be provided in the CW Pumphouse.

- 3 x 50% vertical blowdown pumps
- Motorized butterfly valves at each blowdown pump discharge
- Sumps for blow down pumps

7.8.2 The blowdown pumps shall be located in individual sumps in the CW pumphouse. Each sump shall be provided with screen and groove for stop log gate. The stop log gate shall be used for isolating any pump as required. Material of construction of stop log gates and screens shall as specified elsewhere in this chapter.

7.8.3 Blowdown shall be pumped to the sea and the blowdown pipe shall be routed as indicated in the plot plan. The line coming from the guard pond shall be interconnected to this line so

that waste water is disposed off in a common line to the sea. Suitable isolation shall be provided at this interconnection with motorized butterfly valves.

7.8.4 Suitable interlock shall be provided for the blowdown pumps so that they are operating only when make up is available to the system. Level interlocks also shall be provided to the blowdown pumps from the CW sump. Operation of Blow down system is from DDCMIS

DATA SHEET FOR CIRCULATING WATER (CW) PUMPS

S. No.	Item	Unit	Description
1	Total no. of pumps	Nos.	6, (4 W + 2 Stand-by)
2.	Pump capacity	M^3/hr	By Bidder (Capacity shall fixed taking 10% margin on condenser flow)
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.
5.	Type of pump		Concrete Volute Type
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Sea 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
	Pump operating range		Bidder to indicate
14.	Motor rating		115 % of duty point requirement and also to meet the maximum power requirement over the operating range at 52.5 Hz frequency.
15.	Voltage Level		11 KV
16.	Materials of construction		
a.	Casing & Draft Tube		RCC with internal corrocoat lining
c.	Impeller		Duplex SS 2205 UNS 31803
d.	Shaft		Duplex SS 2205 UNS 31803
e.	Line shaft coupling		Duplex SS 2205 UNS 31803
f.	Line shaft bearing		Duplex SS 2205 UNS 31803
g.	All hardware		AISI SS 316L
h.	Wearing Ring		Duplex SS 2205 UNS 31803
i.	Shaft sleeve		Duplex SS 2205 UNS 31803
j.	Thrust bearing cooling system pipes and valves		SS 316L
k.	Thrust Pads		Carbon steel with white metal lining
l.	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating inside/FRP
m.	Gland Packing		Impregnated Teflon

Note: CW fore bay and Channel design shall be as per HIS standard.

DATA SHEET FOR RUBBER EXPANSION JOINTS

S. No.	Item	Unit	Description
1	Designation		CW system
2.	Expansion joint ID/Pipe ID	Mm	To suit selected pipe diameter
3.	Fluid handled		Sea water
4.	Vacuum	mm of Hg	700
5.	Operating temperature	Deg.C	50
6.	Movements		Max Min.
	(i) Axial Compression	Mm	25 15
	(ii) Axial elongation	Mm	13 10
	(iii) Lateral movement	Mm	13 10
7.	No. of arches		One (1)
8.	Controls unit to be provided		Yes
9.	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
10.	Material of construction		
	(i) Main body		High grade abrasion resistant natural or synthetic rubber compound
	(ii) Reinforcement		Steel rings
	(iii) Retaining ring		Galvanised steel retaining rings
	(iv) Outer cover		Exposed surface shall be given 3 mm thick coating of neoprene
	(v) Bolts & nuts		SS 316L
	(vi) Stretcher bolt plates		SS 316L

DATA SHEET FOR BUTTERFLY VALVES (COMMON FOR ALL SEA WATER APPLICATIONS)

S. No.	Item	Unit	Description	
1	Service		CW pump discharge, Condenser inlet/outlet	Blowdown, ACW water pump discharge, Sea Water Intake pump discharge, Sea Water CT Make UP Pumps and other sea water applications
2.	Valve size	mm	By bidder	
3.	Number of valves		As per Flow Diagram **(min)**	
4.	Supporting legs required		-Yes -	
5.	Valve opening / closing time	Secs.	70 seconds	Maximum 40 seconds
6.	Frequency of vale 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 A 182 F 316L	
	(ii) Disc		ASTM A 182 F 316L	
	(iii) Shaft		ASTM A 182 F 316L	
	(iv) Body seat rings		ASTM A 182 F 316L	
	(v) Disc seal rings		EPDM	
	(vi) Seal retaining rings		ASTM A 182 F 316L	
	(vii) Companion flange		ASTM A 182 F 316L	
	(viii) Internal hardware		ASTM A 182 F 316L	
	(ix) External hardware		SS 316L	
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.			

DATA SHEET FOR BLOWDOWN PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	3 (2 working + 1 stand by)
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		Vertical Turbine Pumps
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Sea 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		Bidder to indicate. Preferrably between 40% to 120% of rated capacity.
14.	Materials of construction		
a.	Casing		Duplex SS 2205 UNS 31803
	Column Pipe		Duplex SS 2205 UNS 31803
c.	Impeller		Duplex SS 2205 UNS 31803
d.	Shaft		Duplex SS 2205 UNS 31803
e.	Line shaft coupling		Duplex SS 2205 UNS 31803
f.	Line shaft bearing		Duplex SS 2205 UNS 31803
g.	All hardware		AISI SS 316L
h.	Wearing Ring		Duplex SS 2205 UNS 31803
i.	Shaft sleeve		Duplex SS 2205 UNS 31803
j.	Thrust bearing cooling system pipes and valves		SS 316 L
k.	Thrust Pads		Carbon steel with white metal lining
l.	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating inside
m.	Gland Packing		Impregnated Teflon
n.	Stuffing Box Housing		SS 316 L

CHAPTER 8

8.0 AUXILIARY COOLING WATER & DMCW SYSTEM

8.1 Auxiliary Cooling Water (ACW) system shall supply cooling water required for secondary side of Plate Heat Exchangers (PHE) of SG & TG auxiliaries and BOP auxiliaries whereas the DMCW system shall supply cooling water for primary side of plate heat exchangers (PHE) of SG & TG & BOP auxiliaries. The ACW pumps shall be installed in the CW Pumphouse

8.2 **ACW System Description**

The Auxiliary Cooling Water (ACW) system shall be designed to operate at 1.3 cycles of concentration (CoC).

8.3 **Scope**

The ACW System foe each unit shall include, but not limited to, the following:

- Two (1 working and 1 standby) - ACW Pumps with drive motors, base frame, foundation bolts, etc for each 660 MW unit auxiliaries.
- Electric actuator operated Butterfly valves at the discharge of each ACW pump, cooling water inlet / outlet connections to the PHE and as required.
- Rubber expansion joints at the discharge of each ACW pump and at any other locations as may be required based on piping layout.
- Non Return Valve at discharge of each ACW Pump.
- ACW piping from ACW pump to PHE & other auxiliaries and back to cooling tower/ 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.
- Two (1W + 1S) Automatic self cleaning filters in discharge header of ACW pumps for each unit.
- Vents, air-release valves and drain valves as per the system layout requirements.
- Three sets (3) of Stop log gates for isolating ACW sumps and two (2) stop log gates for future ACW pumps.
- Four (4) sets of coarse screens for ACW pump sumps.
- One storage rack for storing ACW pump stop log gate.
- EOT crane for handling pumps, motors and other equipment in the ACW pump house.
- Electric hoists for handling stoplog gates and coarse screens.
- Recirculation line from each unit ACW header with motorized isolation valve sized for recurculating 30% of total unit ACW flow back to forebay.

- The protection, control and monitoring of the ACW system including the ACW pumps, butterfly valves and any other equipment in the system shall be implemented through DCS. The operator in the central control room shall be able to start and stop the ACW pumps and its auxiliaries sequentially and should also be able to operate and control them individually from the operator stations at the central control room. Refer clauses 1 & 2 of Annexure 'C' volume V Instrumentation and Control works.

- The pumphouse shall also accommodate the following equipment facilities
  - All auxiliary equipment related to pumpsets such as discharge piping complete with valves and specialties, electric motors etc.
  - Ventilation system for pumphouse.
  - Separate bays for unloading and maintenance.
  - Cranes and hoists as specified in Vol III, Chapter 17.
  - Gates & screens located suitably.
  - Necessary toilets with basin & mirror and operator's cabin with drinking water facility.

8.4 **Auxiliary Cooling Water Pumps**

8.4.1 Two (2) (1 working + 1 stand by) ACW pumps shall be provided to cater the cooling water requirement of SG & TG PHE & Other Auxiliaries for each 660 MW unit auxiliaries. These pumps shall be installed in the Circulating Water Pump House.

8.4.2 The shaft bearings shall be self water lubricated type.

8.4.3 The ACW pump shall be vertical wet pit type suitable for sea water application. Shaft selection shall be based on maximum torque the shaft is subjected to.

8.4.4 Replaceable wearing rings/casing liners shall be provided for impeller and casing.

8.4.5 The ACW pump discharge piping shall be provided with rubber expansion joints, butterfly valves, NRV and other fittings. The piping supports and pump foundation bolts shall be designed to withstand the thrust generated particularly under shut off condition. The pump shall be capable to withstand reverse rotation.

8.4.6 ACW pumps shall be vertical wet pit type, constant speed, mixed flow design with single stage impeller suitable for continuous operation. The pumps shall be designed to have best efficiency point at design duty point.

Total head of the pump shall be calculated as a sum of the following:

- Static lift from minimum water level in ACW sump to the highest point of cooling tower hot water distribution system.

- Friction drop in the entire system with 10% margin on the same and exit losses considering C value as 140 for FRP.

- Pressure drop across the PHE.

- Pressure drop across self cleaning filter.

- Any other pressure loss

8.4.7 The design, construction and speed of the pumps shall be such as to minimise cavitation and ensure long and trouble free operation.

8.4.8 The pump shall have stable head capacity characteristics continuously rising towards shut off condition.

8.4.9 The pumps shall operate satisfactorily without cavitation or deleterious effects or under vibration or noise at all water levels from minimum to maximum. The impeller shall be of non over loading type. Pumps shall be able to operate satisfactorily and continuously at run out capacity conditions. The vendor shall generate the system resistance curve.

8.4.10 The suction specific speed of the pump shall be calculated with NPSH available with consideration to the minimum water level. Net positive suction head required shall be less than Net positive suction head available during all operating conditions including run out condition.

8.4.11 These pumps shall be directly driven by a constant speed squirrel cage induction motor. Continuous motor rating (at 50 deg C ambient) 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 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.

8.4.12 Suitable staircases and platforms shall be provided for access and maintenance of all equipment in the pumphouse.

8.4.13 All drive motors shall be as per relevant sub-section of electrical specification.

8.4.14 The pump shafts shall be designed such that the critical speed of the shaft is sufficiently away from the pump operating speed and in no case shall be between 80% and 130 % of the rated speed. Also first critical speed shall be more than reverse run away speed.

8.4.15 Pump design with single thrust bearing at motor top or separate thrust bearings at pump and motor (as per manufacturer's standard practice) is acceptable. 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.

8.4.16 The pump and motor (complete assembly) shall be designed to withstand the run away speed attained with reverse rotation.Necessary speed switches to detect reverse rotation shall be provided to prevent motor switching "ON" while rotating in reverse direction. The indication and alarm in DCS shall be provided for reverse rotation.

8.4.17 Each ACW Pump shall be installed in an individual sump with suitable partitions.

8,4,18 For plate heat exchangers, spare thermowell provision shall be made at inlet & outlet of ACW & DMCW lines in addition to local & remote temperature monitoring points.

8.5 **Stop Log gates & coarse Screen**

8.5.1 **Scope**

8.5.1.1 Stop log gate assembly {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.

8.5.1.2 Coarse screen assemblies {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.

8.5.1.3 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. Lifting beam shall be supplied separately for each size & type of gate.

8.5.1.4 One (1) set of guide bar and sills for gates and screens for guiding them to operate in the center of the slot.

8.5.1.5 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.

8.5.2 **Stop Log Gates**

8.5.2.1 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 as identical interchangeable units as 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.

8.5.2.2 Permissible stresses in various components shall not exceed those specified under Appendix-B of IS: 5620 for wet conditions (accessible) column and those mentioned in these specifications.

8.5.2.3 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.

8.5.2.4 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.

8.5.2.5 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.

8.5.2.6 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.

8.5.2.7 The stop log unit shall be required to be raised/lowered at a speed of 1 to 2 meters per minute.

8.5.2.8 In closed position, the stop log assembly units shall be completely water tight with the design water head.

8.5.2.9 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.

8.5.3 **Arrangement of Stop Log**

8.5.3.1 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.

8.5.3.2 The side seals shall be music note rubber seals with solid bulbs and bottom seal shall be wedge type.

8.5.3.3 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.

8.5.3.4 The side and bottom seals should have perfect leak proof jointing, and the side seal bulbs should be in a true vertical plane.

8.5.3.5 The end vertical girders shall have suitable inclined cut at bottom, so that only skin plate and bottom seal rest on bottom seal set.

8.5.3.6 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.

8.5.4 **Design Criteria**

8.5.4.1 This stop log assembly units and guiding parts shall consist of the following component parts and shall involve the design of these components:

a. Stop log unit leak consisting of skin plate, horizontal and vertical girders/ plates; end vertical girders; lifting points; guide stems; guide shoes; bearing pads.

b. Seals and accessories e.g., clamp plates, nuts and bolts etc.

c. Guides (Rails/tee sections)

d. Track, bottom and side seal seat assemblies.

8.5.4.2 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.

8.5.4.3 Carbon steel construction suitable bearing pads shall be provided and the bearing surface shall be machined.

8.5.5 **Seals**

8.5.5.1 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.

8.5.5.2 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.

8.5.5.3 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/cm^2.

8.5.5.4 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.

8.5.6 **Construction Materials**

a.	Guides/ Anchors	:	SS 316L
b.	Gate leaf & lifting beam	:	SS 316L
c.	Rubber seals	:	As per Appendix-B of IS: 4622
d.	Storage Rack	:	SS 316L

All the codes and specifications mentioned shall be of latest edition.

8.5.7 **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.

8.5.8 **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.

8.5.9 **Lifting Beam for Stop log Gate/Coarse Screen**

8.5.9.1 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.

8.5.9.2 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.

8.5.9.3 It should be assembled in shop and its operation specially that of automatic engaging and disengaging hook shall be checked for its correct operation.

8.5.9.4 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.

8.5.10 **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.

8.5.11 **Design Considerations & Operating Requirements**

8.5.11.1 The coarse screen shall be designed for 50 percent choking condition.

8.5.11.2 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.

8.5.11.3 The screens shall always remain in position, under water, to stop objectionable large debris and floating matter.

8.5.11.4 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.

8.5.11.5 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.

8.5.12 **Arrangement of Screens Parts**

8.5.12.1 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.

8.5.12.2 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.

8.5.12.3 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

8.5.13 **Design Criteria for Screens**

8.5.13.1 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.

8.5.14 **Material of Construction**

S. No.	Component	Materials
1.	Screen Wire	SS 316L
2.	Side guide-cum-track	SS 316L
3.	Frame	SS 316L
4.	Mechanical fasteners	SS 316 L

All the codes and specifications mentioned shall be of latest edition.

8.5.15 **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 with due consideration given to the special nature of the parts and corresponding accuracy required to secure proper operations.

8.6 **DMCW SYSTEM**

8.6.1 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 of each 660 MW unit. Total no. of pumps is six (6).
- 2 x 100% DMCW Pumps with drive motors for SG auxiliaries of each 660 MW unit. Total no. of pumps is four (4).
- 3 x 50% Plate heat exchangers for TG auxiliaries & BOP auxiliaries of each 660 MW unit. Total no. of PHE's is six (6).
- 2 x 100% Plate heat exchangers for SG auxiliaries of each 660 MW unit. Total no. of PHE's is four (4).
- DMCW Expansion tank of 10 cum effective capacity for each 660 MW unit. Total no. of tanks is two (2).
- Dosing 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 DMCW tank.

- Online measurement of pH.
- Motorized butterfly valves at DMCW pump suction & discharge
- Refer clauses 1 & 2 of Annexure 'C' volume V Instrumentation and Control works.

8.6.2 **All the pumps shall have 10% margin on friction drop over the actual requirement.**

8.6.3 Capacity of pumps shall be fixed by taking 10% margin on overall flow.

8.7 **DMCW System Description**

8.7.1 The DMCW pumps shall take suction from the DMCW expansion tank outlet & pump to respective SG, TG & BOP auxiliaries through primary side of PHE's. Refer P & ID of DMCW system for tentative scheme.

DATA SHEET FOR AUXILIARY COOLING WATER PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	2 (1 working + 1 stand by) per unit – Total 4 nos.
2.	Pump capacity	M^3/ hr	By bidder (Capacity shall be fixed taking 10% margin on total cooling water flow)
3.	Pump total head excluding losses in the pump	MWC	By Bidder
4.	Pump speed (max.)	RPM	1500
5.	Type of pump		Vertical Turbine Pumps
6.	Location		Indoor
7.	Type of internal element		Non pull out
8.	Liquid handled		Sea 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		**At motor top**
13.	Pump operating range		Bidder to indicate. Preferrably between 40% to 120% of rated capacity.
14.	Materials of construction		
a.	Casing		Duplex SS 2205 UNS 31803
	Column Pipe		Duplex SS 2205 UNS 31803
c.	Impeller		Duplex SS 2205 UNS 31803
d.	Shaft		Duplex SS 2205 UNS 31803
e.	Line shaft coupling		Duplex SS 2205 UNS 31803
f.	Line shaft bearing		Duplex SS 2205 UNS 31803
g.	All hardware		AISI SS 316L
h.	Wearing Ring		Duplex SS 2205 UNS 31803
i.	Shaft sleeve		Duplex SS 2205 UNS 31803
j.	Thrust bearing cooling system pipes and valves		SS 316 L
k.	Thrust Pads		SS 316L
l.	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating inside/FRP
m.	Gland Packing		Impregnated Teflon
n.	Stuffing Box Housing		SS 316 L

DATA SHEET FOR DMCW PUMPS

Sl. No.	Item	Units	Description
1	Quantity	Nos.	3 (2 working + 1 standby) for TG & BOP auxiliaries for each unit – total 6 nos. 2 (1 working + 1 standby) for SG auxiliaries for each unit – total 4 nos.
2.	Pump capacity	M^3/ hr	By Bidder (Capacity shall be fixed taking 10% margin on total cooling water 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.	Liquid handled		Passivated DM Water
8.	Liquid for lubrication		Pumped liquid
9.	Type of pump motor coupling		Flexible
10.	Pump operating range		40% to 120% of rated capacity
11.	Materials of construction		
a.	Casing		2 % Ni CI IS: 210 Gr 260
b.	Impeller		SS 304
c.	Shaft		SS 304
d.	Shaft Sleeve		SS
e.	Stuffing Box Packing		Asbestos Free
f.	Flexible Coupling		SS
g.	Base Plate		MS IS 2062
h.	Bolts & Nuts		High Tensile Steel

DATASHEET FOR PLATE HEAT EXCHANGERS
(Common for all PHE's)

The material specification shall be as follows

Heat Transfer Plate	Titanium	
Thickness of plate	By bidder	
Plate gasket	Nitrile rubber	
Carrying bar	CS (IS 2062)	
Guide bar	CS (IS 2062)	
Frame Plate/ Pressure Plate/ nozzle	CS (IS 2062)	
Nozzle Flange	CS (IS 2062), ANSI B 16.5	
Overall friction factor (Minimum)	0.8×10^{-4} $m^2hr^oc/kCal$	
Flow (m^3/hr)	Primary	Secondary
	By Bidder	By Bidder
Temperature	Inlet – 40^0C	Inlet – 32^0C
	Outlet – 35^0C	Oulet -

DATA SHEET FOR AUTOMATIC SELF CLEANING STRAINERS

Description	Unit	Values
Quantity	Nos.	2 (1W + 1S) for each unit – total 4 nos.
Flow rate	m^3/hr	By Bidder (Capacity shall be fixed taking 10% margin on total cooling water flow)
Inlet Size	NB	By Bidder
Outlet Size	NB	By Bidder
Liquid Handled		Sea Water
Screen Opening Area		6 times of the inlet pipe cross section area
DP Measurement System		DP Switch & DP Transmitter
Degree of Filtration	mm	2
Max. Pressure drop in fully choked condition	MWC	6
Material of construction		
Body		SS 316L (Duplex Stainless Steel)
Basket		SS 316L (Duplex Stainless Steel)
Cover Flange/ Slipon Flange		SS 316L (Duplex Stainless Steel)
Filter		SS 316L (Duplex Stainless Steel)
Connection Pipe		SS 316L (Duplex Stainless Steel)
Connection Flange		SS 316L (Duplex Stainless Steel)
Filter Screen		SS 316L (Duplex Stainless Steel)
Gasket		SS 316L (Duplex Stainless Steel)
Fasteners		SS 316L (Duplex Stainless Steel)
Drain		SS 316L (Duplex Stainless Steel)
Vent with plug		SS 316L (Duplex Stainless Steel)
Support Legs		SS 316L (Duplex Stainless Steel)
Davit Arm		SS 316L (Duplex Stainless Steel)
Base Plate		SS 316L (Duplex Stainless Steel)

CHAPTER 9

9.0 NATURAL DRAUGHT COOLING TOWER

9.1 Two (2) Natural Draught Cooling Towers, Cooling Water Basin, Outlet Channel from basin to CW pump sump together with sludge removal sump and valve pit etc. are covered under this specification shall be installed commissioned and tested for its performance as described below. Heat load shall be equal to CW/ ACW heat load plus margin.

9.2 **Design basis**

The design parameters data for NDCT shall be as follows:

Quantity	Two (2) nos.
Type of Tower	Counter flow, Splash bars
Cooling Range	10^{o}C
Capacity	By Bidder. {Bidder to arrive at exact capacity taking 10% margin on CW & ACW flow of each unit)
Design Wet Bulb Temperature	Approach shall be not more than 5 deg C
Approach	5^{o}C
Relative Humidity	Based on meterological data of Chennai for last 50 years
COC	1.3

NDCT has to be designed for worst meteorologiocal conditions.

8.3 **Design Considerations**

The cooling tower shall be designed for continuous operation. The hot water distribution system shall be designed to ensure the 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.

9.4 **Materials of Construction**

Cooling tower basin	RCC
Cooling tower shell	RCC
Internal supports structure, stair cases	RCC
Louvers	RCC
Fill	PVC
Fill supports	RCC
Nozzles, orifices, splash cups	PVC or Polypropylene
Drift eliminators	PVC
Hot water inlet pipes	As per Chapgter 13 Vol III.
Hot water distribution system	PVC/FRP or RCC/HDPE
Distribution trough	RCC
Stop logs & Screens	SS 316 L
Side guides and mountings	SS 316 L
Miscellaneous steel structure	Galvanized steel flat with painting of epoxy coal tar

9.5 **The Structure**

The cooling tower shell shall be hyperbolic paraboloid.

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.
Hot water inlet shall be through a pair of concrete ducts/steel pipes.

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.

The hot water distribution shall be by RCC main and secondary ducts finally through PVC pipes fitted with nozzles for uniform distribution through the fill, which shall be film type

When selecting the spray equipment and its position, it must 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.

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 are to be included on each run at the end of the duct in the main distributor pipes.

The fill packing is to consist of tried and tested plastic packing arranged crosswise over a number of storeys and which guarantees the exchange of heat and mass.

The profile of the drift eliminators is to be selected to ensure a maximum degree of precipitation and a minimum of air pressure loss.

The HW distribution arrangement shall be supported independent of the shell by internal columns finally supported on the floor of the cold water basin.

Access to the hot water distribution platform and further access to the shell top is provided with two Galvanised Steel ladders, mainly for the maintenance of aviation warning lights.

The material used for access facilities including steel components for steps, ladders, platforms, catwalks, railings, doors, base frames, mountings, etc must be resistant to corrosion.

All bolted connections and attachments to concrete must be made out of suitable stainless steel.

The basin shall be designed for a water depth of 1.0 m from normal water level with a free board of at least 0.3 m above maximum water level. The cooling tower basin shall be divided into two equal parts by watertight RCC partition for the cleaning and maintenance of one half while the other half is in service. Arrangements for water drainage shall also be provided.

The cold water from the basin shall be conducted through an opening in the cold water basin and connected 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 a stop log. Suitable handling arrangements with a monorail and a chain-operated hoist with a travelling trolley shall be provided for handling of the stop log. 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 are to be distributed along its perimeter (approximately every 45°), from where the sludge can be pumped out.

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.

Structural Design Concepts shall be designed as described in Volume VI.

9.6 **Fill Supporting Arrangement**

The supporting of the fill is to 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.

Concrete which is impermeable to water is to be used for all components, including reinforced concrete components. The composition of the concrete and the cement are to be chosen depending on the chemical analysis of the cooling tower water/cooling tower make-up water.

9.7 **Aviation warning lights**

In accordance with official regulations, aviation warning lights are to be installed along the perimeter of the NDCT structure. Operating and reserve aviation warning lights are to be positioned next to each other. They are to be connected to completely separate power circuits and to be monitored by relays.

The obstruction lighting shall be done as per Appendix 6 figure 6.2 of ICAO i.e combination of low intensity (Multi LED type-B) & medium intensity (Multi LED Type). The life of the fittings shall be 20 years maintenance free. Total low intensity fittings 12 nos. (1/4 level & ¾ level) & medium intensity fittings (1/2 & tope level. The aviation lighting shall meet the recommendations of ICAQ and Director General of Civil Aviation, India. The Aviation warning lighting system shall also conform to the latest Indian Standard IS :4998.

Lights should be installed in a manner to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.

The minimum number of lights shall be as indicated below depending on the diameter:

- 20 feet (6 m) or less : 3 lights per level
- Exceeding 20 feet (6m) but not more than 100 feet (31 m) : 4 lights per level
- Exceeding 100 feet (31 m) but not more than 200 feet (61m) : 6 lights per level.
- Exceeding 200 feet (61m) : 8 lights per level.

Structures exceeding 600 feet (183 m) should have a second level of light units installed approximately at midpoint of the structure and in a vertical line with the top level of lights.

The technical requirements of aviation warning lighting, lightning protection system, earthing, lighting, and cabling etc. shall be as described in Volume-IV.

9.8 **Guaranteed Particulars**

The contractor shall guarantee the following parameters.

9.8.1 **Cold water temperature**

At the design point of the cooling tower, the cold water temperature guaranteed by the Contractor in accordance with the guarantee curve (cooling tower characteristic diagram) shall be achieved. The fundamental parameter for the design value of the cold water temperature during acceptance measurement shall be the measured across the cooling zone width.

9.8.2 **Drift loss**

At the design point, the total water mass flow entrained in the air shall not exceed 0.005% of the mass of water circulating.

9.8.3 **Material resistance**

All materials (including building materials) are to be chosen and geared to each other such that no damage will be occurred as a result of operational exposure to cooling water.

9.9 **Performance Guarantee tests**

9.9.1 Performance tests shall be conducted by the Contractor on the cooling tower on site to establish the performance of the Cooling tower. The tests shall cover thermal capability and performance parameters of the cooling tower. The Contractor guarantees that the cooling tower shall cool a certain mass flow of cooling water at the given ambient conditions from a certain hot water temperature down to a certain cold water temperature.

9.9.2 Latest versions of the following codes and standards shall be used for conducting the performance tests:

DIN 1947 – VDI - Acceptance test code for water cooling towers (latest version)

BS – 4485	Specification for Water Cooling towers
BS – 1042	Methods for the measurement of fluid flow in pipes
BS – 3435	Measurement of electrical power and energy in acceptance testing
ASME – 19.5	supplements on Instruments and Apparatus

9.9.3 Contractor shall arrange for all the test instrumentation required for conducting the performance guarantee tests. All instruments used in the testing shall be calibrated before and after the tests as per the relevant codes. Should the acceptance tests not produce the guaranteed values, the Contractor shall be granted the right to make improvements. The repeated acceptance measurements shall then be carried out at the Contractor's expense.

DESIGN REQUIREMENT		
1	DESIGNATION	NATURAL DRAFT COOLING TOWER
2	NUMBER OF COOLING TOWERS	TWO (2)
3	DESIGN CAPACITY PER COOLING TOWER (m^3/hr)	By Bidder (CW/ ACW flow plus margin)
4	DUTY	CONTINUOUS
5	RANGE	10^0C
6	APPROACH	5 DEG
7	DESIGN AMBIENT WET BULB TEMPERATURE	Selected so that approach does not exceed 5 Deg C
8	RECIRCULATION ALLOWANCE	BIDDER TO INDICATE AS PER BS
9	DESIGN ENTERING WET BULB TEMPERATURE	(7) + (8)
10	DESIGN RELATIVE HUMIDITY	Based on meterological data of Chennai for last 50 years
11	GUARANTEED DRIFT LOSS	0.005% OF DESIGN CAPACITY PER TOWER
12	WIND VELOCITY FOR PERFORMANCE	6.6 KM/HR
12	CYCLES OF CONCENTRATION	1.3
13	LIQUID HANDLED	SEA WATER
14	COLD WATER BASIN CAPACITY OF THE TOWER	10 MINUTES OF TOTAL COOLING TOWER FLOW (CW & ACW)
15	VELOCITY OF HOT WATER PIPING	NOT TO EXCEED 1.9 M/S
16	TYPE OF COOLING TOWER	COUNTER FLOW

17	TYPE OF FILLS	PVC SPLASH BAR
MATERIALS OF CONSTRUCTION		
1	CASING	RCC
2	FILL SUPPORT	RCC
3	FILLS	PVC – SPLASH BAR
4	WATER DISTRIBUTION PIPES	GRP/FRP
5	DRIFT ELMINATORS	PVC – UV STABILISED
6	WATER DISTRIBUTION NOZZLES, SPLASH PLATES/ CUPS	POLYPROPYLENE
7	STOP LOG GATES & SCREENS	SS 316L
8	ACCESS DOORS	HDG STEEL WITH ETCH PRIMER & EPOXY PAINTING
9	STAIRCASES	RCC
10	LADDERS	SS 316
11	INTERNAL WALKWAYS	RCC
12	HANDRAILS	32NB HDGS PIPE
13	HARDWARE	SS316L
14	COLD WATER BASIN	RCC WITH PARTITION
	TYPE OF CEMENT	
1	SULPHATE RESISTANT PORTLAND CEMENT CONFORMING TO	IS 2330

ACCESSORIES REQUIRED WITH EACH COOLING TOWER		
1	COLD WATER SUMP AT EACH COMPARTMENT	
2	2X100%, SUMP PUMPS, COMPLETE WITH PIPINGS, FITTINGS, VALVES & ACCESSORIES (PUMPS SIZED TO EMPTY EACH BASIN PARTITION IN 10 HRS)	
3	COLD WATER OVERFLOW, DRAIN, QUICK FILL, MAKE UP PIPING, FITTINGS, VALVES	
4	AVIATION WARNING LIGHTS	
5	SCREENS & STOP LOGS	
6	CHAIN PULLEY BLOCK WITH TRAVELLING TROLLEY	
9	ILLUMINATION	
10	LIGHTNING & EARTHING PROTECTION	
11	MONORAILS & HOISTS FOR STOP LOGS & SCREENS	
13	LADDERS, STAIRCASES, WALKWAYS & HANDRAILS	
14	TEMPERATURE & PRESSURE GAUGES ON HOT WATER INLET	
15	INSTRUMENTS REQUIRED FOR PG TEST (AS PER CTI / BS/ ASME)	
PERFORMANCE GUARANTEE		
1	COOLING TOWER CAPACITY	CT Capacity $m^3/hr \pm 10\%$
2	COOLING RANGE	$10^0C \pm 20\%$
3	DESIGN AMBIENT WET BULB TEMPERATURE	$27 \pm 8.5\ ^0C$
4	PUMPING HEAD	BY BIDDER

CHAPTER 10

10.0 MISCELLANEOUS PUMPSETS

10.1 GENERAL INFORMATION

10.1.1 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

10.1.2 Pumps under this specification have been divided into following three (3) groups according to different duty envisaged and location of sumps/pits.

10.1.2.1 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 15 mm.

Group-A pumps shall also be provided to all indoor sumps of the plant and outdoor sumps of capacity 5 cu.m and above and underground cable vaults (if any) under the scope of this specification.

10.1.2.2 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/HSD etc. and particle size shall not normally exceed 20 mm. These types of pumps shall be used in different plant areas.

10.1.2.3 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.

10.2 CODES AND STANDARDS

10.2.1 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:

10.2.2 IS-1710 : Vertical Turbine Pumps for clear cold and fresh water.

10.2.3 IS-5120 : Technical Requirements – Roto-dynamic special purpose pumps.

10.2.4 IS-5600 : Sewage and drainage pumps.

10.2.5 Hydraulic Institute Standards of USA.

10.2.6 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

10.3 GENERAL PERFORMANCE REQUIREMENT

10.3.1 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.

10.3.2 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.

10.3.3 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.

10.3.5 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.

10.3.6 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).

10.4 SCOPE OF WORK

10.4.1 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:

10.4.2 For the vertical Group - A sump pump motor sets

Two (2) nos. redundant unltrasonic type level transmitter (2 Nos.) with limiter technique shall be provided for alarming, auto start & auto stop. 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.

10.4.3 For each of the trolley mounted horizontal Group-B sump pump motor sets/pump-Diesel Engine sets

a) One (1) no. 7.5 meters long hose for the pump suction and one (1) no.30 meters long hose for the pump discharge, either ends of each hose being provided with female hose coupling.

b) One (1) no. 500 mm long straight pipe piece, with both ends flanged, one end matching with the pump suction nozzle.

c) Two (2) nos. 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 meters 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 metres 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.

10.4.5 For each of the portable submersible Group-C sump pump motor sets.

a) Two (2) nos. 30 metres 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) no. 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 metres 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 metre long power cable shall also be provided with a suitable power plug at one end.

10.4.6 Lubrication of one (1) initial fill and one additional fill after commissioning.

10.4.7 Rust inhibiter paint at Manufacturer's works.

10.5 DESIGN AND CONSTRUCTION

10.5.1 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.

10.5.2 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 IV.

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.

10.5.3 All electrical items shall conform to the stipulations of Electrical Specification Vol IV as applicable.

10.5.4 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.

10.5.5 All valves shall be steel body type as per applicable IS/BS/ANSI standard, with pressure class compatible with the maximum working pressure.

10.5.6 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.

10.5.7 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.

10.6 Pumps

10.6.1 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.

10.6.2 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.

10.6.3 Pumps under Group-C shall be submersible pump-motor type, single stage and non-clog design and shall be portable type.

10.7 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.

10.8 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.

10.9 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.

10.10 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.

10.11 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.

10.12 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.

10.13 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.

10.14 Coupling

Pump and motor shall be connected with a suitable flexible coupling. Coupling shall be provided with coupling guard.

10.15 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.

10.16 Suction Bell

The pumps under Group-A, C shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

10.17 Material of Construction

For material of construction of various parts of data specification sheet shall be referred to.

10.18 **INSPECTION AND TESTING**

10.18.1 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".

10.18.2 The pump integral accessories like thrust bearing, pump motor coupling etc. shall be subject to tests as per manufacturer's standard.

10.18.3 Test on motors, control panels, starter panels, cables shall be conducted as per the requirement of Vol.IV of this specification and as per Quality Assurance Plan to be approved by Owner during detail engineering.

10.18.4 After delivery/erection at site, pumps shall be operated to prove satisfactory and trouble free performance.

10.19 **DRAWINGS, DATA, INFORMATION REQUIRED**

10.19.1 Location and dimension of all sumps which requires assisted evacuation, present in the areas covered under the scope of this specification.

10.19.2 List of location of Group-A .

10.19.3 Characteristic curves of pumps showing effective head, pump input power, efficiency, submergence and NPSH, against capacity ranging from shut-off condition to 125% or rated capacity for Group A, B pumps and to 150% of rated capacity for Group C pumps.

10.19.4 Speed vs. torque curve of the pump corresponding to recommended mode of pump starting, super-imposed on speed vs. torque of the motor, corresponding to 80% and 100% rated voltage.

10.19.5 Diagram showing the type of lubrication system etc.

DATA SPECIFICATION SHEET

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	Yes
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 410	SS 410	SS 410
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

Note : In all areas where Group A pumps are installed and will handle Sea Water like CWPH Pit the material of construction of all components of the pumps shall be Duplex Stainless steel.

CHAPTER 11

11.0 EFFLUENT TREATMENT PLANT

11.1 The waste water treatment system shall be designed to collect waste water from all sources in the power plant and provide treatment to enable it to be disposed /reused in the power plant. The quality of effluent shall conform to norms stipulated by Central Pollution Board, suitable for disposal to storm water drain/ sea.

11.2 The sources of plant effluent are mainly:

a) Cooling Tower Blowdown
b) Clarifier Sludge & filters
c) RO Stage I Reject
d) RO Stage II Reject
e) CPU Effluent
f) MB Regeneration Waste
g) Boiler Blowdown
h) Coal area mill drain
i) Oil Handling Area run off
j) CHP dust suppression & Coal pile area run off
k) Boiler & ESP area Drains
l) Condenser Wastewater
m) Transformer yard Wastewater
n) Remote Ash Silo Area Effluent
o) Guard Pond
p) Sanitary Waste from Plant Toilet.
q) Canteen waste
r) Ash-pond recycling.

11.3 GENERAL DESCRIPTION

11.3.1 Cooling Tower Blow down (CTBD)

CTBD will be pumped back to the sea with the help of blowdown pumps installed in CW pumphouse. Connection from CTBD shall also be given to the ash water sump with isolation valve.

11.3.2 Water Pretreatment Plant Clarifier Sludge & filters

The water pre-treatment plant waste (sludge) & filters contains suspended particles in high concentration. These effluents will be sent to a reject sump and led to guard pond from there by means of sludge disposal pumps.

11.3.3 RO Stage I Reject

The RO stage I reject shall be led to the guard pond.

11.3.4 RO Stage II Reject

The RO stage II reject shall be used for CHP dust suppression, green belt development and led to central monitoring basin.

11.3.5 Condensate Polishing Unit Effluent

Condensate Polishing Plant (condensate polishing plant is located at TG area ground floor) will generate regeneration effluent. This effluent shall be collected in a DM Plant N pit.

11.3.6 **MB, SAC, SBA Regeneration Waste**

MB Regeneration Waste is generated due to periodic regenerations of resin-beds in the water demineralization plant. The waste quality and quantity depends on influent water quality, cycle of operations, type of resins etc. This stream contains salts of sodium, magnesium, calcium etc. and may also contain insignificant amount of heavy metals, if dissolved in DM Plant inlet water. This stream thus have high amount of dissolved solids and also may be acidic or alkaline.

This stream will be first neutralized in a N. Pit by adding acid or alkali as required. The neutralized effluent will then be sent to the Central Monitoring basin.

11.3.7 **Coal Mill area drain**

This effluent is generated due to floor washings, Oil leakages from the coal mill area. This effluent is expected to contain substantial high quantity of oil and suspended solids. This stream will chanelised to Coal Mill Oily wastewater sump from where it will be pumped to power house oily wastewater sump (PHOWS) by screw pumps for further treatment and disposal.

11.3.8 **Power House Building and Boiler Area Oily Effluent Drain**

This effluent is generated from floor washings, leakages from bearing and turbine cooling systems, leakage from pumps, hydraulic couplings, oil leakage from oil burners etc. This effluent basically contains suspended solids and some oil and grease. This stream will be channelised to a PHOWS. From PHOWS this effluent will be pumped to Common Tilted plate interceptor (TPI) by screw pumps. In TPI type oil-water separator suspended solids would be efficiently separated at bottom and oil / grease at the top and collected in suitable slop oil tank. Since this oil will be a mixture of lubricants, grease, hydraulic oil, HSD, HFO etc., it will be sold out after recovery through authorized agency for handling such waste. Clean water from the middle portion of the TPI will be led to the Tube settler .

Common TPI will be located near the central monitoring basin

11.3.9 Oil Handling Area run off

This effluent will be led to a baffled Oil Water Separator (OWS) of API design by gravity, from where oil from upper layer will be periodically removed using suitable oil skimmer / oil removal mechanism and collected in suitably designed slop oil tank from where separated oil will be disposed / sold out. Treated oily effluent from this OWS may contain oil & grease beyond 10 mg/l (the permissible limit of discharge to surface water) will be collected in a sump from where taken to the Common Tilted Plate Interceptor (TPI) for removal of balance oil to meet the standard of discharge before sending to the Tube settler.

The sump inside the F. O. Pump House collects leakage oil and cleaning water. The sump is provided with necessary pump to evacuate the sump. The discharge of this sump will be pumped out to the inlet of the API type Oil- water separator.

Design of API, covered under this Volume, will include the above effluent from F. O. Pump House also.

Common TPI to take care of oily effluents from Power House/Boiler Area oily drains and also F. O. Pump House will be located near the Guard Pond.

The treated effluent from oil handling run off shall be led to the CMB.

11.3.10 CHP dust suppression & Coal pile area run off

Coal pile area run off will be generated due to rainfall on the coal stockpile area. This waste stream will thus only be generated during monsoon months. The coal pile yard will be provided with a garland drain to channelize the run off to a properly designed settling pond. The overflow from the settling pond will be led to a sump and from this sump the same will be reused in CHP dust suppression.

Effluents generated from the coal pile area due to dust suppression system will also be conveyed by the same garland drain and treated in the same settling pond.

There will be two settling ponds, one in operation and the other in stand-by mode. One settling pond will be filled while the other will be excavated. The excavated sludge (fine coal particles) will be disposed off in a suitable manner.

The garland drain around the coal pile yard will also have a by-pass arrangement for diverting the coal pile area run-off to rain water discharge channel for final disposal through storm water drainage system after initial minutes of heavy shower when the run-off will be only clear water and meet the permissible standard. The excess water by-pass system shall be overflow weir controlled. Properly designed overflow weir will be provided to ensure the heavy downpour by-pass.

11.3.11 Boiler Area (except oily drains) & ESP area Drains

Boiler & ESP area floor washing drain generally contains very high TSS. This effluent will be led to a Pre-setting pit. Overflow from this pre-settling pit will be led to a sump. Sump pumps will be installed to transfer this effluent to Tube settler for further treatment in tube settler. The treated water from the tube settler will be led to CMB for equalization.

The trench that will convey boiler and ESP area wash water may receive huge rainfall runoff during heavy down pour. During such condition of continuous heavy rains, the total quantity of waste water at the trench leading to the pre-settling pit will be so high that it cannot be handled in the pre- settling pit and Tube Settler. In fact, after initial few minutes of heavy rains the rainfall runoff is not expected to contain any suspended solids. Hence, an overflow weir controlled by-pass system is proposed before the pre-settling pit to divert such rainfall runoff to the nearby storm drain.

11.3.12 Condenser Wastewater

This is an irregular wastewater that may be generated occasionally during maintenance. This effluent shall be led to trhe guard pond directly.

11.3.13 Transformer yard wastewater

This effluent is generated only in case of exigency. As per convention in the event of fire and / or bursting of transformer causing loss of containment of transformer oil, spilled oil is collected in common oil pit for a cluster of transformers as required by the provisions of Indian Electricity Rules. Oil is retrieved deploying special means. Residual oil and water mixture (after emergency) and oily effluents that may get accumulated over a long period encompassing rainwater and leakage oil (under normal condition), shall be disposed through the Common TPI in controlled manner.

11.3.14 **Ash Silo Area Effluent**

This effluent is generated due to dust suppression and floor cleaning in the ash silo area. This effluent will be managed by allowing it to a dedicated sump in the ash silo area. This sump will be provided with sump pump(s) to enable the ash-rich effluent to be sent to the ash slurry sump.

Suitable agitation system will be employed in this sump to prevent the ash laden particles to settle.

11.3.15 **Guard Pond**

All liquid sea water effluent after required treatment and unused treated effluent from Central monitoring basin will be led to a Guard Pond, which acts as an equalization basin. This Guard pond will also take care of shock loads and/or mal-functioning/failure of any treatment equipment/process.

The pond will have at least 24 hour's detention period calculated based on average hourly flow of total effluents. The minimum effective capacity will be 3000 cum.

Water from this guard pond will conform to the stipulated standards and will be pumped to sea/ used in wet ash disposal or CHP dust suppression.. To comply to PCB norms, suitable acid and alkali tanks with metering pumps shall be located near guard pond for pH correction. Monitoring also will be provided before the final discharge point from the guard pond.

The treated effluent from guard pond shall be pumped back to the hot water return channel of NCTPS Stage I near seal well. Connection from guard pump discharge shall also be provided to the ash water sump.

11.3.16 Necessary instruments shall be provided for monitoring the quality of effluents. This system shall be complete with all pipes, valves and fittings etc.

11.3.17 **Debris Filter Waste**

The debris filter waste shall be led to the ash pond. If pressure is not adequate then the waste shall be pumped by 2 x 100 % pumps. Pump shall be of SS 316 L construction.

11.3.18 **Central Monitoring Basin (CMB)**

All non sea water effeluent shall beled to the central monitoring basin. These wastes shall include RO Stage II Reject, N Pit Effluent, Effluent from oil Water Serparator etc. The CMB shall have 24 hours retention capacity.

Water from this CMB will conform to the stipulated standards and will be pumped to sea/ used in wet ash disposal or CHP dust suppression.. To comply to PCB norms, suitable acid and alkali tanks with metering pumps shall be located near CMB for pH correction.

Water ftrom CMB shall be used for CHP Dust Suppression, Horticulture and excess shall be led tyo guard pond by means of 2 x 100% pumps.

11.3.19 **Sanitary Waste from Plant Toilet**

Refer Chapter 31

11.4.00 **OPERATION AND CONTROL PHILOSOPHY**

The operation and control procedure for wastewater treatment and management will be simple. All sump pumps will be operated by level controls at the sump. At all the inlets and

outlets of the treatment systems, sampling points should be provided to check the operating efficiency of the systems.

For auto operation, one pump has to be kept in Auto running and the other pump has to be kept in Auto standby. The pump selected in Auto running shall start at high level LT and trip at low level LT.

Alarms will be generated at Low level and High level Annunciation will be in local ETP Panels if any and as well as in ETP control room HMI.

The operation and control of the Effluent Treatment Plant shall be through PLC based Control System. This shall cover the total functional requirement of sequence control, interlock & protection, monitoring, alarm, data logging. PLC shall have some basic mode of operations such as auto-mode, manual mode, operator guide mode, and simulation mode. ETP control room will be located near the CMB & Guard Pond.

The overall operation and control of entire ETP shall be provided at the ETP Control Building. For the all the Local Sumps located at different locations in the plant.

Suitably located Remote I/Os shall be provided for control and monitoring of the nearby drives and systems.

Sample shall be taken manually at the outlet and tested in the Laboratory for other parameters as suspended solids, and oil content etc. as per requirement. Necessary sampling ports with bib-cock shall be provided at discharge headers of the CMB outlet pumps.

Required have pH measurements and chemical measurements as insisted by TNPCB shall be provided in effluent plant.

Bidder to refer clause 5.00 of Annexure ‘C’ volume V Instrumentation and Control works.

11.5 Piping, Valves & Specialties

Bidder shall include all necessary, piping, instrumentation, valves and specialties required for successful commissioning of the the system

DATA SHEET FOR EFFLUENT TREATMENT PLANT

S. No.	Item	Units	Description
1.1	Ash Silo Area Sump transfer pump		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	5m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Vertical type
	e. Capacity of Sumps	m3	10.0
	Material of Construction		
	Base Plate/ Cover Plate		MS – IS 2062
	Column Pipe		MS – IS 2062
	Casing		2% NiCi
	Impeller		CF8M
	Pump/ Impeller Shaft		SS 410
	Shaft Sleeve		SS 410
	Shaft Coupling		SS 410
	Shaft Bearing		BUSH GM as per IS 306
	Gland		CI IS 210 FG 260
	Fasteners		SS 304
1.2	Coal mill oily water sump transfer pump		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	5m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Screw type
	e. Capacity of Sumps	m3	5.0
	Material of Construction		
	Casing		2% NiCi as per IS 210 FG 260
	Rotor		CF 8M
	Shaft		CF 8M
	Stator		Nitrile Black
1.3	Power house oily water sump transfer pumps		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	10m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Screw type
	e. Capacity of Sumps	m3	10.0
	Material of Construction		
	Casing		2% NiCi as per IS 210 FG 260
	Rotor		CF 8M
	Shaft		CF 8M
	Stator		Nitrile Black
1.4	Fuel Oil Area Sump transfer pumps		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	10m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Screw type

S. No.	Item	Units	Description
	e. Capacity of Sumps	m3	10.0
	Material of Construction		
	Casing		2% NiCi as per IS 210 FG 260
	Rotor		CF 8M
	Shaft		CF 8M
	Stator		Nitrile Black
1.5	Fuel oil overflow sump transfer pump		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	10m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Screw type
	e. Capacity of Sumps	m3	10.0
	Material of Construction		
	Casing		2% NiCi as per IS 210 FG 260
	Rotor		CF 8M
	Shaft		CF 8M
	Stator		Nitrile Black
1.6	TPI overflow sump transfer pump		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	20m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Screw type
	e. Capacity of Sumps	m3	20.0
	Material of Construction		
	Casing		2% NiCi as per IS 210 FG 260
	Rotor		CF 8M
	Shaft		CF 8M
	Stator		Nitrile Black
1.7	PSP overflow transfer pumps		
	a. No. of pumps	Nos.	2 nos. (1w+1s)
	b. Rated Capacity	m^3/hr	10m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Vertical type
	e. Capacity of Sumps	m3	5.0
	Material of Construction		
	Base Plate/ Cover Plate		MS – IS 2062
	Column Pipe		MS – IS 2062
	Casing		2% NiCi
	Impeller		CF8M
	Pump/ Impeller Shaft		SS 410
	Shaft Sleeve		SS 410
	Shaft Coupling		SS 410
	Shaft Bearing		BUSH GM as per IS 306
	Gland		CI IS 210 FG 260
	Fasteners		SS 304
1.8	Condenser Waste Water pumps		
	a. No. of pumps	Nos.	2 nos. (1w+1s) per unit

S. No.	Item	Units	Description
	b. Rated Capacity	m^3/hr	10m^3/hr
	c. Head of the pumps	m	As required
	d. Type	----	Vertical type
	Material of Construction		
	Casing		Duplex SS 2205 UNS 31803
	Column Pipe		Duplex SS 2205 UNS 31803
	Impeller		Duplex SS 2205 UNS 31803
	Shaft		Duplex SS 2205 UNS 31803
	Line shaft coupling		Duplex SS 2205 UNS 31803
	Line shaft bearing		Duplex SS 2205 UNS 31803
	All hardware under water		AISI SS 316
	Wearing Ring		Duplex SS 2205 UNS 31803
	Shaft sleeve		Duplex SS 2205 UNS 31803
	Thrust bearing cooling system pipes and valves		SS 316
	Thrust Pads		Carbon steel with white metal lining
	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating or cement mortar coating inside
	Gland Packing		Impregnated Teflon
	Stuffing Box Housing		SS 316 or 13.5 to 17.5 % Ni Ci
2.0	N Pit for DM Plant & CPU		
	a. Quantity	No.	1 no. each for MB & CPU in two sections
	b. Capacity	M^3	Each section to hold 1.5 times the waste quantity generated during one regeneration of cation & Anion resins
	c. MOC	-----	RCC with acid/ alkali proof lining
2.1	Ash Silo Area Sump		
	a. Quantity	No.	1 no.
	b. Capacity	M^3	10 m^3
	c. MOC	-----	RCC with agitation system
2.2	Coal mill oily waste sump		
	a. Quantity	No.	1 no.
	b. Capacity	M^3	5 m^3
	c. MOC	-----	RCC
2.3	Power house oily water sump		
	a. Quantity	No.	1 no.
	b. Capacity	M^3	10 m^3
	c. MOC	-----	RCC
2.4	Fuel oil area sump		
	a. Quantity	No.	1 no.
	b. Capacity	M^3	10 m^3
	c. MOC	-----	RCC
2.5	Fuel oil overflow water sump		
	a. Quantity	No.	1 no.

S. No.	Item	Units	Description
	b. Capacity	M^3	10 m^3
	c. MOC	-----	RCC
2.6	TPI overflow sump		
	a. Quantity	No.	1 no.
	b. Capacity	M^3	20 m^3
	c. MOC	-----	RCC
2.7	Condenser waster water sump		
	a. Quantity	Nos.	2 nos.
	b. Capacity	M^3	5 m^3
	c. MOC	-----	RCC
2.8	Pre Settling Pit		
	a. Quality	No.	1 no.
	b. Capacity	M^3	10 m^3
	c. MOC	-----	RCC
2.9	PSP overflow sump		
	a. Quality	No.	1 no.
	b. Capacity	M^3	5 m^3
	c. MOC	-----	RCC
3.0	API Separator		
	a) Quantity	No.	1
	b) Depth to Width ratio	--	0.3 – 0.5
	c) Oil Globus size	Microns	150
	d) Design Capacity	M3/hr	10
	e) Sludge Removal	--	By Pump
3.1	TPI Separator		
	a) Quantity	No.	1
	b) Design Capacity	M3/hr	20
	c) MOC	--	RCC / MS
	d) No. of slope oil tank	Nos.	2
	e) Plate Pack	--	PVC
	f) Oil Skimmer	--	Epoxy Painted
3.2	Guard Pond		
	Effective Capacity	M^3	2000
	Type of tank		Partially underground/ partially overground
	No. of compartments		Two
	MOC		RCC
3.3	Guard Pond Pumps		
	Number of pumps		2
	Type of pumps		Vertical Turbine
	Capacity of each pump	M^3/hr	1000
	Head	MWC	Bidder to decide
	Material of Construction		
	Casing		Duplex SS 2205 UNS 31803
	Column Pipe		Duplex SS 2205 UNS 31803
	Impeller		Duplex SS 2205 UNS 31803

S. No.	Item	Units	Description		
	Shaft		Duplex SS 2205 UNS 31803		
	Line shaft coupling		Duplex SS 2205 UNS 31803		
	Line shaft bearing		Duplex SS 2205 UNS 31803		
	All hardware under water		AISI SS 316		
	Wearing Ring		Duplex SS 2205 UNS 31803		
	Shaft sleeve		Duplex SS 2205 UNS 31803		
	Thrust bearing cooling system pipes and valves		SS 316		
	Thrust Pads		Carbon steel with white metal lining		
	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating or cement mortar coating inside		
	Gland Packing		Impregnated Teflon		
	Stuffing Box Housing		SS 316 or 13.5 to 17.5 % Ni Ci		
3.4	TUBE SETTLER				
	a. No. of clarifier	No.	One		
	b. Type of Construction		RCC/MS (Material shall be decided during detailed engg.)		
	c. Capacity	m3/hr	125		
	d. Detention period				
	Flocculation zone	Min.	30		
	Clarifier zone	Min.	150		
	e. Surface overflow rate	m3/m2/h	1.5 to 2.0		
4.1	Chemical Dosing system (Gravity System) at clarifiers		Coagulant	Lime	Poly
4.1.1	Capacity MOC		5 Cum (nett) MSRL	5 Cum (nett) MS/EP	5 Cum (nett) MSRL
	Constant head box device with tapered / needle arrangement (for both alum and lime)		----------To be provided----------		
4.1.2	Dosing arrangement		Dozing Pump		
4.2	Chemical House		Near TUBE SETTLER		
4.3	Sludge Disposal				
	a. No. of sludge sump	No.	One		
	b. Construction		RCC		
	c. Sludge disposal pumps				
	Number	No.	2 (1w +1s)		
	Type		Vertical (Non-Clog)		
5.0	Sanitary System				
5.1	Septic Tank	No.	One		
	a. Disposal pump	No.	2 (1w + 1s)		
	b. Type		Vertical		
	c. Capacity	m3/hr	10		
	d. Discharge head	M	Bidder to specify		
	e. Material of construction		CI		
5.2	Material of pumps				

S. No.	Item	Units	Description
	Col pipe / Discharge Head		Carbon Steel IS 2062
	Impeller		Stainless Steel CF 8M
	Shaft / Shaft Coupling		SS 316
	Shaft Sleeve		SS 316
	Line Shaft Bearing		Cutless Rubber
	Casing / Bell mouth		2.5% Ni Cl, IS 210 FG 260
5.3	Up flow filter		
	a) Number	No.	One
	b) Capacity	m3/hr	5
	c) Chlorination		To be provided for 2 ppm dosing
6.0	Central Monitoring Basin (CMB)		
	Effective Capacity	M^3	24 Hours Retention
	Type of tank		Partially underground/ partially overground
	No. of compartments		Two
	MOC		RCC
6.1	CMB Disposal Pumps		
	Number of pumps		2
	Type of pumps		Vertical Turbine
	Capacity of each pump	M^3/hr	To empty CMB in 1 hour
	Head	MWC	Bidder to decide
	Material of Construction		
	Casing		SS 316
	Column Pipe		SS 316
	Impeller		SS 316
	Shaft		SS 316
	Line shaft coupling		SS 316
	Line shaft bearing		SS 316
	All hardware under water		SS 316
	Wearing Ring		SS 316
	Shaft sleeve		SS 316
	Thrust bearing cooling system pipes and valves		SS 316
	Thrust Pads		Carbon steel with white metal lining
	Discharge Pipe & flanges		Fabricated steel as per IS:2062 with epoxy painting outside and glass coating or cement mortar coating inside
	Gland Packing		Impregnated Teflon
	Stuffing Box Housing		SS 316 or 13.5 to 17.5 % Ni Ci

ANNEXURE – I

INDIAN GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS: EFFLUENTS

SNo.	Parameters	Standards for discharge into/on			
		Inland Surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
1.	Colour and odour	*	*	*	*
2.	Suspended solids, mg/l	100	600	200	a) For process wastewater-100 b) For cooling water effluent 10% above total suspended matter of influent
3.	Particle size of suspended solids	Shall pass 850 micron IS sieve	–	–	a) Floatable solids, max. 3 mm b) Settable solids, max.850 microns
4.	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
5.	Temperature	Shall not exceed 5 ^{0}C above the receiving water temperature	–	–	Shall not exceed 7 ^{0}C ** above the receiving water temperature
6.	Oil and grease, mg/l	10	20	10	20
7.	Total residual chlorine, mg/l	1.0	–	–	1.0
8.	Ammonical nitrogen, mg/l	50	50	–	50
9.	Total Kjeldahl nitrogen (as N), mg/l	100	–	–	100
10.	Free ammonia (as NH3), mg/l	5.0	–	–	5.0
11.	Biochemical oxygen demand (5 days at 20 0C), mg/l	30	350	100	100
12.	Chemical oxygen demand, mg/l	250	–	–	250
13.	Arsenic (as As), mg/l	0.2	0.2	0.2	0.2
14.	Mercury (as Hg), mg/l	0.01	0.01	–	0.01
15.	Lead (as Pb), mg/l	0.1	1.0	–	2.0
16.	Cadmium (as Cd), mg/l	2.0	1.0	–	2.0
17.	Hexavalent chromium (as Cr+6), mg/l	0.1	2.0	–	1.0
18.	Total chromium (as Cr), mg/l	2.0	2.0	–	2.0
19.	Copper (as Cu), mg/l	3.0	3.0	–	3.0
20.	Zinc (as Zn), mg/l	5.0	15	–	15
21.	Selenium (as Se), mg/l	0.05	0.05	–	0.05
22.	Nickel (as Ni), mg/l	3.0	3.0	–	5.0
23.	Cyanide (as Cn),mg/l	0.2	0.2	0.2	0.2
24.	Fluoride (as F), mg/l	2.0	15	–	15
25.	Dissolved phosphates (as P), mg/l	5.0	–	–	–
26.	Sulphide (as S), mg/l	2.0	–	–	5.0
27.	Phenolic compounds (as C6H5OH), mg/l	1.0	5.0	–	5.0

SNo.	Parameters	Standards for discharge into/on			
		Inland Surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
28.	Radioactive materials (a) Alpha emitters, uc/ml (b) Beta emitters, uc/ml	 10-7 10-6	 10-7 10-6	 10-7 10-6	 10-7 10-6
29.	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
30.	Manganese (as Mn), mg/l	2.0	2.0	–	2.0
31.	Iron (as Fe), mg/l	3.0	3.0	–	3.0
32.	Vanadium (as V), mg/l	0.2	0.2	–	0.2
33.	Nitrate nitrogen, mg/l	10	–	–	20

Note : * All efforts should be made to remove colour and unpleasant odour as far as practicable. Schedule VI inserted by Rule 2 (d) of the Environment (Protection) Third Amendment Rules,

** 1993 notified vide G.S.R. 801 (E) dated 31.12.1993.

Source : Pollution Control Acts, Rules and Notifications issued there under : Pollution Control Law PCL) / 2 / 1992, published by Member Secretary, Central Pollution Control Board

ANNEXURE-II

THERMAL POWER PLANT: STANDARDS FOR LIQUID EFFLUENT

Source	Parameter	Concentration not to exceed, (mg/l) (except for pH)
Boiler blowdown	Suspended Solids	100
	Oil & Grease	20
	Copper (total)	1.0
	Iron (total)	1.0
Cooling tower blowdown	Free available Chlorine	0.5
	Zinc	1.0
	Chromium (Total)	0.2
	Phosphate	5.0
	Other corrosion inhibiting material	Limit to be established on case by case basis.
Ash Pond Effluent	pH	6.5 - 8.5
	Suspended Solid	100
	Oil & Grease	20
Source: EPA Notification [S.O. 844 (E), dated 19th November1986].		

CHAPTER 12

12.0 FIRE PROTECTION & DETECTION SYSTEM

12.1 GENERAL INFORMATION

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 2 x 660 MW Unit and its auxiliary plants to reduce consequential damages by containing and extinguishing the same. Bidder's scope of work covers design, manufacture, supply, erection and 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.**

RO stage I Permeate shall be used for fire fighting system. The fire pumps shall be installed in the filtered water pumphouse on RO Stage I Permeate Tank.

12.2 CODES AND STANDARDS

The system shall be designed keeping in view the recommendations of Tariff Advisory Committee (TAC) of Insurance Companies of India / FOC U.K. / NFPA USA. Any other International Standard having equivalent stringent codes may also be considered. However, the system shall be approved by statutory authorities.

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

12.3 SYSTEM DESCRIPTION

Fire extinguishing system shall cover the entire proposed plant.

Fire detection and extinguishing system for complete coal preparation firing system including coal feeding system and mills in steam generator is excluded from scope of work.

The Fire Extinguishing System is broadly divided into the following sub-systems:

12.3.1 Hydrant System

The Hydrant System of Fire Protection essentially consists of a large network of pipe, both underground and over ground which feeds water to a number of hydrants valves – indoor as well as outdoor and to a number of outdoor type fixed installations. Water in the pipe network is kept pressurised by jockey pump arrangement. These hydrant valves are 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 Houses" (for outdoor hydrants) and in "Hose Boxes" (for indoor hydrants). When the fire hoses are coupled to the hydrant valves through the instantaneous coupling, jet of water is directed towards the fire. At least two headers shall be taken out of pumphouse for making loops around various risks. Each loop shall be interconnected for better reliability of the system. For isolating the system due to damage/ repair, suitable nos. of gate valves should be provided.

Hydrant system protects the following building/facilities:

a) Entire Power House including Boiler and ESP Areas

b) Mill Reject Handling System compressor house.

c) ESP Control Building

d) Fly ash equipment building

e) HFO & HSD Pump House Area.

f) HFO & HSD storage tanks and dyke area

g) Compressor House

h) Diesel Generator Area

i) Generator, Station, Unit transformers and all auxiliary Transformers

j) CW Pump House

k) Electrochlorination building (CW). Portable fire extinguishers shall be provided for elctrochlorination building near sea water intake pumphouse.

l) Water Pretreatment Plant

m) Sludge Pump House

n) FIltered Water Reservoir and Pump House

o) Sea Water Intake Pump House

p) DM Plant with acid and alkali bulk storage tanks

q) Chemical House

r) Coal Handling Plant and Coal Storage Yards including all transfer points, bunker bay conveyors, sub-stations and control room, office building. Coal handling shall include complete ECHS & ICHS.

s) Crusher House

t) Coal Handling Control Building

u) Ash Handling Plant Area including Ash Slurry Pump House, Ash Water Pump House, FA Conveying Blower Room, MCC rooms

v) All storage areas including O & M Store

w) Effluent treatment Plant

x) Open Storage Yard.

y) Transformer Yard, GIS Switchyard & Grid Control Room Building.

z) Service Building

aa) Administrative building

bb) CPU Regeneration building

cc) All gate houses

dd) Canteen

ee) Workshop

ff) Chimney area

gg) Diesel filling station

hh) Fire water pump house

ii) Cooling Tower Area

jj) Fire Station*

kk) Ash silo area

ll) Hydrogen Generation Plant

Note: Buildings not specifically identified above but required to be covered by hydrant system shall also be included in the scope of the Bidder.

12.3.2 **High Velocity Water Spray System (HVW System)**

a) **Category – A**

This system shall automatically detect, control and extinguish any out-break of fire and simultaneously give audible alarm. Water line 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 Local Zonal Fire Alarm Panel as well as in the Central Fire Detection and Alarm Panel.

The system shall also have a manual over riding facility along with regular testing facility.

Category – A type HVW Spray Protection shall be provided for the following equipment :

a) All transformers located in transformer yard of Main Plant area.

b) All other transformers of rating 10 MVA and above.

b) **Category – B**

In this system fire shall be detected by use of heat detectors, flame detectors depending upon the area. Upon detection of fire, HVW Spray System shall be brought in operation automatically by opening deluge valves.

Category – B type HVW Spray System shall be provided for the following areas:

a) Main and unit turbine oil tanks and purifiers.

b) Boiler Burner Front

c) Hydrogen cooling and Generator seal oil areas

d) Turbine generator under-deck area

e) Emergency DG set

f) Central Lub Oil Tanks (Clean & Dirty oil tanks) and purifier units.

g) Boiler Feed Pump lub oil tanks, coolers, consoles etc.

h) Turbine oil canal pipelines in main plant.

The operation of Deluge Valves shall be annunciated in the Local Zonal Fire Alarm Panel as well as in the Central Fire Detection and alarm Panel with repeat alarm at Fire Station Buildings.

The HVW system shall exclusively fed from the spray water pump.

12.3.3 **Medium Velocity Water Spray System (MVW 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 valves in MVW Spray System shall be annunciated in the respective local zonal panels and in the central fire detection and alarm panel with repeat alarm at Fire Station Buildings.

The MVW system shall be tapped off from the hydrant system.

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. MVW shall be provided for above equipment in ECHS & ICHS.

b) The open conveyors installed in NCTPS/ Coal Berth shall also be provided with MVW spary system. It may be noted that full length of each conveyor both top and bottom belt shall be protected with MVW Spray System

c) Complete Pipe conveying system from NCTPS to proposed power plant. It may be noted that full length of each pipe conveyor both top and bottom shall be protected with MVW Spray System

b) Cable vault/cable galleries/cable spreader room in Power House, CHP Control room, Ash Water Pump House, CW Pump House and in other ancillary buildings as applicable and stated elsewhere.

c) HFO/HSD storage tanks, unloading pump house and pressurizing pump house

d) HV Transformer Rectifier sets at ESP roof top meeting the requirement of NFPA.

12.3.4 **Fixed Foam Protection System**

Water based automatic activated low expansion foam protection systems shall be provided for main HFO and HSD storage tanks.

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.

Foam concentrate will be pumped from the foam concentrate storage tank by two foam pumps to foam proportioner skids one provided for each fuel oil tank. Pressurized water connection is provided to the eductor of each foam proportioner skid. In the event of fire, the foam system for respective tank shall be automatically activated on detection of fire by ROR heat detectors provided inside the FO tanks. Water will start flowing through the eductor where foam concentrate is induced and mixed with the flowing water in definite proportion. This foam water mixture flows to tank, where the foam solution expands by sucking air from the atmosphere and foam thus formed fills the oil surface inside tank by suitably designed deflectors.

In general the system shall be in line with NFPA-11 regulations.

12.3.5 **Inert gas flooding system**

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, inside panels/cabinets and inside the rooms for both the units.

b) Electronic equipment rooms, Computer rooms & UPS rooms.

The inert gas flooding system for the above areas shall consist of battery of inert gas storage cylinders of adequate capacity, which shall be located suitably at a centralized location. 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 initiate an alarm in the local panel, and main fire alarm panel. Simultaneously, the detection signal opens the deluge valve automatically and 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 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.

Note :

1. Highly sensitive linear heat sensing cable and solar blind infra-red detector shall be used to detect fire in coal conveyor. Upon detection of fire, drive motor shall automatically stop and zone-wise annunciation shall be made available in Coal Handling Plant Control Room. Simultaneously, the MVW spray system shall be automatically brought into operation by opening the solenoid operated deluge valve with the energisation of the solenoid from the detection circuit. The spray system shall be designed to spray water on the three zones of Conveyors (one forward & one preceding zone and the zone under fire).

   The entire area of the coal handling system (i.e. conveyors galleries, conveyor tunnels and bunker bay conveyors of the coal handling plant) is to be sectionalised into suitable number of zones and each zone shall be protected by automatic operation of MVW spray system. The solenoid operated deluge valve shall also have manual overriding and regular testing facility.

2. For cable vault and cable spreader room, addressable, analogue type multi criteria smoke detectors in cross zoning principle used in conjunction with linear heat sensor shall be provided on each tray to detect the fire. Upon detection of fire and actuation of zone annunciation, MVW Spray System will be brought into operation by automatically opening deluge valve, which will allow the projectors located in that zone to direct water in the form of spray which will cut-off oxygen supply and extinguish the fire.

   The entire area of cable spreader room and cable vaults is to be sectionalised into suitable number of zones and each zone shall be protected by automatic operation of MVW Spray System.

12.3.6 Portable Fire Extinguishers

Portable fire extinguishers shall be provided as per datasheet.

12.3.7 The main source of water to the fire pumps and jockey pumps shall be the RO Stage I Permeate water. Dedicated storage shall be provided for the fire water pumps in the RO Stage I Permeate sump in RO Stage I Permeate tank. The firewater storage shall be of adequate capacity as per TAC requirement. However, the effective capacity(from top of pump casing upto the “high-level” of fire water tanks) of the fire water storage in the RO Stage I Permeate Sump shall not be less than 3000 cum. Water for both hydrant and High/Medium Velocity Water Spray System shall be supplied by automatic firewater pumps. The pumps will be started automatically in proper sequence when a large quantity of water flows out from pressurised water circuit. There shall be adequate arrangement of meeting up system leakages and at the same time the system pressure shall be maintained by providing a hydro pneumatic tank along with jockey pumps and compressors. All the pumps used in the Fire Protection System shall be horizontal centrifugal type.

Fire Pumps with all auxiliary equipment as specified in the paragraph above shall be located in the RO Stage I Permeate Pumphouse.

12.3.8 Microprocessor based addressable analog type multi criteria smoke detectors connected in cross-zoning principle as per NFPA/FOC recommendation and in two wire circuitry shall be provided in the following areas :

a) All cable Spreader Rooms & Cable Vaults, cable gallery in powerhouse and in all ancillary plant buildings.

b) All Electrical Switchgear / MCC Rooms located in Power House and in all ancillary plant buildings.

c) Central Control Rooms, Control equipment room housing DCS, UPS etc. and in all ancillary plant building control rooms.

d) Inside turbine acoustic insulation enclosure near governing system.

12.3.9 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.

a) Battery and battery charger rooms.

b) 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.

c) Dry type L.T. Transformers located anywhere in the plant area.

d) Main and unit Turbine Lube Oil Tank and purifier.

e) Boiler Firing Floors.

f) Inside turbine acoustic insulation enclosure near governing system.

12.3.10 Quartzoid bulb detectors shall be used in all transformers.

12.3.11 Heat sensing cable as detector shall be used for coal conveyor gallery & tunnel including bearings and both drive pulley and non drive pulley. This shall be used in whole length of top belt and bottom belt (in a zig-zag fashion). These detectors shall also be used for tripping the conveyor drives.

12.3.12 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. Rate of rise cum fixed temperature heat detectors shall be used for Boiler burner fronts, turbine oil tanks and HFO / HSD storage tanks inside. Heat detectors shall be analogue addressable type.

12.3.13 The entire Power House Building and the outdoor yard of plant have been divided into a number of zones with a few addressable manual call points in each zone. The outdoor call points shall be installed on approximately 1 metre high angle iron supports for ease of operation. The manual call points inside the Power House Building shall be suitable for wall mounting, Manual call points of "break glass push button station type" or "lever type" shall be provided specifically in the following areas.

a) Switch gear and MCC room in Power house.

b) Outdoor transformer yard.

c) All floors in power House, including Boiler House.

d) All areas of boiler house.

e) Coal stock yard.

f) Coal bunker and coal mill area.

g) Crusher house and transfer points.

h) All pump houses namely Raw water pump house, CW/ACW Pump House, clarified water reservoir and pump house Chemical House, Sludge Pump House, Ash Water Pump House, F.O Pump House, Ash slurry pump house, Fire Water Pump House etc.

i) All buildings like Compressor and DG area etc.

j) GIS

K) Hydrogen Genration Plant shall be provided with gas detection & falme proof mnual call points

Number of manual call points shall be decided during detailed engineering.

12.3.14 All detectors shall be located and spaced as per NFPA-72E and shall be UL/FM approved. On receipt of impulse from the detectors, in the event of fire, suitable annunciations signal shall be exhibited in the respective Satellite fire panels as well as Main and Master Fire Panels. The areas including electrical control rooms, switchgear rooms, cable vault, coal conveyors etc shall be suitably sectionalized as far as the fire detection is concerned and as such the affected Zone can also be spotted.

12.3.15 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.

12.3.16 The Transformer to be protected by automatic High Velocity Water Spray System shall be separated from each other by explosion proof barrier walls of 120 minutes fire rating so that fire in one does not affect the adjacent Transformers.

12.3.17 The Cable Spreader Room and Cable Vault shall be divided into a smaller risk zones. LHS cable in cable vault shall be on alternate trays in Zig- Zag fashion.

12.3.18 Back Lit maintained type emergency "exit light" shall be provided in control room, control equipment rooms, switchgear and MCC rooms, battery charger rooms, escape stair case in power house, crusher house and transfer points in coal conveyor area and other buildings in the plant. These shall be switched on upon detection of fire.

12.3.19 Addressable analog smoke detector shall also be provided in all false ceiling in power house i.e. Control room, Control equipment room, ESP control room.

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.

12.3.20 “First aid fire protection system" shall be provided for Power house.

12.3.21 Gas sensing fire detectors working on air sampling shall be provided for all control rooms, and control equipment room.

12.3.22 Provision should be kept for automatic closing of fire dampers in ventilation ducts or tripping of related ventilation fans as required on detection of fire.

12.3.23 It is proposed to use the existing Fire station building along with the Firemen and other station fire fighting equipments available with them for the proposed project.

12.4 **OPERATIONAL PHILOSOPHY**

12.4.1 **Hydrant System**

12.4.1.1 Operation of hydrant system shall be semi-automatic. A pressurised hydrant main shall be maintained through the combination of hydro pneumatic tank, jockey pumps and compressors. 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.

12.4.1.2 Hydro-pneumatic tank shall be filled up with water up to 2/3rd portion of its height. Air space shall be kept above the water- filled portion. The hydro-pneumatic tank will be equipped with necessary level switches and pressure switches. Minor leakage in the pressurised fire water system shall be replenished from hydro-pneumatic tank. When the level of hydro pneumatic tank is low, jockey pump shall be started automatically to replenish the level of water in the tank. Jockey pump shall cut-out automatically when the level of water in the hydro pneumatic tank reaches its higher limit. Pressure switches provided in the hydro pneumatic tank shall be interlocked with the cut-in/cut-out operation of compressor which is used to maintain a constant pressure in the hydro pneumatic tank and there by to the whole fire fighting system.

12.4.1.3 All fire hydrant pipelines shall be located overground except in coal yard.

12.4.2 **Spray Water System**

12.4.2.1 Operation of Spray Water System shall be automatic.

12.4.2.2 Header pressure of spray water system shall be maintained at a constant value with the help of jockey pump as stated earlier in case of hydrant system.

12.4.2.3 When the pressure of spray water system falls down to a preset value, it will be detected by pressure transmitter which in turn shall send starting signal to the motor driven spray water pump for automatic starting. If the pressure falls further below, stand-by Diesel engine driven pump shall start automatically from the signal of it's pressure transmitter. Further, if necessary to arrest the falling pressure, pumps for hydrant system shall also be started automatically and deliver water to the spray water system.

In each case above, "pumps fail to start" alarm shall be annunciated in LCP if any pump does not start even the start-up of signal from it's pressure switch is through.

12.4.2.4 Any Fire water pump, if started automatically, shall not be stopped without manual intervention.

12.4.2.5 In case of detection of fire in HT transformer, "deluge valve" in spray water line shall open automatically and spray water system shall come into operation fully automatically. Operation shall be annunciated.

12.4.2.6 In case of detection of fire in coal conveyor, alarm shall be annunciated in the local fire panel located in the CHP control room and the solenoid operated deluge valve in spray water line shall be opened automatically and the spray water system shall be brought into operation.

12.4.2.7 In all other areas of spray water system, detection of fire shall produce annunciation in the respective local fire panel and the spray water system shall be brought into operation by opening automatically the deluge valves of the particular area.

12.4.3 Inert **Gas Flooding System**

In the event of fire, the fire detectors initiate an alarm in the local panel, and main fire alarm panel. Simultaneously, the detection signal opens the deluge valve automatically and 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.

12.4.4 Functional Requirement of Various Panels In Fire Protection System

Bidder shall provide necessary local control panels for the fire protection system, which shall contain the following components and perform the following functions as minimum

12.4.4.1 Distributed Control System (DCS) based Local Fire Water Control Panel, common for both the units, located in Fire Water Pump House shall be provided. The system shall be complete with dual redundant controllers, dual redundant power supply modules and communication processors and necessary input output devices, work station and termination units. Connections from all field devices and interfacing signals with MCCs related to the fire protection system shall be terminated in the Termination units.

In addition to Local Operation, facility for Remote Operation and monitoring from either of the Workstation Keyboards of the Fire Detection and Alarm Panel / workstation located in the Central Control Room (CCR) as well as in Fire Station Building shall be provided.

Minimum operating facility shall be as follows

a) Starting/Stopping of motor driven fire water pumps with status indication .

b) Local Remote Selection for Local/ Remote Operation of the Fire Water Pumps.

c) Starting/Stopping of "starting DC motor" of Diesel engine driven pumps with status indication. Provision of local and remote indication for Diesel Driven Pump Running shall also be made.

d) Starting/Stopping of jockey pumps with status indication.

e) Starting/Stopping including local Remote Selection for Local/ Remote Operation of compressor with status indication.

f) Opening/Closing of motorised valves on fire water main header with indication in Local Panel

g) Auto/Manual selection for fire water pumps, jockey pumps & air compressors.

h) Current indication for motors.

i) All other fuses, wiring, cabling, tubing, space heater etc.

j) DCS driven local Annunciation system.

12.4.4.2 All control and protection interlocks for the fire water pumping system shall be configured in the Distributed Control System (DCS). General requirements of DCS are elaborated in Volume V of the specification.

Separate Local Satellite Fire Alarm Panel for the Fire Detectors of nearby areas to be provided and to be housed in the FW Pump House.

12.4.4.3 Microprocessor based Main Fire Detection and Alarm panel (FAP) with PC and Monitor with Printer for each Unit (total two numbers) to be located in Central Control Room (CCR). Each Fire Detection and alarm Panel (FAP) shall receive

a) All annunciations from transformer to stack unit wise.

b) All annunciations from the Local Satellite Fire alarm panels eg. Fire Alarm Panels in DM Plant control room, Ash handling Plant Control Room, CW, ACW Pump House, Switchyard Control Room, CHP Control Room etc.

12.4.4.4 **Fire Alarm Panel located in Coal Handling Plant (CHP) Control Room**

a) All annunciations from detectors used in coal conveyor system, transformers, switchgear / MCC rooms, control room.

b) Annunciations from manual call points of coal handling area.

c) Opening / closing of solenoid operated deluge valves used in coal conveyor area.

12.4.4.5 Repeater Fire Alarm Panel with PC and Monitor with Printer located in Fire Station which shall receive :

a) All annunciations from the respective unit main fire alarm panels in CCR and CHP control room.

b) All grouped annunciations from the Satellite Fire Alarm Panels indicating zone & area.

12.4.4.6 **Satellite Fire Alarm Panels located in various Plant areas**

All annunciations from Detectors and Manual Call Points of respective areas.

12.4.5 Following annunciations windows shall be provided as minimum to the local control panels

12.4.5.1 Local Control Panel for Fire water System located at FW Pump House

a) Running / Tripping of fire water pumps (6 nos.)

b) Running / Tripping of jockey pumps (2 nos.)
c) Running / Tripping of compressors (2 nos.)

d) Fire water pumps "fails to start" (6 nos.)

e) Jockey pump "fails to start" (2 nos.)

f) Compressor "fails to start" (2 nos.)

g) Low level in fuel oil tank of DE driven fire water pumps (2 nos.)

h) Low/High water level of hydro pneumatic tank (2 nos.)

i) Low/High pressure of air in hydro pneumatic tank (2 nos.)

j) Lub oil pressure low of Diesel engine (2 nos.)

k) Engine overspeed (2 nos.)

l) High temperature of engine (2 nos.)

m) Fire water header pressure low (1 no.)

n) Power supply trouble (1 no.)

o) Motorised valve on fire water main header “fail to open".

12.4.5.2 **Fire Alarm Panel located at CHP Control Room**

Apart from fire alarms from Detectors and Manual Call Stations, following annunciations shall be available:

Pressure (high) at down stream of solenoid operated deluge valve (1 no. for each zone).

12.5 **SCOPE OF WORK**

12.5.1 **Mechanical**

a) Three (3) nos. of horizontal centrifugal fire water pumps with drive 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.

b) Three (3) nos. of horizontal centrifugal fire water pumps 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.

c) One No. RCC fire water storage tank (provided in RO Stage Permeate Sump). Effective capacity of fire water storage shall be decided based on TAC requirements. However the effective capacity, in any case, shall ne be less than 3500 cum with all accessories as specified.

d) One (1) no. of hydro-pneumatic tank along with electric motor driven jockey pumps (1w + 1s) and compressors (1w + 1s) with drive motors. Jockey pumps & compressors shall be provided with all regular accessories.

e) Two (2) nos. of horizontal centrifugal type booster pumps (One motor driven and the other diesel engine driven) for hydrant service on higher floors of power house and boiler building.

f) Foam tank skids for foam concentrate storage, complete with foam concentrate feed pumps (1w + 1s), piping, fittings, valves, tank sludge trap and sludge disposal arrangement, safety valves, pressure gauges, level transmitter, level indicator and other required accessories.

g) Foam proportioner skids, complete with skid base frame, foam and water piping, water line strainers, deluge valve, eductor, foam nozzles, ROR heat detector and alarm system, local alarm panel and other required accessories for the protected areas as specified elsewhere in the specification.

h) One centralized inert gas flooding system for the areas specified, complete with cylinder rack, gas manifold, pressure reducing stations, detection system components and panel, nozzles, piping, fittings and valves.

i) Outdoor hydrant valves with hoses, solid jet/triple purpose/fog type branch pipes with nozzles and quick coupling as required for the entire outdoor hydrant system specified as per TAC rules. The equipment shall be as per specification.

j) Indoor hydrants (landing valves) with hoses, triple purpose branch pipe with nozzles and quick coupling end & "hose boxes" as required for the entire indoor hydrant system specified as per TAC rules.

k) Out of total nozzles provided in indoor & outdoor hydrant system, at least 10% shall be "fog type" and balance shall be of ordinary type.

l) Minimum six (6) nos. of "Hose Houses" for outdoor hydrant system. Same shall be strategically located in outdoor plant area.

m) 32 mm NB connections for first aid hose reels, first aid hose reels along with branch pipe fitted with nozzles and quick coupling ends and isolating valves, hose boxes as required for the entire first aid fire protection system specified.

n) Lot of "water monitors" on as required basis for the areas identified in the specification.

o) Sets of hydraulically operated deluge valves with bypass valve, isolating valve & test valve for all HT transformers as specified.

p) Sets of solenoid operated deluge valves with bypass valve, isolating valve & test valve for entire spray system for coal conveyors, conveyor tunnels, turbine lube oil tank, LT Transformers, boiler burner front and cable vault/spreader rooms, CHP control room, HFO/HSD storage tanks, pump houses and other ancillary buildings as specified.

q) Two (2) nos. of basket type strainers to be located at the discharge of spray water pumps.

r) Sets of Chrome plated frangible bulb type detectors for areas identified elsewhere in the specification.

s) Sets of addressable analog optical type of smoke detection arranged in X-zoning fashion for areas identified in the specification.

t) Sets of addressable analog multi criteria smoke detectors arranged in X-zoning fashion for areas identified in the specification.

u) Sets of Analogue Addressable type heat detectors for the areas identified in specification.

v) Three (3) nos. Solar blind Infrared detectors with inbuilt air purging unit for each conveyor. Dual wavelength Infrared flame detectors for boiler burner fronts and turbine oil tanks (for two units).

w) Lot of linear heat sensing cables (non-electrically operated Fibre Optic LHSC) for the areas mentioned in the specification.

x) Gas sensing fire detectors working on air sampling for all control rooms and control equipment room.

y) Required nos. of addressable manual call points for the areas mentioned in the specification.

z) Lot of open sprayers for HVW & MVW spray system.

aa) For periodic testing of deluge valve, one frangible bulb detector with GI pipe & isolating valve connected to detector network shall be provided for each of HT transformers.

bb) One (1) no. of siren of 10 KM range (minimum diametric).

cc) Complete lot of pipelines including all fittings for :

i) Entire hydrant system.

ii) Entire spray water (both HVW & MVW) system including network of sprayers.

iii) Entire compressed air piping for pressurising hydro pneumatic tank.

iv) Entire foam solution pipe line.

v) Entire inert gas pipe line.

dd) Lot of cut-off gate valves, globe type instrument root valves and discharge valves for pumps & also for compressors. NRV's as required for firewater & compressed air lines. Motorised valves for firewater header.

ee) RCC Pipe enclosures/hume pipes of appropriate class for buried pipelines for all road crossings, rail crossing & for all places where buldozer may operate.

ff) Vents and drains as required. Vent and drain valves shall be lockable type and drain lines shall be terminated to nearest surface drain.

gg) Pressure break-down orifices as required for hydrant system, spray system and first-aid-fire protection system.

hh) One foam tender with supplementary agents - carbon dioxide and dry chemicalpowder conforming to IS: 10460 (latest)

i) One water tender as per IS:950 (latest)

jj) One fire jeep

kk) Miscellaneous equipment such as oxygen masks with cylinders and otheraccessories, industrial canister type masks for chlorine contaminated areas andfor general purpose, first aid kits, telescopic ladders, fiber glass blankets, fire suits etc.

ll) Ambulance (Tata – 407) with all standard fittings

mm) All the vehicles listed above have to be registered, permit and tax paid before handing over to TANGEDCO with name transfer.

12.5.2 **Civil**

a) Design and construction of FW 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 for spraying system as per specification.

e) Design & construction of hose houses as specified.

f) Construction of pylon support including foundation for spray water ring and water circuit for detection of H.T. Transformer.

g) Design & construction of foundation of fire water steel storage tanks mentioned above.

h) Adequate no. of staircases as per TAC.

12.5.3 **Control and Instrumentation**

Complete control and instrumentation system for safe and reliable operation of the system shall be included.

12.5.4 **Electrical**

a) Distributed Control System (DCS) based Local Fire Water control panel for Fire Water Pumps located in F.W pump house common for both units for operation of the Fire water pressurising and pumping system.

b) Fire Detection and Alarm Panel for each Unit to be located in the Central Control Room. Each of the Panels shall be provided with a 21 in. TFT SVGA Monitor 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.

Fire Detection and Alarm Panel for each Unit in the Central Control Room shall provide hardwired contacts for Group Alarms for the fire detection system and to be connected to the DDCMIS of the respective unit.

c) Satellite Fire Alarm Panels as enclosed in Vol III, Part C wherein all connections from the Fire Detectors and Manual call Points of the respective areas shall be terminated.

d) 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.

This panel is to be provided with a 21 in. SVGA Monitor with colour graphic software. 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.

A mini 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

Computer and Monitor of the Panel. Technical Requirements and features of the UPS is provided in the Vol III Part C of the Specification.

e) All Fire Detection and Alarm Panels in CCR, CHP, Satellite Fire Alarm Panels 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 III Part C of the specification.

f) Two (2) sets (1 working & 1 standby, 100% capacity) of 24 Volt (2x12V) Automotive type battery with charger for each diesel engine driven fire water pumps primarily for starting the engine and control power supply to DCS based fire pump local control panel.

g) Two (2) sets (1 working & 1 standby, 100% capacity) of 24 Volt (2x12V) 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.

h) 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.

i) Adequate no. of Back-lit maintained type emergency exit signs as per TAC.

j) 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.

k) Fire stops of 2 hours rating at 750°C in wall/floors.

l) Fire stops below switchgear /MCC / Switchboards, junction boxes/panels/ cabinets etc. which are floor-mounted type.

m) Fire retardant coating of 30 minutes rating at 750°C to be applied for installed cables.

n) Fire barrier / baffle wall in transformer yard, fire barriers for compartmentalizing the cable spreader rooms, fire proof door.

o) Materials for fire barrier walls/baffle wall in Transformer Yard.

p) Materials for fire barrier for compartmentalizing the cable spreader rooms.

p) Materials for fire proof doors.

12.5.5 Fire station & other facilities

Fire station is to be provided with facilities to park fire tenders, fire control room, fire officerroom, store, dormitory for fire staff etc. Repeater panel is provided in the fire station tomonitor and control the fire in power station. This panel is provided with audio-visualalarms regarding status of fire in different areas, status of deluge valves, repeatannunciations from main fire detection and alarm panel in unit control room, PLC basedpanel fire water control

cum alarm panel in fire water pump house & in foam pumphouse. Following facilities/equipment shall be provided in the fire station:

i) One foam tender with supplementary agents - carbon dioxide and dry chemical powder conforming to IS: 10460 (latest)

ii) One water tender as per IS: 950 (latest)

iii) One fire jeep

iv) Miscellaneous equipment such as oxygen masks with cylinders and otheraccessories, industrial canister type masks for chlorine contaminated areas and for general purpose, first aid kits, telescopic ladders, fiber glass blankets, fire suits etc.

v) Ambulance (Tata – 407) with all standard fittings

vi) All the vehicles listed above have to be registered, permit and tax paid before handing over to TANGEDCO with name transfer.

12.6 DESIGN BASIS AND INPUT

12.6.1 Mechanical

12.6.1.1 Hydrant System

a) Unless specified the hydrant system shall be as per guideline of TAC.

b) Provision of "double headed hydrants" as per the configuration of "risk area" shall be acceptable. For protection of crushed coal stock pile in Coal Handling area which are of elevated position, water monitor shall be provided.

c) Spacing of hydrant (outdoor) shall be 45 M in general and for internal hydrant / landing valves spacing shall be 30 M (max.).

d) Pressure at each hydrant point (both outdoor & indoor) shall be 3.5 Kg/Sq.cm (g).

e) Based on total nos. of hydrants (outdoor), nos. of branch pipes, tripple purpose nozzles & hoses shall be determined as per guideline of TAC.

f) Based on total nos. of indoor hydrants (landing valves), nos. of hoses branch pipe, tripple purpose nozzles & hose boxes shall be determined as per guideline of TAC.

g) First aid fire protection system for power house floors and service building as per guide line of TAC.

h) All fire hydrant pipes shall be routed overground except in coal yard.

12.6.1.2 Spray Water System (HVW & MVW System)

a) Unless specified the HVW and MVW systems shall be as per guideline of TAC.

b) Minimum pressure at HVW nozzles and MVW nozzles shall be 3.5 Kg/Sq.cm (g) and 1.4 Kg/Sq.cm (g) respectively. However, for cable vaults, same shall be as per TAC regulations.

c) Water density for top & bottom conveyor belt shall be 10.2 lpm/ sq.m.(min.).

d) Water density for all surfaces of Transformer shall be 10.2 lpm/Sq.m only.

e) Water density for Cable Spreader Room/ Cable Vault shall be 12.2 lpm/sq.m. (min.) of cable tray area.

f) For turbine oil tank and purification area, burner front water density shall be 10.2 lpm/sq.m. (min.).

g) Chrome plated nozzles shall be arranged in the form of ring to all transformers and nos. of such rings/tiers shall be decided considering maximum gaps between two (2) consecutive tier of rings as 2.5 M. The distance of the deluge valves from the transformers shall be approx. 10 metres.

h) All nozzles shall be open sprayer type and chrome plated.

i) No. of nozzles for any particular risk shall be selected considering the characteristic of nozzles provided by the bidder and also the density of water needed to protect completely the risk as per sl. no. (b) to (e) above/NFPA.

j) Cable vaults/cable spreader rooms shall be suitably zoned. Total water requirement for each zone shall be limited to one-third the capacity of each spray water pump.

k) 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.

l) MVW System shall be tapped off from hydrant line.

m) HVW line shall fed exclusively from dedicated spary pump.

12.6.1.3 Fixed Foam Fire Protection System

a) Unless specified the fixed foam fire protection system and its components shall be as per guidelines of NFPA-11.

12.6.1.4 Inert gas flooding system

a) Unless specified the inert gas flooding system and its components shall be designed as per NFPA 2001 recommendations.

b) Proprietary inert gas shall be used for inert gas flooding system.

c) The centralized inert gas flooding system shall be designed considering the single largest protected volume.

d) Required number of pressure reducing stations shall be provided in the gas manifold for gas pressure reduction from cylinder pressure to required gas flooding pressure.

e) The cylinder rack shall be designed to accommodate sufficient number of inert gas cylinders so that the largest protected volume can be flooded.

12.6.1.5 **Detection System (Microprocessor Based)**

a) Coverage of Frangible bulb type detectors, Infra red type heat detectors and multi criteria smoke detectors shall be considered as 50 Sq M at a height of 7M (max.)

b) Solar blind IRD with inbuilt air purging unit shall be 3 nos. minimum for each conveyor, 1 no. each at a distance of 1-2 M from tail end and head end and 1 no. at middle. However, same shall be verified with the covering range indicated by the manufacturer.

c) Linear heat sensing cable shall be provided along the whole length of the top belt and bottom belt of each conveyor and on bearing and pulley of driving and non driving ends.

12.6.1.6 **General**

a) Each zone of cable spreader room shall be provided with one (1) no. cut-off quick opening type BFV.

b) Each zone of conveyor belt shall be provided with one (1) no. Solenoid operated deluge valve.

c) Water velocity in Fire water pipes shall be as per TAC recommendation. However, Velocity of water thru' pipelines at pump's suction and discharge shall be limited to 1.2 M/sec. to 1.5 M/sec and 2.1 M/sec to 2.5 M/sec respectively.

d) Frictional drop shall be calculated based on Hazen-Williams equation considering "C" as 100. Hardy-cross Method shall be applied to find out total frictional drop during selection of pump head. 10% margin in frictional head shall be considered during pump head selection.

e) Actual pipe size & TDH of pumps shall be selected by Bidder based on "design basis & inputs" specified herein and as approved by the Owner/Consultant.

f) Cut-off gate valves shall be provided for each small and big loops on as required basis.

g) Pressure break-down orifice shall be provided as necessary to restrict pressure of all hydrant point upto 3.5 Kg/cm.sq.(g).

h) 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.

12.7 **Control & Instrumentation**

12.7.1 The automatic fire detection and alarm system shall be designed with electronics having built-in redundancy to ensure availability at all times.

12.7.2 Bidder shall offer microprocessor based Intelligent/ analogue addressable type fire detection and alarm system. Fire alarm system working on microprocessor based system shall have dual redundant fibre optic data highway.

The fire detection and alarm system shall essentially consist of Fire Detection and Alarm Panels with respective workstations located in CCR, Fire Detection and Alarm Panel in Coal Handling Plant, Repeater Fire Alarm Panel with workstations located in Fire Station, Satellite Fire Alarm panels located in various Plant areas, detectors, Manual Call stations, alarm devices, accessories, wiring and all connections to devices.

12.7.3 The Fire Detection and Alarm Panels in CCR and CHP and the Satellite Fire Alarm Panels shall be used for fire detection, associated annunciation system, power supply distribution etc. of the

fire protection system. Satellite Fire Alarm panels shall be strategically located in different areas of the Power Plant considering zone-wise detection.

The Fire Detection and Alarm panels in CCR and CHP and the Satellite Fire Alarm Panels shall be microprocessor based and their primary function shall be to raise an effective alarm by visual and audible means upon receipt of an alarm signal from any of its detection circuit(s) and to activate any device(s) that may be connected to the system(s).

Each detection circuit shall be continuously monitored for fire and fault. Alphanumeric indications shall be provided for fire and fault. Facility shall also be provided for simulation, for test purposes, of these conditions by operation of a control switch, which shall also have a facility to isolate and reset the alarm-receiving group.

12.7.4 The Fire Detection and Alarm Panels located in CCR shall be used to hook-up with each Satellite Fire Alarm Panel to indicate group zone-wise fire annunciation from Satellite Fire Alarm Panels. Fire Detection and Alarm Panels shall also supervise, monitor and annunciate the abnormal condition of the circuitry of the fire detection system through local panels.

The Fire Detection and Alarm Panels shall also be connected to, a Repeater Fire Alarm Panel, to be installed in Fire Station, for repetition of alarms from Fire Detection and Alarm Panels and Satellite Fire Alarm Panels. The Master Fire Alarm Panel shall also supervise the fiber Optic link connected with Fire Detection and Alarm Panels; and shall be provided with a PC with Monitor to display all the alarms and colour graphics for the entire plant fire alarm system.

12.7.5 External circuit supervision shall not require additional wires other than the pair used for detection or alarm. These two wires shall provide both supervision and alarm signals.

12.7.6 Upon activation of any detection device installed in the circuit, the system shall automatically report the status and initiate the sequence of operations with the following functions as minimum :

a) Sound an alarm on audible devices.

b) Notify automatically central fire station.

c) Light an indicating lamp on device initiating the alarm.

d) Display "zone" and / or device no. on the panel with defined message.

e) Activate the output relays for shutdown of ventilation/air- conditioning system, coal conveyor etc. as per requirement.

f) Actuate in fire protection devices & deluge valves etc.

12.7.7 Alarm shall have priority over trouble. All trouble conditions shall be reported to include the zone / device no., location etc.

12.7.8 In the event of detection of fire, auxiliary systems like ventilation, air-conditioning may require shutdown. For this purpose potential free contacts from the output of the fire protection system shall be made available in the local / main fire panel and terminated in the terminal block

12.7.9 Refer clause 13.00.00 of Annexure ‘C’ volume V Instrumentation and Control works.

12.8 **Civil**

12.8.1 For piping layout consideration refer Chapter 13.

12.8.2 Construction of Valve chamber for under ground pipes, Hose house and shed for deluge valves and compressor as per good engineering practice.

12.9 **DESIGN AND CONSTRUCTION**

12.9.1 **Fire Water and Jockey Pumps**

12.9.1.1 **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).

12.9.1.2 **Constructional Features**

a) The design and Testing Standards of the Pumps shall conform to the standards as indicated in the Specification of Vertical Pumps in Volume II-I 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.

12.9.1.3 For technical requirements of Electrical drive motors, Volume II-F shall be referred to.

12.9.2 **Diesel Engine**

12.9.2.1 Performance requirement of the diesel engine shall be guided by TAC recommendations.

12.9.2.2 The engine shall be capable of operating continuously on full load at the site conditions for a period of at least six (6) hours.

12.9.2.3 The engine shall be naturally aspirated, super charged or turbo-charged as recommended by the manufacturer. (Ref. Fire Protection Manual by TAC).

12.9.2.4 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 :

a) 3% for each 305 metre elevation above MSL (Ref. NFPA, Volume-2, 1978).

b) 1% for each 5.6° C rise in air temperature above 15.6° C (Ref. NFPA, Volume-2, 1978).

The base power rating of the diesel engine shall be referred to any accepted datum like BS/SAE Standard condition or equivalent. In any case, horsepower rating shall not be higher than the limit set by Tariff Advisory Committee.

12.9.2.5 Design and construction of the diesel engine shall be guided by TAC recommendations.

12.9.2.5.1 **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. 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.

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.

c) 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 charger is automatically disconnected and the battery is charged by engine dynamo.

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.

12.9.2.5.2 **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.

12.9.5.3 **Fuel System**

a) The diesel engine will 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.

12.9.5.4 **Lubricating Oil System**

Automatic pressure lubrication shall be provided by a crankshaft driven oil pump.

12.9.5.5 **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.

12.9.5.6 **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.

12.10 Air Compressors

12.10.1 Air Compressors shall be designed for intermittent operation with high efficiency to satisfy the requirement as specified in the data sheets.

12.10.2 The design, manufacture of air compressors shall comply with the Specification data sheet enclosed with this section.

12.10.3 Compressor shall be mounted on an air receiver of ample size so that delivery air pressure is kept within (±) 5% of rated pressure without excessive start-stop operations in the working cycle.

12.10.4 Air receiver of 2 cum capacity shall be provided.

12.10.4 **Instrumentation and Miscellaneous Accessories:**

The package air compressor and drive shall be supplied complete with the following instrumentation and accessories as minimum.

a) Discharge air pressure gauge.

b) Pressure switch to control actuation of compressor drive motor.

c) Starter for drive motor.

d) Pressure relief valve.

e) Drain valve.

f) Delivery valve.

12.11 **Hydro-pneumatic Tank**

12.11.1 Design of Hydropneumatic tank shall conform to IS-2825 /ASME Section-VIII, Div.1. Design pressure should be the maximum expected pressure to which the vessel may be subjected plus 5% extra margin. Maximum expected pressure for vessel placed in the discharge line of pumps shall be based on the shut off head of the pump plus static head at pump suction, if any.

12.11.2 Design temperature of vessel shall be 10°C higher than the maximum temperature that any part of the vessel is likely to attain in course of operation.

12.11.3 Corrosion allowance of 2 mm (minimum) on shell and dished ends shall be considered while designing the tank. Suitable mill-allowance shall also be considered for shell and dished ends. Thinning/scaling allowance of 2 mm (minimum) shall be considered for dished ends.

12.11.4 **Tank Connections**

a) Bidder shall furnish all pipe material required for vessel connections. All flanged connections should be supplied complete with matching counter flanges, nuts, bolts and gasket materials.

b) Bolts and nuts shall be of hexagonal head conforming to IS-1367 or equal.

c) Gaskets shall be full-face type.

d) Level gauge with isolating valve shall be provided.

e) All connection as required for pressure gauge, pressure switch, level switch etc.

f) Manholes/inspection hole shall be provided in the tank for providing easy access into the same.

g) Suitable ladders attached to the tank shall be provided for easy access to various instruments mounted there on.

12.12 **Piping, Fittings, Valves and Specialties**

12.12.1 All pipelines under Bidder's scope of work shall be sized considering flow velocities as indicated in "Design Basis and Inputs".

12.12.2 Design condition of piping and material of construction, galvanisation etc. for pipes and fittings, handling different fluid shall conform to piping data sheet enclosed.

12.12.3 Pipes shall be provided with vent connection and vent valves at all high points and drain connection & drain valves at all low points. Drain valves shall be lock-closed type.

12.12.4 Gate valves shall be outside screw rising spindle type.

12.12.5 Gate valves shall be provided with hand wheel, position indicator, pressure-equaliser for valves 350 mm NB and above and drainage arrangement. Locking facility shall also be required where necessary. Gate valve shall be provided with back seating bush to facilitate gland renewal during full open condition. Globe valve shall have adequate profile for controlling action, check valve shall be swing check type and shall have arrow inscription to show the direction of flow.

12.12.6 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform, handwheel with floor stand or chain operator shall be provided for the same.

12.12.7 For the operation of valves located in the valve pits, suitable arrangement shall be provided to operate the valves from the ground level (i.e. from the top of Valve Pit). For this purpose wrench-operated valve may be looked for.

12.12.8 Valves above 200 mm NB shall be provided with gear operator.

12.12.9 **Safety Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

12.12.10 **Deluge Valves**

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.

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.

For further details of Specification of all valves mentioned above, Data Sheet shall be referred to.

12.12.11 **Strainers**

a) For basket strainer details Data Sheet shall be referred to.

b) Y-type Inline Strainer (If required).

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.

12.12.12 **Hydrant Valve (Outdoor) & Stand Post Assembly**

The general design of hydrant valve shall conform to IS:5290 type A and shall be suitable for outdoor operation and for further details data sheet shall be referred to.

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as approved by the Regional Committee of the Tariff Advisory Committee/NFPA.

12.12.13 **Indoor Hydrant Valves (Internal landing valves)**

The general design of hydrant valve shall conform to IS:5290 Type- A and shall be suitable for indoor operation. It shall be identical with hydrant valves (outdoor) as outlined above to facilitate interchangeability.

12.12.14 **Hydrant Valves for First Aid Fire Protection System**

The Water Supply connection for the first aid hose reels shall be taken /tapped from the closest hydrant riser.

The general design and construction of the hydrant valves for first aid fire protection system shall conform to IS:5290 Type-A and shall be suitable for indoor operation.

12.12.15 Fire Water Monitors shall be provided in accordance with the data sheet.

12.12.16 **Hoses, nozzles, branch pipes and hose boxes**

a) The first aid hose shall be provided with cotton-reinforced hoses as per IS: 884 with corrugated external surfaces. Each fire hose shall be provided with quick coupling, branch pipes, nozzles, spanners, etc. The hoses for the internal and external hydrant system should be Rubber impregnated woven jacketed type conforming to IS:636 Type-II.

b) Branch pipes shall be constructed of Stainless steel (SS-304) and have rings at both the ends. One end of the branch pipe will receive the quick coupling while the nozzle will be fixed to the other end.

c) The nozzle sizes shall be of not less than 16mm (or 5/8 inch.) in diameter, nor more than 25 mm (or 1 inch.) in diameters for indoor and outdoor hydrants and 6.35 mm (or 1/4 inch) for first aid fire protection system.

d) 2 Nos. 15m long Hose pipe fitted with quick coupling ends, branch pipes, nozzles, spanner etc. shall be kept in a hose box, which shall be located near point of use. The furnished design must meet the approval of the Regional Committee of the Traffic Advisory Committee/NFPA. The general design and construction of instantaneous couplings, branch pipes and nozzles shall comply with IS:903 (latest revision).

e) All instantaneous couplings, shall be of identical design (both male and female designs shall be utilised) so that any one can be interchanged with another. One male/female combination shall get locked in by mere pushing of the two valves together but will provide leak tightness at a pressure of 21 Kg/sq.cm. Designs employing screwing or turning to have engagement shall not be accepted.

12.12.17 **First Aid Hose Reels (Small Bore Hose Reels)**

a) First aid hose reels shall be provided inside the power house building and service building only to provide facilities of preliminary fire fighting by people other than fire personnel.

b) At each floor 32 mm (or 1 and 1/4 inch) diameter first aid hose connection shall be provided from the hydrant risers. The first aid hose reels shall comprise of one no. SS (AISI- 304) isolation valve, reinforced (cotton) rubber hose pipe and one no. SS (AISI-304) nozzle (with isolation arrangement) duly mounted on a swing type (90 deg. min) hose reel.

c) The number and distribution of hose reels shall be such that the whole or each floor is protected and that no part of the floor is more than 6m (or 20 ft.) distant from a hose nozzle when the hose is fully extended.

12.12.18 All instrument root valves shall be stainless steel Gr. 316 globe type.

12.13 **Detectors (Microprocessor Based)**

12.13.1 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.

12.13.2 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.

12.13.3 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.

12.13.4 The various fire detectors serving a particular area/zone of plant may be wired-up in group and one common signal for each area or zone is 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.

12.13.5 The detectors shall be located where the largest combustion gas concentration can be expected.

12.13.6 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.

12.13.7 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.

12.13.8 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.

12.13.9 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.

12.13.10 Make and type of detectors shall be subject to Purchaser's approval.

12.13.11 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.

12.13.12 The detectors shall not be effected by temperature, humidity, air flows.

12.13.13 **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/cu.m.

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.

12.13.14 **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.

12.13.15 **Detection System by Linear Heat Sensing Cable**

a) Linear Heat sensing cable shall be non-electrically operated optical fibre type.

b) The detector system shall consist of an optical fibre sensor and the detection unit. The detector unit shall house the electronic circuitry that interfaces with the optical fiber sensor.

c) The optical fibre shall be connected to the detector unit in a single continuous loop to ensure redundancy and full coverage of the protected zones even if the cable is broken/cut/damage at one point.

d) The fire or excessive temperature condition shall be sensed by the fibre. The detector unit shall recognize the change in optical transmittance of the fiber and cable breakor Fire/Alarm condition shall be identified within 1 mtrs locational accuracy.

e) For details of linear heat sensing cable, data sheet shall be referred to.

12.13.16 **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/Cm^2 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.

12.13.17 **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.

12.13.18 **Infra Red Flame Detector**

The Dual wavelength Infrared Flame Detector shall be provided in Boiler Burner front and Turbine Oil tanks to provide an alarm in case of fire.

12.13.19 **Gas Sensing Fire Detector**

Gas sampling type fire detectors working on the principle of air sampling shall be provided for early detection of fire in the high value control rooms.

12.14 **Manual Call System Of Fire Alarm (Intelligent Addressable Type)**

12.1.4.1 Each Manual Call point unit shall comprise of a push button of reputed make enclosed in a M.S Box. The push button shall have minimum 1 NO and 1NC contact. The push button shall not be shrouded and the same shall be projected out from the surface the MS box. This whole assembly of push button in MS box shall again be enclosed in an external MS enclosure with all sides covered except the front side. The front side shall be sealed with breakable glass cover using neoprene or equivalent gasket. The glass cover shall be fixed in such a way that the actuating push button is kept depressed (with NC contact closed and NO contact Open) so long as the glass cover is intact. In case of fire, when glass cover is broken to give fire warning, the push button shall be released due to spring action hence giving remote fire alarm through NC contact which is now changed over. The status of the change over of contact may be conveyed digitally also.

12.14.2 The MS Box and the external MS 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.

12.14.3 Clear inscription reading (in English) “FIRE ALARM - IN CASE OF FIRE BREAK GLASS” shall be provided for each manual call point unit, either on the MS enclosure or on a separate metal plate mounted behind the glass cover. The metal plate for inscription shall not tarnish under the atmospheric conditions

12.14.4 **Each manual call point unit shall be provided with the following accessories:**

i) An iron hammer of sufficient weight, which could be used to break the glass cover. The iron hammer shall be suspended on a hook fixed to the external MS enclosure by means of a non-corrodible iron chain of sufficient length and play to facilitate easy breaking of the glass cover.

ii) Two numbers diametrically opposite earthing studs located on the outside surface of the external MS enclosure.

iii) An identification number (on a number plate) which will be invariably same as the number given to the fire alarm indicating point on the Zonal and Main Fire Alarm panel. The identification number shall match with the address of the intelligent addressable Manual call point for easy identifying the Call Point unit.

iv) A dust sealing gland or equivalent on the external MS enclosure for outgoing cable from the unit.

v) A compression type cable terminating brass gland of reputed make for out going cable from the internal MS enclosure.

vi) In addition to this 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.

12.15 **Control and Instrumentation**

For technical features and requirements of the control and instrumentation items including Field instrument, Panels and Panel mounted instruments, annunciators , DCS and other hardware and peripherals under scope of supply for the Fire water system, Bidder shall refer the relevant clauses of the Volume III, Part C of this specification.

12.16 **Battery and Battery Charger**

12.16.1 **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) Battery and Battery Charger unit.

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 (2 × 12V) Battery and Battery charger Unit. The Battery for each Satellite Fire Panel 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 (2 × 12V) 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 PC 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.

12.16.2 **Battery Charger**

For design and construction of Battery Charger refer Volume: III, Part C, Chapter 7 of specification.

12.16.3 **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.

12.16.4 **Fittings & Accessories**

Battery

Each battery shall be furnished with necessary accessories required.

12.17 **Fire Panels**

12.17.1 **Design Criteria**

a) **Satellite Fire Panels**

i) Satellite fire panels will be used to cater for the zonal fire detection, firefighting system (automatic deluge valve operation), associated annunciations system and power supply distribution network for the Fire Protection system. These Zonal 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 fool proof 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 III Part C of specification and as finalized during detailed engineering. Any more no. of panels as required shall also be provided.

b) **Fire Detection and Alarm Panels in CCR**

i) The Fire Detection and Alarm Panel for each 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 computer, Monitor 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.

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.

ii) 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 each unit.

c) **Master Fire 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. The Master panel shall also monitor supervise the circuitry between the Fire Alarm Panels in CCR and the Master fire panel. The master fire alarm panel shall be located in the Plant Fire Station.

ii) One number of Repeater Fire Panel complete with all hardware and accessories and requisite software is to be provided, common for two units.

d) **Local Fire Water Control Panel**

The Local Control Panels shall be provided for the following services

i) Auto manual control, interlock, indication supervision and 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.

One (1) no. of Local Control Panel for motor driven pumps and one (1) of Local Control Panel for Diesel Engine driven shall be provided

e) The Fire detection and alarm panels and Repeater Fire Panel shall have the provision for receiving two (2) 240V ± 10% 50 Hz single phase feeders.

Satellite Fire Panels shall have provision of two (2) no. of A. C Power Supply System as above.

All Fire alarm panels and local control panels located in Fire water pump house shall be provided with 24 V Battery and Battery Charger unit as back up power supply to A.C power supply of system of the panel.

f) In case of under voltage below the parameter of working voltage the system will change over to battery with alarm in the fire alarm panels. Rate of voltage drop need not be monitored

All Fire alarm panels shall conform to IS 2189 / BS 3116 / ISI 1976 (Part IV), NFPA codes as applicable and shall have the features conforming to FM, VL, BS codes / standards.

12.17.2 **Specific Requirements**

a) **Local Fire Panels**

i) Local Fire panels shall be indoor, air insulated, metal clad, floor, wall or column mounted type. Type of mounting shall be determined by the contractor depending upon layout convenience, type, rating and duty involved in each category of panels.

ii) Each local fire panel shall be fabricated out of 2 mm thick for load bearing CRCA sheets. Degree of protection of the panel enclosure shall be IP-54. However the hooter box to be mounted to the top of each panel shall have degree of protection IP-40.

iii) 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.

iv) 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.

v) 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.

vi) Each intelligent addressable local fire panel shall be capable of operating the intelligent addressable detectors and provided with the following plug-in type modules:

Power Module

The Power Module shall be provided with AC to DC conversion circuits and the battery charger circuits. The panel which requires more than 16 Amps., A.C. power supply shall be suitable to receive 415 Volts ±10%, 3-Phase, 50 Hz ±5%, 3-wire power supply through switch-fuse unit. 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 switch fuse unit.

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.

The automatic with manual over-ride change over inclusive of all metering, control, indication and interlock system shall be provided.

Regulated power supply 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.

Monitor Module

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.

Control Module

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.

Zone Module

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.

vii) 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.

viii) 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.

ix) “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.

x) The panel shall have Ammeter and Voltmeter for 24 V D.C. System.

xi) 240 Volts Bus System shall be provided in the panel for solenoid operated valve required for Fire Fighting System in Coal Conveyors.

xii) 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.

xiii) 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) Fire Water pressure high (c) Deluge valve operated (i.e. FIRE).

xiv) 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.

b) **Microprocessor based Fire Detection and Alarm Panels in CCR**

i) Fire Detection and Alarm Panel shall have microprocessor based annunciation system. It will supervise; monitor the detection circuit through the Satellite Fire Panels.

ii) 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.

Iii) Alarm Annunciation System for common system of two (2) generating units shall be provided in Fire Detection and Alarm Panels in CCR in addition to the alarm annunciation system for unit system of the respective generating units.

iv) The Fire Detection and Alarm Panel shall be indoor, air insulated, metal clad, floor mounting type.

c) **Master Fire Alarm Annunciator Panel in Fire Station**

The Repeater Fire Alarm Annunciator Panel shall be of similar type as described in clause no. (b). This panel shall be hooked-up with the Fire Detection and Alarm Panels only for supervision, monitoring and annunciation of the Fault and Fire alarms being displayed in the Fire Detection and Alarm Panels. The Repeater Fire Alarm Annunciator Panel shall also supervise the circuitry between Fire Detection and Alarm Panels and Repeater Fire Alarm Annunciator Panel.

d) **Local Control Panel for Fire Water System / Diesel Engine Driven Pumps and other Fire Protection Equipment located F.W. Pump House**

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 Contractor depending upon layout convenience and size of the panel.

ii) The panel shall be fabricated out of 2 mm thick for load bearing and 1.6 mm thick for non-load bearing 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 AC to DC conversion circuits and the battery charger circuits. The panel shall have in-built stabiliser power supply unit for its electronic circuits which rectifies AC power supply to 24 volt DC for system operation.

The automatic with manual over-ride changeover inclusive of all metering, control, indication and interlock system shall be provided.

iv) 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 four (4) nos. of electric driven fire pumps, two (2) nos. of jockey pumps and two (2) nos. compressors and one (1) no. auto-start control section for two (2) diesel engine driven pumps shall be provided inclusive of following gadgets as minimum :

- Auto / Manual Selector Switch for each electrical driven fire pump, jockey pump and air compressor.
- 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.
- All annunciations as listed elsewhere and as required for safe and trouble-free operation of the plant / equipment supplied.

12.17.3 **Contact Rating and Contact Multiplication for Pressure Switch/Limit Switch of Valves**

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.

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.

12.17.4 **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.

In order to achieve this, "Detector Operated Digital Signal" will be generated in the Fire Panel by the Contractor (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.

b) 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.

The list of such inputs required shall be developed by the successful Bidder.

c) 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.

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.

12.17.5 **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.

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.

k) The performance and characteristics of audio-visual annunciation system shall conform to BS, NFPA codes.

12.17.6 **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 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.

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.

The control unit shall be micro processor based and controlled by a programme contained in nonvolatile memory (EPROM).

Licensed version of Run and Edit mode of Software for the Fire Alarm Panels, DCS System and Human Machine Interface System are to be provided

iii) The control unit shall be suitable for accepting inputs from addressable type detector. It shall also have the facility to monitor the contact inputs.

iv) 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.

v) 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.

vi) Each addressable line module shall have its own microprocessor-based circuit, working independently from the central processor unit located in the control unit.

vii) 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.

viii) The detector shall be exchangeable without any change of programme.

ix) It is Bidder's responsibility to include required number of zone modules for the addressable detector.

x) Any special type of cable required for the detection system shall be provided by the contractor.

xi) 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 has been indicated previously. However some general criteria are elaborated additionally below for Bidder's guidance.

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.

ii) 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.

iii) Guidelines in various standards such as NFPA-72, IS 2189, AERB standards etc. shall be followed.

iv) In addition to the requirements stated elsewhere in the specification following requirements shall be met with.

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 :

A SVGA Monitor, with a keyboard and a printer. The VDU is essentially a 21 inch TFT 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.

12.18 **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.

12.18.1 **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.

12.18.2 **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.

12.18.3 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 Contractor. The necessary steel section for fabrication of frames shall be supplied by the Contractor without any extra cost. Any, civil works required to be done in the openings shall be carried out by the Contractor. 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.

12.19 **Power and Control Cables**

12.19.1 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.

12.19.2 **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.

12.20 **Portable Fire Extinguishers**

12.20.1 The portable fire extinguishers shall be selected according to the type of fire that may be encountered.

In this system, the following classes of fire are envisaged:

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.

Class-E: Fires in Electrical Equipment

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, Part-I.

12.20.2 **DESIGN, CONSTRUCTION AND SPECIFIC REQUIREMENTS**

12.20.2.1 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.

12.20.2.2 All the extinguishers along with accessories shall be guaranteed for satisfactory and trouble-free operation.

12.20.2.3 Portable extinguishers shall be complete with brackets/fittings suitable for mounting on wall and a carrying handle of ample strength.

12.20.2.4 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.

12.20.2.5 Spanner and other accessories as required shall be supplied with each fire

extinguisher.

12.20.2.6 Each extinguishers shall be designed, constructed, tested and painted in accordance with respective Indian/International Standard and marked with BIS Certification.

12.20.2.7 First charge of chemicals in each extinguisher shall be provided. All chemical charges shall be refilled after testing at site.

12.20.2.8 As required by Tariff Advisory Committee, 20% spare charge of the total no. of extinguishers installed, with a minimum of six recharges, shall be supplied for each type of extinguishers.

12.20.2.9 Fire extinguishers shall be fitted with pressure gauges as applicable to indicate whether the extinguisher is charged or in need of a recharge.

12.20.2.11 For design and construction standard, capacity and accessories of various portable/mobile extinguishers, Annexure-I shall be referred to.

12.20.2.12 For the quantities of the portable/mobile extinguishers to be supplied, refer to datasheet..

12.20.2.13 The discharge horn of the Carbon-Dioxide Extinguishers shall be made of a material non-conducting to electricity.

12.20.2.14 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.

12.20.2.15 Fire proof entry suits (at least 2 nos.) and oxygen masks with cylinder and other accessories (at least 4 nos.) should be furnished.

DATA SHEET FOR FIRE WATER PUMPS

			Elec. Motor Driven	**Diesel Eng. Driven**	**Jockey Pumps**
1.00.00	Service	:	a) Fire Hydrant System b) Fire spray water system		For pressurization of fire water system
2.00.00	Duty	:	---------- Intermittent ----------		
3.00.00	Location	:	---------- Indoor ----------		
4.00.00	Number of Pumps Required (Minimum – Bidder to work out exact Quantity required as per TAC)	:	a) Hydrant Pump – Two (2) Nos.	Hydrant Pump – Two (2) No.	Two (2)
			b) Spray Water Pump – One (1) No.	Spray Water Pump – One (1) No.	
			c) Fire water booster pumps – One (1) no.	Fire water booster pumps – One (1) no.	
5.00.00	Number of Pumps working (Minimum – Bidder to work out exact Quantity required as per TAC)	:	a) Hydrant Pump– Three (3) Nos. b) Spray Water Pump- One (1) No. c) Fire water booster pump – One (1) no	Nil	One
6.00.00	Number of Pumps Stand- by (Minimum – Bidder to work out exact Quantity required as per TAC)	:	Nil	a) Hydrant Pump – 1 No.	One
				b) Spray Water Pump – 1 No.	
				c) Fire water booster pump – One (1) no	

			Elec. Motor Driven	**Diesel Eng. Driven**	**Jockey Pumps**
7.00.00	Pump Performance Requirement				
	a) Performance standard	:	------- Hydraulic institute standard -----		
	b) Tentative Rated capacity (Cu.m/hr.) Bidder to size according to reqt of TAC	:	410	410	50
	c) Total head, (MLC) not less than	:	Bidder shall decide to meet TAC Requirements		Should be more than that of fire water pumps
	d) Rated speed (rpm) Max.	:	---------- 1500 ----------		
	e) Permissible tolerance in rated capacity (%)	:	---------- As per IS : 5120 ----------		
	f) Permissible tolerance in efficiency at rated capacity (%)	:	---------- No negative tolerance --------		
	g) Range of operation	:	--------- As per IS-6595 Part-2----------		
	h) Suction specific speed	:	Should be within 9000 US unit		
8.00.00	Design standard	:	HIS/IS-6595 Part-2/Equivalent Standard		
9.00.00	Type	:	---------Horizontal Centrifugal--------		
10.00.00	Impeller type	:	----------Closed----------		
11.00.00	Type of gland lubrication and sealing	:	----------By Bidder----------		
12.00.00	Shaft sealing arrangement	:	---------- Mechanical seal ----------		
13.00.00	Axial thrust balancing device to be designed for pump shut-off operation	:	---------- Yes ----------		
14.00.00	Type of pump-motor connection	:	----------Direct ----------		
15.00.00	Type of coupling	:	---------- Flexible Coupling ----------		
16.00.00	Mode of pump starting	:	-- Discharge valve fully open ---		

			Elec. Motor Driven	Diesel Eng. Driven	Jockey Pumps
17.00.00	Material of Construction				
	a) Casing	:	SS 316		
	b) Casing liner	:	SS 316		
	c) Diffuser	:	SS 316		
	d) Impeller	:	SS 316		
	e) Wearing rings	:	SS 316		
	f) Pump shaft	:	SS 316		
	g) Shaft sleeve	:	SS 316		
	h) Shaft bearings	:	---------- By Bidder ----------		
	i) Shaft Coupler	:	SS 316		
	j) Base plate	:	----- Carbon Steel as per IS-2062 with epoxy painting-----		
	k) Wetted Fastners	:	---------- SS-316 ----------		
	l) Companion flange	:	---------- MS ----------		
18.00.00	Supply of accessories & services				
	a) Base plate	:	---------- Yes ----------		
	b) Foundation bolts, nuts, sleeves etc.	:	---------- Yes ----------		
	c) Suction & Discharge companion flanges with bolts, nuts & gaskets	:	---------- Yes ----------		
	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 ----------		

			Elec. Motor Driven	**Diesel Eng. Driven**	**Jockey Pumps**
	g) Pump-motor coupling and guard	:	---------- Yes ----------		
	h) Drain connection with valve		---------- Yes ----------		
	i) Eye-bolts, lifting tackle etc.	:	---------- Yes ----------		

DATA SHEET FOR DIESEL ENGINE

1.00.00	**GENERAL INFORMATION**		
1.01.00	Service	:	Fire Water Pumps (Hydrant, Spray and Booster)
1.02.00	Designation	:	Internal combustion Diesel Engine.
1.03.00	Type	:	Compression ignition, mechanical (airless) direct injection, multicylinder and four stroke cycle and cold starting type.
1.04.00	No. of engine required	:	Three (3) (One for each of hydrant, spray and booster).
1.05.00	No. of engine working	:	Three (3).
1.06.00	Duty	:	Intermittent.
1.07.00	Location	:	Indoor.
2.00.00	**ENGINE PARAMETERS**		
2.01.00	Nominal output of engine at site operating under ambient conditions	:	Bidder to indicate during detailed engineering.
2.02.00	Speed of the engine	:	Not more than 2300 rpm.
2.03.00	Brake horse power rating at rated speed	:	As per TAC / Factory Mutual
2.04.00	Oil Lubrication System	:	As per TAC / NFPA
2.05.00	Fuel Oil System	:	As per TAC / NFPA
2.06.00	Governing System	:	As per TAC / NFPA
2.07.00	Starting System	:	As per TAC / NFPA
2.08.00	Cooling System	:	As per TAC / NFPA

DATA SHEET FOR AIR COMPRESSOR

1.00.00	Service		For Pressurisation of Hydro pneumatic Tank.
2.00.00	Number required	:	Two (2) (1- working + 1- standby).
3.00.00	Type	:	Oil free, water cooled, Rotary Screw Compressor.
4.00.00	Duty	:	Intermittent from receiver pressure.
5.00.00	Location	:	Indoor.
6.00.00	Drive	:	Electric motor

DATA SHEET FOR PIPING, FITTINGS, VALVES AND SPECIALTIES

A. **PIPING AND FITTINGS**

1.00.00	Type	Buried pipes	Overground pipes normally full of water	Overground pipes normally empty but periodically charge with water & foam system applications	Overground 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 Chapter 17, Vol III, part A			
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 employer. After welding, welded portions shall be applied with three coats of zinc silicate treatment/rich paint over one coat of suitable primer. Further the contractor shall provide proper zinc paint at the point of welding.
6.00.00	Fittings		
	Ratings/Wall thickness	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.	
	Material	The material shall conform to ASTM A234 Gr. WPB or ASTM A 105 or equivalent.	

Note :

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.

B. **VALVES**

I. **Gate, Globe & Check Valve**

1. **Basic Design Code**

a) Gate Valve : i) IS-14846 for sizes 65 mm NB to 300 mm NB. ii) IS-2906 for sizes 350mm NB and above.

b) Globe Valve : BS EN-13789.

c) Check Valve : BS-1868

2. **Construction** : Cast body and bonnet/cover.

3. **Material of Construction for Gate and Globe Valve**

a) Body and bonnet Material for Gate and Globe valve cover IS-210 Gr. FG 260.

b) Trim/disc. : IS-210 Gr. FG 260.

c) Stem : Stainless steel to AISI-410 13% Cr. St.

4. **Material of Construction of Check Valve shall be as given below** :

a) Body, Bonnet & Cover : ASTM-A-216 Gr. WCB

b) Trim/Disc : 13% Cr. Steel as per ASTM-A-182 Gr. F6 Heat treated and Hardened, min. Hardness-250 HB.

c & d) Back seat & Hinge Pin : 13% Cr. Steel as per ASTM-A-182 Gr. F6.

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.

II. **Deluge Valve**

1. Type : Differential pressure type with diaphragm & clapper assemblies.

2. Code/Standard : As applicable.

3. Material of construction

a) Body : CI conforming to IS-210 Gr. FG-260.

b) Valve internal : Brass/bronze.

4. Water motor alarm gong shall be provided for hydraulically operated Deluge valve. For solenoid operated deluge valve, same is not required.

C. **HYDRANT VALVE (OUT DOOR)/LANDING VALVE (INTERNAL HYDRANT VALVE) / HYDRANT VALVE FOR FIRST AID FIRE PROTECTION SYSTEM**

1. Type : Female oblique type with the outlets angled towards ground.

2.	Code/Standard		:	IS-5290 Type-A
3.	Material of Construction			
	a)	Body	:	SS-304
	b)	Stop valve	:	SS-304
	c)	Spindle	:	SS-304
	d)	Seat	:	SS-304

D. **WATER MONITORS**

1.	Type		:	Fixed type
2.	Code/Standard		:	IS:8442
3.	Flow		:	2500-2700 litre/min at 7 Kg/Sq.cm
4.	Rotation of body			
	a)	Horizontal	:	360°
	b)	Vertical	:	+ 105° - 20°
5.	Throw of monitors			
	Horizontal		:	55 - 60 M
	Vertical		:	25 - 30 M
6.	**Material of construction**			
	a)	Base flange	:	M.S. conforming to IS:6392.
	b)	Reducer	:	M.S. conforming to IS:1239 Part-II.
	c)	Water nozzle	:	SS304

E. **FIRE HOSE FOR INTERNAL AND OUTDOOR HYDRANTS**

	Type	:	Impregnated woven jacketted
	Code/Standard	:	IS-636 type-II
3.	Wt. (gm/M)	:	Not more than 250
4.	Coil diameter	:	Not more than 44 Cm. (for 30 M long)

F. **FIRE HOSE FOR FIRST AID FIRE PROTECTION SYSTEM**

1.	Manufacturer	:	As per approved make
2.	Type	:	Corrugated external surface, reinforced rubber hose pipe.
3.	Code/Standard	:	IS-884

G. **BRANCH PIPES AND NOZZLES**

1.	Manufacturer	:	As per approved make
2.	Type	:	Triple purpose, solid jet and Fog type
3.	Code/Specification	:	IS-2871 for branch pipe and IS- 952 for Fog Nozzles.
4.	Material of construction		

	a)	Branch pipe	:	SS AISI-304 & Construction as per IS-2871
	b)	Nozzle	:	SS-304
	c)	Diffuser	:	SS-304 & Construction as per IS-2871
	d)	Fog Nozzle	:	SS-304 & Construction as per IS-952.

H. **HOSE BOXES/CABINET (INDOOR)**

1.	Manufacturer	:	As per approved make.
2.	Material of construction	:	MS 16 SWG & 3 mm thick glass panel in front door with lock & two keys.
3.	Size	:	To accommodate a pair of hoses one branch pipe, nozzles, spanner etc.
4.	Mounting	:	Wall/Column

I. **HOSE BOXES/CABINET (FIRST-AID FIRE PROTECTION)**

1.	Manufacturer	:	As per approved make.
2.	Material of construction	:	MS 16 SWG & 3 mm thick glass panel in front door with lock & two keys.
3.	Size	:	To accommodate One (1) no. of hose with end fittings, one branch pipe, nozzles, spanner etc.
4.	Mounting	:	Wall/Column

J. **STRAINERS**

1. Type : Simplex basket type

2. Material of construction

a)	Body	:	MS fabricated IS:2062 tested quality
b)	Internal	:	SS (AISI 316), 30 mesh suitably reinforced

K. **SPRAY NOZZLES FOR HVW AND MVW SPRAY SYSTEM**

1.	Manufacturer	:	As per approved make
2.	Type	:	Open head type
3.	Discharge angle	:	60^{o} . - 150^{o}
4.	K - factor	:	Bidder to indicate
5.	Flow rate	:	Bidder to indicate
6.	Material of construction		
a)	Body	:	SS-304
b)	Insert	:	SS-304

DATA SHEET FOR HOSE HOUSE

1.00.00	Service	:	To accommodate the hoses for outdoor hydrants with nozzles, branch pipes, spanner etc.
2.00.00	Location	:	Outdoor, to be strategically located in the entire plant area.
3.00.00	Number	:	Six (6) nos. (min.)

DATA SHEET FOR DELUGE VALVE SHED

1.00.00	Service	:	To accommodate deluge valves of transformers rating more than 10 MVA, deluge Valves of coal conveyor fire protection system.
2.00.00	Location	:	Outdoor. Bidder to select the Suitable locations based on piping layout.
3.00.00	Number	:	Bidder to indicate.

DATA SHEET FOR DETECTORS

A. MULTI CRITERIA SMOKE DETECTORS

1.00	Manufacturer	:	As per approved make.
2.00	Type	:	Combination of Photo electric sensing and heat sensing, intelligent Analogue Addressable.
3.00	Code/Specification	:	NFPA-72E/BS-5839/IS.
4.00	Sensitivity	:	Preset at factory/Adjustable at site (as per UL-268).
5.00	Temperature range	:	1.6 Deg.C to + 60 Deg.C
6.00	Humidity range	:	15% to 90% RH.
7.00	Air velocity	:	0 to 300 ± 25 feet/minute.
8.00	Plug in type detector to be provided	:	Yes.
9.00	No. of terminals on detector on mounting base	:	Bidder to indicate.
10.00	Area covered by single detector	:	Bidder to indicate.
11.00	Operating voltage	:	24 volt D.C.
12.00	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].
13.00	Material of detector body	:	Metallic/Plastic.
14.00	Detector is approved by UL/FOC/FM/TAC	:	Yes.
15.00	Detector Base	:	Mounting box (if applicable) Double Compression gland.
16.00	Coverage area	:	Considering maximum spacing as per IS:2189.

B. HEAT DETECTORS

1.00.00	Manufacturer	:	As per approved make.
2.00.00	Type	:	Fixed temperature cum rate of rise type, intelligent Addressable Analog.
3.00.00	Sensitivity	:	Preset at factory/Adjustable at site.
4.00.00	Operating temperature range	:	54°C. to 60°C.
5.00.00	Humidity range	:	5% to 90% RH.
6.00.00	Detector automatically resets after actuation	:	Yes.
7.00.00	Area covered by single detector	:	Bidder to indicate.
8.00.00	Operating voltage	:	24V DC.
9.00.00	Type of contacts	:	Silver.
10.00.00	Principle of operation	:	As per Specification.
11.00.00	Detector approved by FOC/FM/UL/TAC	:	Yes.

12.00.00	Detector Base	:	Mounting box (if applicable) Double Compression gland.
13.00.00	Coverage area	:	50 Sq.m per detector (Max.).
14.00.00	Special cable	:	To be provided.

C. **QUARTZOID BULB DETECTORS**

1.00.00	Manufacturer	:	As per approved make.
2.00.00	Type	:	Frangible bulb type.
3.00.00	Operating temperature	:	79°C.
4.00.00	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.
5.00.00	Working pressure	:	3.5 Kg/Sq. cm (g) minimum.
6.00.00	Detector approved by TAC/FOC/UL/FAS/NFPA	:	Yes.

D. **LINEAR HEAT SENSING CABLE**

1.00.00	Manufacturer	:	As per approved make
2.00.00	Type	:	Non electrically operated Fusible Optical Fibre type linear heat sensing cable. It shall be totally immuned to EMI/RFI.
3.00.00	Operating voltage	:	24 Volt D.C.
4.00.00	Ambient temperature	:	-20^{o} C to 70^{o}.C.
5.00.00	Operating temperature	:	Programmable type, with combination of fixed temperature and Rate of Rise in temperature.
6.00.00	Cable Optical Paramter	:	62.5/125 µm graded index, Multimode Fibre.

7.00.00	Cable Jacket	:	Steel Type (for conveyor)	Thermoplastic (for cable tray)
	i) Nominal Cable Diameter	:	3.2mm	4 mm
	ii) Maximum weight	:	33 kg/km	23 kg/km
	iii) Minimum Bending Radius	:	75 mm	63 mm
8.00.00	Typical Performance	:		
	i) Sampling Resolution	:	1.0 meter	
	ii) Measurement Time	:	10 sec for 4 kms	
	iii) Measurement Range	:	-20^{o} C to 150^{o}C	

9.00.00	Detector/Control Unit	:	LED for Power ON/Fault/Alarm Condition It shall have freely programmable Relay Contact, minimum 16 nos.
10.00.00	Enclosure for Detector Unit	:	Weather tight and gasketted, IP-54 or better
11.00.00	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
12.00.00	Linear Heat Detector approved by FOC/FM/UL/ TAC/NFPA/VDS/LPCB	:	Yes
13.00.00	Interface	:	PC Interface via Ethernet/Mod-bus output etc.
14.00.00	Fire Detection	:	Unit should be able to detect abnormal/hot spot within 1 mtrs. Span. Further it shall be able to measure both side of the FO LHS cable in the event of wire break. So as to ensure continued fire protection over the entire length.

E. **INFRARED DETECTORS**

1.00.00	Manufacturer	:	As per approved make.
2.00.00	Type	:	Infrared Spark/Ember detectors, (Solar Blind) Intelligent analogue addressable with inbuilt air purging unit.
3.00.00	Operating Voltage	:	24V DC
4.00.00	Ambient Temperature	:	8°C to 45°C
5.00.00	Temperature Range	:	- 40°C to 60°C
6.00.00	Nominal Response Time	:	75 m.Sec. (Max.)
7.00.00	Sensitivity	:	1.0 to 5.0 Microwatt shall be Field Adjustable.
8.00.00	Dimensions	:	As per manufacturer's standard.
9.00.00	Enclosure	:	Dust and Water proof.
10.00.00	Mounting	:	To be mounted in protective sheet metal housing above conveyor.
11.00.00	Quiesent Current	:	10 mA/As per manufacturer standard.
12.00.00	Alarm Current	:	20 mA/As per manufacturer standard.
13.00.00	Acceptance Angle	:	120^{o}./As per manufacturer standard
14.00.00	Spectral Response	:	0.8 to 2.0 Micron/As per manufacturer standard.
15.00.00	Half Power Cone Vision	:	90^{o}./As per manufacturer standard.
16.00.00	All accessories such as air purging facilities for cleaning lens, protective housing mounting hinge & latch, J. Box Glands etc. as required.	:	Yes

17.00.00	Detector shall be solar blind	:	Yes

F. **INFRARED FLAME DETECTORS**

1.00.00	Manufacturer	:	As per approved make
2.00.00	Type	:	Dual wavelength Infrared flame detectors.
3.00.00	Application	:	Boiler Burner Fronts and Turbine Oil Tanks
4.00.00	Operating voltage	:	24V DC
5.00.00	Ambient temperature	:	8°C to 45°C
6.00.00	Temperature range	:	-40°C to 60°C
7.00.00	Response time	:	Flame - 20 Sec.
8.00.00	Sensitivity	:	One (1) foot diameter flame at 35 foot distance.
9.00.00	Field at view	:	90 Degrees.
10.00.00	Quiescent current	:	7.5 mA/As per manufacturer's standard.
11.00.00	Alarm current	:	25 mA/As per manufacturer's standard.
12.00.00	Stability	:	Bidder to indicate.
13.00.00	Dimensions	:	As per manufacturer's standard.
14.00.00	Mounting	:	Bidder to indicate in the offer itself.
15.00.00	Enclosure	:	Dust and weather proof.
16.00.00	All accessories such as air purging facilities for cleaning lens, protective housing, bracket etc. as required	:	Yes

G. **GAS SENSING FIRE DETECTORS**

1.00.00	Manufacturer	:	As per approved make.
2.00.00	Type	:	Gas sensing fire detectors working on air sampling.
3.00.00	Application	:	All control rooms and control equipment room.
4.00.00	Operating voltage	:	24V DC
5.00.00	Ambient temperature	:	8°C. to 45°C.
6.00.00	Relative Humidity	:	0.95%, non condensing.
7.00.00	Sensitivity	:	0.006 to .06% obscuration per foot.
8.00.00	Maximum Transport time	:	120 seconds.
9.00.00	Detector Current	:	300 Ma.
10.00.00	Dimensions	:	Bidder to indicate.
11.00.00	Mounting	:	Bidder to indicate in the offer itself.
12.00.00	Enclosure	:	Dust and weather proof.
13.00.00	All accessories as required	:	Yes.

DATA SHEET
FOR
HYDRO-PNEUMATIC TANK

Description	:	**Hydro-pneumatic Tank**	**Type**	:	**Vertical Cylindrical**
Installation	:	Outdoor	Capacity of Cylindrical Portion	:	[22.5 Cu.M (min.)] To be indicated by Bidder
Fabricated	:	At shop	Water space capacity	:	[15 Cu.M (min.)] To be indicated by Bidder
Construction	:	Welded	Working Pressure	:	Discharge pressure of Compressor
Steel	:	As per IS-2002 Gr. 2A	Design & Testing Code :	:	IS-2825/ASME Section VIII Div. I

(*) Plate Thickness (Min.)	:	
Shell (for all Houses)	:	Bidder to indicate
Dished ends	:	Bidder to indicate
Corrosion Allowance	:	2.0 mm (Min.)
Joint Efficiency Factor	:	0.85

(*) Bidder to indicate plate thickness after giving back-up calculation as per ASME SEC.VIII DIV.-I, Boiler & PV Code.

DATASHEET - PORTABLE FIRE EXTINGUISHERS

SL. NO.	DESCRIPTION	CARBON-DIOXIDE TYPE	MECHANICAL FOAM TYPE/ STORED PRESSURE TYPE	DRY CHEMICAL POWDER TYPE/ STORED PRESSURE TYPE	STORED PRESSURE TYPE (ABC FIRE)
	APPLICATION	Equipment Control Rooms, Control equipment room [housing DDCMIS, UPS etc.], MCC/ Battery charger room/ Switchgear Rooms. Dry Type L. T. Trans-former, GIS 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. Electrochlorination building near Raw water intake pumphouse.	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. 5 KG - 50 nos.(Stored Pressure Type (ABC Fire)	75 Kg - 4nos. 10 Kg - 15 nos. 5 Kg - 65 nos. .(Stored Pressure Type (ABC Fire)	5 KG - 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.			

SL. NO.	DESCRIPTION	CARBON-DIOXIDE TYPE	MECHANICAL FOAM TYPE/ STORED PRESSURE TYPE	DRY CHEMICAL POWDER TYPE/ STORED PRESSURE TYPE	STORED PRESSURE TYPE (ABC FIRE)
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 per applicable design standard.	Nozzle, mounting bracket, screws etc. as required as per relevant standard

CHAPTER 13

13.0 LP PIPING, VALVES & SPECIALITIES

13.1 Equipment sizing Criteria

13.1.1 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.

13.1.2 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.

13.1.3 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/s 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 – 15.0 m/sec. (under Average Pressure & Temp. conditions)

13.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.

13.1.5 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than 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.

13.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.

13.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.

13.1.8 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.

13.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.

13.1.10 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.

13.1.11 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.

13.1.12 Threaded joints shall be provided with Teflon sealant tapes.

13.1.13 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 200 NB size shal be butterfly valves.

13.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). 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.

13.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

13.2.00 TECHNICAL SPECIFICATION

13.1.00 GENERAL

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. 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.

13.2.00 Pipes and fittings

13.2.1 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 as adhered to. The bidder shall furnish the pipe sizing / thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

13.2.2 Piping ad fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

13.2.3 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 he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

13.2.4 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).

13.2.5 Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.

13.2.6 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.

13.2.7 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

13.2.8 For rubber lined ERW pipes, beads shall be removed.

13.2.9 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.

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

13.2.11 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 valve on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

13.3.00 Material

13.3.1 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.

13.3.2 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.

13.3.4 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.

13.3.5 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.

13.3.6 Material of construction for pipes carrying various fluids shall be as follows:

1.	Circulating Water (CW) – CW Pumphouse to Condenser & Condenser to Cooling Tower	RCC DUCT WITH INSIDE PROTECTIVE COATING AS INDICATED IN VOLUME VI
2.	Circulating Water (CW) – Pump Discharge, condenser risers including header near condenser and cooling tower riser.	IS 3589 FABRICATED FROM IS 2062 PLATES –INTERNALLY LINED WITH CORROCOAT OR POLYUREA COATING OF 1500 MICRONS DFT /GRP/ FRP
3.	ACW	UPTO 150 NB - ASTM A 312 TP 316 L (ERW)/ DUPLEX SS 200 NB & ABVOVE - ERW IS 1978 (OR) API5L (OR) IS 3589 FABRICATED FROM IS 2062- Internally lined with Corrocoat or polyureA Coating inside of 1500 microns DFT
4.	RO Stage I reject, RO Stage II	UPTO 150 NB - ASTM A 312 TP 316

	Reject, Guard pond inlet & discharge, Piping from Reject sump,. Ash water piping using sea water and all other sea water applications.	L (ERW)/ DUPLEX SS 200 NB & ABVOVE - ERW IS 1978 (OR) API5L (OR) IS 3589 FABRICATED FROM IS 2062- Internally lined with Corrocoat or polyureA Coating inside of 1500 microns DFT/ GRP/ FRP
5.	Sea Water Intake Pipe, CT Make up, Make up upto clarifier & CT Blowdown Pipe	GRP
6.	RO Stage I Permeate, Filtered Water, service water, AHP Seal Water, HVAC Make up, 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. 150 NB & above pipes shall be spiral welded.
7.	RO Stage II Permeate, Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
8.	Drinking water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
9.	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.
10.	Fuel Oil piping	API5L
11.	HOSES FOR HFO TANKER HEATING (STEAM/ CONDENSATE)	CARBON STEEL – ELECTRO ZINC PLATED
12.	FUEL OIL UNLOADING LINES	IS1239 / IS1978 / API5L Gr.B (ERW) / IS3589 FABRICATED FROM IS 2062 PLATES
13.	FUEL OIL PUMP DISCHARGE LINES	ASTM A 106 GR B
14.	UF Feed/ Chemical Backwash (Upto 150 NB) (Pipes & Fittings)	CPVC ON 10 Sch 40
15.	UF Feed/ Chemical Backwash (> 150 NB)	GRP
16.	Sodium Hypochlorite (pipes & Fittings)	CPVC Sch 80 ASTM
17.	RO High pressuer Discharge (Pipes & Fittings)	Dupless SS
18.	Cleaning Solution Line (Pipes & Fittings)	CPVC ON 10 Sch 40

13.3.7 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 and condensate spill lines.

13.3.9 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).

13.3.10 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.

13.3.11 Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.

13.3.12 Instrument air, Plant (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 gr. Heavy, 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).

13.3.13 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.

13.3.14 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard'' as minimum to be maintained.

13.3.15 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.

13.4.0 Piping Wall Thickness

13.4.1 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.

13.4.2 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)	30 (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

13.5.00 Piping Layout

13.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.

13.5.2 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.

13.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/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.

13.5.4 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 by Project Manager to 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.

13.5.5 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.

13.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.

13.5.7 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.

13.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.

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

13.5.10 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.

13.6.00 Slope/Drains and Vents

13.6.1 Suitable slope shall be provided for all pipelines towards drain points. It is Bidder 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. Vent shall not be less than 15 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.

13.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

13.7.0 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.

13.7.1 Screwed

(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. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

(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.

13.7.2 Welded

(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.

13.7.3 Flanged

(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.

13.8.00 Bends/elbows/mitre bends/Tees/Reducers & other fittings

13.8.1 Unless otherwise specified elbows shall be of long radius type.

13.8.2 For pipe sizes up to 65 Nb, 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.

13.8.3 For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 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 deg. 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/BS534.

13.8.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.

13.8.5 For pipe fittings such as reducers an 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.

13.8.6 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.

13.8.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

13.9.00 Flanges

13.9.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.

13.9.2 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. For all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water (Sea water) etc flanges & bolts & nuts shall be SS 316 L construction.

13.10.00 Specific technical requirement of laying buried pipe with anti corrosive treatment

The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.

13.10.1 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.

(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.

13.10.2 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) 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 230 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

13.10.4 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.

13.10.5 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.

13.11.00 Cleaning and Flushing

13.11.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

13.11.2 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.

13.11.3 After erection, all water lines shall be 1.2-1.5 times the operating velocities in the pipelines.

13.11.4 All compressed air pipe work shall be cleaned by blowing compressed air.

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13.12.00 Painting of Pipes

13.12.1 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.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

13.12.2 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 150 microns.

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.

13.12.3 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 was 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.

13.12.4 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.

13.13.00 Specification for hangers and supports

13.13.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

13.13.2 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.

13.13.3 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.

13.13.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS:226/ 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.

13.13.5 The support shall be so interspaced as to minimize sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.

13.13.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

13.13.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.

13.13.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

13.13.9 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.

13.14.00 Design/Construction/Material Particulars of Gate/Globe/Check Valves/Globe Stop Valve/Butterfly Valve

13.14.1 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) The valves as well as all accessories shall be designed for easy disassembly and maintenance.

(c) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.

(d) 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.

(e) 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.

(f) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.

(g) 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.

(h) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.

(i) 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.

(j) Valves coming under the purview of IBR shall meet IBR requirements.

(k) 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.

(l) 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.

(m) Check valves shall be used for non-return service. They shall be swing check type or double door (Dual plate) check 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.

(n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

(o) 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.

(p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(q) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer 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 small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer.

(r) 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.

(s) 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.

13.14.2 VALVE BODY MATERIAL

Valve body material for various services shall be as follows:

Valve body material for water application like DM Cooling Water (Passivated DM Water) (DMCW), RO Stage I Permeate, AHP Seal Water, APH/ ESP Wash, Service Water, Potable Water, HVAC Make UP shall be cast iron for sizes 65 NB and above; gun-metal/ Forged Carbon Steel for sizes 50 Nb and below.

Valve body material for sea water application like Circulating Water. Auxiliary Coling water, Blowdown, CT make up, sea water Intake, Guard pond inlet & Discharge, Ash Water using sea water, RO Stage II reject, RO Stgae I reject, Reject Sump discharge and all other sea water applications shal be SS 316 L for all sizes.

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.

13.14.2.1 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

13.14.2.2 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 (steel flanges), ANSI B 16.1 (Cast Iron flanges)

13.14.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).

13.14.2.4 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.

13.14.2.5 All gun metal body valves shall have screwed ends.

13.14.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

13.15.00 Check Valves

13.15.1 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.

13.15.2 Drilling on flanges of flanged valves must correspond tot eh drilling on flanges of the piping system on which the valves are to be installed.

13.15.3 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.

13.15.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

13.16.00 Globe Valves

13.16.1 The globe valves shall have the following characteristics;

Straight conveyed flow

Right angle

Preferably, the valves shall be of the vertical stem type.

13.16.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

13.16.3 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.

13.16.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

13.16.5 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.

13.17.00 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.

13.18.00 Air Release Valve

(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 BS 1452 Gr. 14/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.

13.19.00 Butterfly Valves

13.19.1 Design/Construction

(a) 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 mm 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.

13.19.2 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/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated
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
Companion Flanges	IS 2062
External hardware	SS 316
Internal hardware	SS 316

(b) Duplex Stainless Steel Butterfly valves (All Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water (Sea water) etc.)

Body & Disc	SS 316 L
Shaft	SS 316 L.
Seat ring	SS 316 L
Seal	Nitrile Rubber
Companion Flanges	SS 316 L
External hardware	SS 316 L
Internal hardware	SS 316 L

(c) 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/Equivalent
	Disc & Seat Rings	EPT/BUNA-N/Neoprene
	Companion Flanges	SS 304
	External hardware	SS 316
	Internal hardware	SS 316

(d) Carbon Steel Butterfly Valves

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene
Companion Flanges	IS 2062
External hardware	SS 316
Internal hardware	SS 316

13.19.3 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.

13.20.00 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 Valves	ASTM A 216 Gr. WCB/ ASTM A 105
Trim.	ASTM A 182 Gr. F6 or Equivalent
Companion Flanges	IS 2062
External hardware	SS 316

	Internal hardware	SS 316
(2)	**Stainless Steel Valves**	
	Body & Bonnet	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
	Disc	-do-
	Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body
	Companion Flanges	SS 304
	External hardware	SS 316
	Internal hardware	SS 316
(3)	**Cast Iron Valves**	
	Body & bonnet	BS 1452 Gr. 14/IS-210 Gr. FG 260
	Seating surfaces and rings	13% chromium steel/13% Chrome overlay
	Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr FG 260
	Hinge pin for non-return valves	AISI 316
	Stem for gate globe valves	13% chromium steel or Equivalent
	Back Seat	13% chromium steel / 13% Chrome overlay
	Companion Flanges	IS 2062
	External hardware	SS 316
	Internal hardware	SS 316
(4)	**Gun Metal Valves**	
	Body and bonnet	IS 318 Gr. 2/Equivalent Standard
	Trim	-do-
	Companion Flanges	IS 2062
	External hardware	SS 316
	Internal hardware	SS 316

(5) **Duplex Stainless Steel (**All Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc**)**

Body & bonnet	SS 316 L
Disc for non-return	SS 316 L
Stem	SS 316L
Trim.	SS 316 L
Companion Flanges	SS 316 L
External hardware	SS 316 L
Internal hardware	SS 316 L

(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 except for sea water application.

13.21.00 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 200 or equivalent, and float shall be of copper with epoxy painting of two (2) coats. For all sea water applications the complete valve shall be SS 316 L construction.

(g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.

(h) The valves shall have flanged connections.

13.22.00 PAINTING OF VALVES:

Two (2) coats of primer followed by three (3) 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 150 micron (minimum). 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 to the satisfaction of the project manager.

13.23.00 RUBBER EXPANSION JOINTS

13.23.1 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.

13.23.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.

13.23.3 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 deg. A for outer and 50 deg. A for inner cover.

13.23.4 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.

13.23.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.

13.23.6 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.

13.23.7 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.

13.23.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

13.23.9 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.

13.23.10 The 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.

13.23.11 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.

13.23.12 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.

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

13.23.14 Bidder to note that any metallic part which comes in contact with DM / Corrosive water shall be of stainless steel material.

13.23.15 **For a**ll Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc the bolts & nuts, stretcher plates and companion flanges shall be SS 316 L.

13.24.00 STRAINERS

13.24.1 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 mm Nb. (For DM water/ -Body: AISI 316 or equivalent) SS 316 L (**a**ll Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)
(b)	Strainer Element	Stainless steel (AISI 316) SS 316 L (**a**ll Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)
(c)	End connection	Screwed upto 50 mm Nb, and flanged above 50 mm Nb

13.24.2 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 mm Nb, and IS:210, Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted above 50 NB.

	SS 316 L (**a**ll Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)
Strainer element	Stainless steel (AISI 316)/ SS 316 L (**a**ll Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)
End connection	Screwed up to 50 mm NB, and Flanged above 50 NB. Gasket shall be of full face type

(c) The strainer will 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.

13.24.3 Three 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.

CHAPTER 14

14.0 COAL HANDLING SYSTEM

14.0	Coal Handling Plant [Internal Coal Handling Plant]
14.1	Scope of work
14.1.1	Scope of work covers design, manufacture, supply, fabrication, delivery/transit insurance, unloading at site, storage, handling, erection, painting, testing, commissioning including performance guarantee test of Internal Coal Handling Plant designated as "ICHP Package" and includes all associated mechanical, civil & structural steel works including architectural works, electrical, control & Instrumentation works.
14.1.2	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 TANGEDCO, 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 TANGEDCO/Consultant.
14.1.3	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.
14.1.4	Miscellaneous Services under Scope of Bidder.
i	Contractor shall impart training for a period of three (3) months to O&M personnel of OWNER on operation & maintenance of Internal Coal Handling Plant including Pipe Conveyors, during course of erection & before commissioning of ICHP. For this purpose adequate no. of qualified & experienced personnel in mechanical / electrical / instrumentation / other disciplines shall be made available by Contractor for the above period of three (3) months.
ii	Internal Coal Handling Plant including Pipe Conveyors shall be operated and maintained by the Contractor for three (3) months after handing over of the entire plant along with BTG package to TANGEDCO. For this purpose adequate no of qualified & experienced personnel in mechanical / electrical / instrumentation / other disciplines shall be made available by Contractor for the above period of three (3) months.
iii	Detailed Operation & Maintenance Instruction Manual / Spare part manuals and As Built drawings for of all Conveyors / Equipment / associated Systems in soft copy & hard copy (refer Commercial Volume) shall be furnished.
iv	Furnishing of all test certificates, characteristic curves, technical data sheet (as built) etc. as applicable for all equipment and materials supplied by the Contractor.

v	Supply of all lubricants, oil, etc. for initial fill, flushing, cleaning, refill and topping up to handing over of ICHP and also upto three (3) months post handing over of ICHP.		
vi	Bidder shall conform to the requirements of all the relevant Inspection & Test Plan / QAP etc. as required by TANGEDCO/Consultant.		
vii	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 the ICHP Contractor		
14.1.5	Major Items of Work Included Under ICHP Package: Internal 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 Internal Coal Handling System.		
14.1.6	Scope of Work (Mechanical Works)		
S. no.	Item Description	Qty	Remarks
1.	Belt Conveyor # BCZ-1A/1B & SFC-1A/ 1B	4	.....
2.	Belt Feeders # BFB-1A / 1B	2	.....
3.	Pipe conveyor # PC-1A /1B with skirt board and complete in all respects including maintenance trolley.	2	From Transfer tower #TH-1 to Crusher House CRH-1.
4.	Belt feeder # BF- 1A/1B/1C&1D	4	In crusher house #CRH-1
5.	Reversible belt feeder # RBF-1A/1B	2	In crusher house #CRH-1
6.	Belt Conveyors # BC-1A/1B, BC-2A/2B, BC-3A/3B, BC-4A/4B, BC-5A/5B	10	----
7.	Yard Belt Conveyors#YBC-1A/1B	2	----
8.	Reclaim Conveyor# RC-1	1	----
9.	Tripper Belt Conveyor# TBC-1A/1B/1C/1D & TBC-2A/2B /2C/2D for Unit-1 & 2 respectively	8	----
10.	Travelling tripper #TRT-1A/1B/1C/1D & TRT-2A/2B /2C/2D complete with two way discharge chute having flap gate	8	----
11.	Belt sealing arrangement # BSA-1A/1B/1C/1D & BSA-2A/2B/2C/2D for Unit-1 & 2 respectively	8set	----
12.	Bunker level Transmitter (3-D scanner type)	lot	As per flow diagram/requirement
13.	Fixed tripper # FT-1A / 1B /2A/2B/3A/3B/4A/4B	8	----
14.	Discharge chute	Lot	As per flow diagram/requirement

15.	Surge Bin # SB-1A / 1B and SBB-1	Lot	As per flow diagram
16.	Floor cleaning chute/tramp iron chute	Lot	As per flow diagram/requirement
17.	Diverter Gate for two(2) way chute	Lot	As per flow diagram/requirement
18.	Rod gate	Lot	As per flow diagram/requirement
19.	Rack & pinion gate	Lot	As per flow diagram/requirement
20.	In line Magnetic Separator complete with Elec. Hoist & Tramp metal trolley	6	As per flow diagram/requirement
21.	Suspended Electro magnet complete with manual Hoist with Electric Trolley & Tramp metal trolley	3	As per flow diagram/requirement
22.	Vibrating Grizzly Feeder # VGF-1A/1B/ 2A/2B	4	For feeding uncrushed coal to crushers while separating(-)20mm coal fraction
23.	Crusher# CR-1A/1B / 2A/2B	4	Necessary RCC Deck, GERB Make Vibration Isolation system along with temperature detection system & vibration monitoring system shall be provided for each crusher.
24.	Rail mounted Stacker cum Reclaimer Machine # SR-1A / 1B / 1C / 1D (Bucket Wheel Type) with on board Dry Fog Dust Suppression System	4	Machine shall be complete with Anti- collision device.
25.	Belt Weigher	Lot	As per flow diagram
26.	Metal Detector	Lot	As per flow diagram
27.	Coal Scooper (to operate in conjunction with Metal Detector)	Lot	As per flow diagram
28.	Bar grid [steel construction] for underground RCC Reclaim hoppers of Emergency Reclaim Hopper Complex#ERH-1	Lot	As per flow diagram
29.	Vibrating feeder	Lot	As per flow diagram
30.	Sampling System	Lot	As per flow diagram
31.	Sump Pump complete with discharge piping	Lot	As per flow diagram/requirements
32.	Manual Hoist with monorail	Lot	For equipment removal / maintenance & Qty as per requirement
33.	Electric Hoist with monorail	Lot	For equipment removal / maintenance & Qty as per requirement
34.	Belt Vulcanizing Machine #BVM-1/2	2	-----

35.	Ventilation system # VS-1 for conveyor tunnel / associated underground area of Emergency Reclaim Hopper Complex # ERH-1	Lot	To suit
36.	Plain Water Dust Suppression System #PWDS-1/2 each with its tank / piping / valves/ sprinkler etc.	Lot	PWDS-1 for crushed coal Stockpile # CCS-1/1A/2/2A & PWDS-2 for crushed coal Stockpile # CCS-2/2A/3/3A
37.	Dry Fog Type Dust Suppression System For Transfer Points of ICHP	Lot	As per flow diagram/requirements
38.	Dry type Dust Extraction system	Lot	As per flow diagram/requirements
39.	High wall mounted split type A.C Unit & Wall mounted Fans	Lot	-----
40.	Air Curtain with auto door facility at entry door	Lot	-----
41.	Unitary Type Pressurized Ventilation System	Lot	-----
42.	Exhaust Fans	Lot	
43.	Goods Cum Passenger Lift	3	As per flow diagram
44.	Bull dozer with one coal blade & one earth blade	4 set	For Dosing of coal into underground hopper and Stockpile compaction 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 Lubricants etc.	Lot	----
50.	Tools & Tackles	Lot	----
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 ICHP	Lot	----

4.1.7	Scope for Electrical work/ Control & Instrumentation Works (Broad list of major items is indicated below Please refer also Chapters on Electrical & Instrumentation works)	
Sr. No	Item Description	Qty.
1	Motors (LT/ HT) All LT motors of continuous duty (S1) shall be Energy efficient level I class.	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 and 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 Deinterlock switches.	Lot
11	Heavy Duty Limit Switches/ Torque Limit Switches /Proximity limit Switches.	Lot
12	Hooters	Lot
13	Lighting/Illumination 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 Transfer Tower / Crusher House.	Lot
19	Three Phase Welding Receptacles	Lot
20	Any other items not covered above but required for satisfactory completion / Installation / operation of CHP	Lot
4.1.8	Scope for Civil work: Civil work shall be complete for all structures/buildings under “ICHP Package” that are above or below ground level and shall include but not be limited to following items/items of work.	
Sr. No	Item Description	Qty.

1.	Site Survey and Soil Investigation and providing benchmarks for all buildings / trestle locations, etc including complete survey and checking work connected with the different foundation for the Internal Coal Handling Plant. and including fixing location / coordinates of various CHP buildings / Transfer towers / crusher house / Pipe Belt / Covered coal shed etc.	Lot
2.	Excavation / backfilling/ transportation / disposal of excavated material [as per requirements]	Lot
3.	Grading, leveling & compacting [as per requirement of ICHP area /building/structure]	Lot
4.	All temporary roads and approach roads necessary for construction purpose.	Lot
5.	RCC Foundations/Footings for Crusher House# CRH-1/ all Transfer &Junction/Towers/Sampling Towers/drive house, Covered coal shed / other CHP buildings, base slab at grade level, roof slabs, RCC floors & RCC roof for all ICHP buildings/transfer towers/Crusher House. Brick work enclosure [up to 1.5m high for each Transfer &Junction Tower/Crusher House etc.] with inside & outside plastering and painting.	Lot
6	Electrical / Control Room Buildings(RCC framed)	Lot
7	Pump House Buildings(RCC framed)	Lot
8	Foundations for pipe belt / other belt conveyors supporting trestles/take-up tower trestles / Staircase / Cwt. Tower/HGTU Structure etc. & foundation for equipment/drives as required. RCC Trestle for Pipe Conveyors	Lot
9	RCC base for stockpile #CCS-1/1A/2/2A/3/3A.	Lot
10	Suitable Soling with mortar covering between rails for M/C # SR-1A/1B/1C/1D	Lot
11	RCC deck with Vibration Isolation System for Crusher # CR-1A/1B/2A/2B	Lot
12	RCC deck with Vibration Isolation System for Drive Unit of Pipe Conveyor # PC-1A/1B	Lot
13	RCC deck with Vibration Isolation System for conveyor Drive Unit in Transfer Tower# TT-10,TT-12 & Junction Tower # JTB-4	Lot
14	Drainage system around Crushed Coal Stockpiles i.e.CCS-1/1A/2/2A/3/3A, all buildings of ICHP i.e. Crusher House, Transfer towers, Sampling Tower, all electrical buildings, all pump houses etc. and including connecting drain to main Power Plant drainage system. Garland drain for ICHP buildings located outside power plant boundary	Lot
15	Doors/windows for Crusher House, Transfer/Junction Towers, Sampling Tower, other ICHP buildings / Conveyor Galleries etc.	Lot
16	Construction of water tight RCC pit/semi ground tunnel for Conveyor # BC-3A/3B complete in all respects.	Lot
17	Septic tank / Plumbing / Sanitary Works etc for toilets & Unirals etc	Lot
18	Construction of RCC water tight underground portion of Transfer Towers and Sump pits etc.	Lot
19	Construction of underground RCC water tight pit / Tunnel for Emergency Reclaim Hopper Complex # ERH-1 complete in all respects covering underground RCC hoppers etc.	Lot
20	Construction of underground RCC water tight tunnel for Reclaim Conveyor # RC-1 & associated Pent House# PH-1 with brickwork enclosure and inside/outside plastering with doors etc, complete in all respects.	Lot

21	Underground RCC cable trenches with necessary RCC covers, duct bank including GI conduits, pipes for laying of electrical cables.	Lot
22	RCC Water tanks /other tanks for dust suppression systems for ICHP	Lot
23	Over head Sintex water tank for Service water & Potable Water System.	Lot.
24	All Inserts plates, Anchor bolts, Foundation bolts etc including other hardware.	Lot
25	Grouting of various equipment including pipe sleeves, pockets for equipment supports by adding non-shrinking agent in grouting mortar.	Lot
26	Any other associated civil works for satisfactory completion and operation of the Internal Coal Handling Plant is deemed included in the Bidder's scope of work.	Lot
4.1.9	Scope for Structural Steel Works	
Sr. No	Item Description	Qty.
1	Steel frame construction Covered coal shed for stockpiles / all Transfer/Junction Towers / Drive House including JTB-3, Sampling Tower # ST-1 & Crusher House Building 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 / equal 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
2	Boarding & Deboarding Station (one at head end & one at tail end) for Pipe Belts.	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)	Lot
4.	Chequered plate walkways with anti-skidding flats for over ground conveyor galleries including pipe belt gallery complete with hand railing and toe plate etc.	Lot
5.	Access Cage Ladders for pipe belt gallery	Lot
6.	Crossover platforms in conveyor gallery complete with ladder hand railings etc.	Lot
7.	Minimum 5mm thk. Seal plate (throughout gallery) for each conveyor & at transition length of Pipe Belt Conveyors.	Lot
8.	Doors / Windows for all Transfer/Junction Towers / Crusher House / other ICHP Buildings.	Lot
9.	Counter Weight / Take-up towers steel structure, Miscellaneous steel fabricated ladders, staircase, platforms, structural supports/ base frames for equipments, hand railings, gratings, chequered plates, removable chequered plates & grating, hand railing for floor openings, pipe supports etc.	Lot
10.	Rails complete with fixing accessories for Stacker/Reclaimer Machine # SR-1A / 1B /1C / 1D & Traveling Tripper #TRT-1A/1B/1C/1D & TRT-2A/2B /2C/2D	Lot
11.	Cable trays, cable supports etc.	Lot

12.	Separate gallery/structure (excluding pipe conveyor system) shall be provided for routing of cables to avoid fire.	Lot
13.	Monorails / Beams [for Electric Hoists and Manual hoist] in Transfer/Junction Towers / Crusher House / Pump House & above drive of Tripper Conveyors & Travelling Trippers.	Lot
14.	Supply / fabrication / Erection / Painting of all structural steel works / other items for the entire ICHP Package.	Lot
15.	Any other associated requirements / items for the satisfactory completion and operation of the Internal Coal Handling Plant shall be deemed included in the Bidder's scope of work.	Lot

List of Building required for ICHP[other than Junction/transfer towers/ crusher house/ sampling tower/drive house],

SW: service water, PW: potable water

S. No.	Building	PW Facility	SW Facility	Toilets / Urinal Facility	A.C unit{split type}	Exhaust fan	Unitary Type Pressure Ventilation System	Remarks
1	Bldg # ERZ-1 / ERZ-2 / ER-1	Yes	Yes	Yes Two (2) Urinals & Two (2) Toilets shall be provided in each building having heavy duty ceramic tile with matt finish	AC unit to be provided in Office/Control Room area at 1st floor. Wall mounted fans to be provided for operator seating area. Ample glassed area shall be provided to have all around view of ICHP On Ground Floor MCC, other electrical items etc. shall be located.	To be provided in Toilets & other locations if required.	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 with glazed glass etc shall be provided. Stair case upto roof level shall be provided, IPS flooring at ground floor.
2	Electrical Bldg # ER-2 [MCC Room bldg]	Yes	Yes	Yes one (1) Toilet shall be provided in the building having heavy duty ceramic tile with matt finish	.....	To be provided in Toilets & other locations if required	To be provided for MCC/other electrical items area located at ground floor of this building.	RCC Framed building [single storey] I.P.S (cement concrete flooring)with metallic hardener. Stair case upto roof level shall be provided

S. No.	Building	PW Facility	SW Facility	Toilets / Urinal Facility	A.C unit{split type}	Exhaust fan	Unitary Type Pressure Ventilation System	Remarks
3	Pump house building # PMH -1A / 1B / 1C / 2A / 2B & PMZ -1	Yes	Yes	Yes one (1) Toilet shall be provided in the building having heavy duty ceramic tile with matt finish	Nil	To be provided	.....	RCC Framed building [single storey] I.P.S (cement concrete flooring) with metallic hardener .Stair case upto roof level shall be provided Ample area shall be available around each equipment Monorail with manual hoist shall be provided to suit.
4	Operators cabin in JTB-4 / CRH-1 / DH-1	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.

14.2	System Description for ICHP [Refer Flow Diagram of ICHP]
i.	Coal of (-)100 mm lump size will be brought to Coal Berth # CB-III via Panamax size vessel and will be unloaded from vessel and delivered into Junction Tower #JTB-3 (of ICHP)on conveyor #BCZ-1A/1B (of ICHP)by using External Coal Handling System (ECHP) installed at above Berth. ECHP is covered under Separate Package.
ii.	Conv. # BCZ-1A/1B [rated capacity: 4000tph each] shall receive coal from conv. # BCP-3A/3B [rated capacity: 4000tph each] having two way chute with Divertor gate at its discharge end. Conv. # BCZ-1A/1B will transport coal to Junction Tower # JTB-4 and feed coal into surge bin# SBB-1. One diverter gate with 2-way chute has been provided at discharge end of each belt conv. # BCZ-1A/1B for uniform distribution/filling of coal into Surge Bin # SBB-1.Thus coal will be filled into above surge bin # SBB-1 @ 4000tph if single stream of ECHP operates @4000tph or both stream of ECHP operate simultaneously @2000tph each.
iii.	At the bottom of Surge Bin # SBB-1, rod gate (RGB) and weigh belt feeder #BFB-1A/1B are provided. Rod Gate is provided for isolation of Surge Bin from belt feeder during maintenance work on feeder # BFB-1A/1B.
iv.	Belt feeder # BFB-1A/1B will draw coal at a controlled rate (2000 tph max.) from the bottom of Surge Bin # SBB-1 and deliver the coal onto belt conveyor # SFC-1A/1B (called sacrificial conveyor) located prior to pipe belt conveyor # PC-1A/1B. Two (2) way chute with diverter gate is provided at discharge end of feeder # BFB-1A/1B so that material can be fed to either of conveyor # SFC-1A/1B. Thus, each sacrificial belt conveyor will receive coal @ 2000 tph from the surge bin#SBB-1 and deliver the same tph onto pipe belt#PC-1A/1B[capacity:2000tph each] in transfer house#TH-1 for onwards transportation of coal to Crusher House located within the premises of Power \plant .
v.	Each of sacrificial conveyor # SFC-1A/1B shall be provided with suspended Electromagnet (SEMB), Metal Detector (MDB), Coal Scooper (CSCU), Belt Weigher (BWB), and Inline Magnetic Separator (ILMSB) located at head end.
vi.	The above auxiliary equipments are provided on sacrificial conveyor for following reasons.
vii.	a) Belt weigher will measure the coal flow rate before coal is fed to the pipe belt # PC-1A/1B, Suspended electromagnet (SEMB) will be located on conveyor # SFC-1A/1B near to its loading point for removal of tramp metal pieces from coal mass on belt # SFC-1A/1B. Thus, tramp metal free coal is fed to the pipe belt conv. # PC-1A/1B so as to prevent damage to the expensive pipe belt. b) Non ferrous metal is detected by Metal Detector. Post metal detector, Coal scooper (Hammer type) unit is mounted on each sacrificial conveyer. Once non-ferrous metal is detected by metal detector, the detector will give signal to coal scooper (CSCU). Based on belt speed & distance between scooper & Metal Detector, hammer device of coal scooper will operate and scoop out coal mass contaminated with nonferrous metal without stopping conveyor belt. c) Further, one inline magnetic separator (ILMSB) as insurance, is also mounted at discharge end of conveyor # SFC-1A/1B so that no tramp metal enters along-with coal mass into pipe belt # PC-1A/1B.
viii.	Using pipe belt # PC-1A/1B, uncrushed coal will be transported from Transfer House # TH-1 into Crusher House # CRH-1 located within the premises of the proposed TPS (2x660 MW).
ix.	In crusher house# CRH-1,Vibrating Grizzly feeder # VGF-1A/1B/2A/2B will separate out (-) 20mm coal and feed +20mm coal into crusher #CR-1A/1B & CR-2A/2B which will crush the coal down to (-) 20mm product. Belt feeder#BF-1A/1B will receive crushed coal of (-) 20mm lump size from crushers & coal of (-) 20mm lump size from

	bottom of grizzly feeders and will feed crushed coal onto conveyor#BC-1A/1B for onwards transport of coal to either Coal Bunkers or Stockpiles.
x.	Coal will be crushed to (-) 20 mm within the Crusher house and delivered using conveyor system[i.e conveyor# BC-1A/1B,fix tripper #FT-1A/1B,and conveyor#BC-2A/2B &connected conveyors] either directly to Coal Bunkers of Unit-1 & 2 or into Crushed Coal Stockpile # CCS-1/2/3 (open stockyard of crushed coal) and CCS- 1A/2A/3A (covered stockyard of crushed coal) via conveyor#BC-1A/1B & fix tripper#FT-2A/2B & conveyor discharge end and Rail Mounted Travelling Bucket Wheel Type Stacker Reclaimer M/C # SR-1A/1B/1C/1D operating in conjunction with yard belt conveyor#YBC-1A/1B.
xi.	Coal under stockpile#CCS-1A/2A/3A shall be provided under covered storage having total storage capacity of not less than 75000tonne. Suitable structural steel fabricated shed along with precolor coated sheeting shall be provided above stockpile# CCS-1A/2A/3A to prevent wetting of coal due to rains
xii.	Coal under stockpile#CCS-1/2/3 shall be provided under open storage having total storage capacity of not less than 525000tonne. Thus total coal stockyard capacity of minimum 600000 tonne shall be provided.
xiii.	In crusher house# CRH-1,Reversible belt feeder# RBF-1A/1B are provided below surge bin # SB-1A/1B to bypass the crushing circuit. Thus, coal can be delivered directly from pipe belt # PC-1A/1B onto conveyor# BC-1A/1B via reversible feeder #RBF-1A/1B and unidirectional belt feeder # BF-1C/1D. For stream changing diverter gates have been incorporated in the discharge chute of feeder# RBF-1A/1B & BF-1C/1D as well as at other locations for flexibility of operation.
xiv.	Bucket Wheel type rail mounted Stacker cum Reclaimer M/C # SR-1A/1B and M/C # SR-1C/1D have been provided for crushed coal storage / reclaim & blending operation under the ICHP (refer coal blending scheme).
xv.	One Emergency Reclaim Hopper Complex # ERH-1with five (5) underground RCC hoppers has also been provided under ICHP for emergency reclaiming and feeding of crushed coal to Coal Bunkers.
xvi.	Bunker filling operation (for Coal Bunkers of Unit-1&2) with crushed coal shall be carried out as under :
a.	When ship arrives at berth, coal will be unloaded and delivered to crusher house # CRH-1wherein it will be crushed to desired size. From Crusher House # CRH-1, crushed coal will be fed into Coal Bunkers of Unit-1&2 by using conveyor # BC-1A/1B/2A/2B and connected conveyor system including bunker filling Tripper conveyor # TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D.
b.	When ship arrives at berth, coal will be unloaded and delivered to crusher house # CRH-1wherein it will be crushed to desired size. From Crusher House # CRH-1, crushed coal will be fed into Coal Bunkers of Unit-1&2 by using conveyor # BC-1A/1B/ yard belt #YBC-1A/1B [bypassing stockpiles] and connected conveyor system including bunker filling Tripper conveyor # TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D.
c.	In the event, the Coal Bunkers are full, and then coal will be delivered from ship to Crushed Coal Stockpiles # CCS-1/2/3 & CCS-1A/2A/3A (using Stacker Cum Reclaimer M/C # SR-1A/1B & SR-1C/1D) via. ECHP / JTB-3/ JTB -4 /TH-1 / Crusher House#CRH-1 & set of connected conveyors & fixed trippers /yard belt #YBC-1A/1B system to stockyard..

d.	When ship does not arrive at coal berth, then crushed coal from Crushed Coal Stockpiles # CCS-1/2/3 & CCS-1A/2A/3A will be delivered to Coal Bunkers using Stacker Cum Reclaimer M/C # SR-1A/1B/ 1C/1D, Yard Belt # YBC-1A/1B and connected conveyor system to Coal Bunkers including bunker filling Tripper conveyor # TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D.
e.	In the event when ship do not call at berth and also Stacker Cum Reclaimer M/C # SR-1A/1B / 1C/1D are under maintenance, then crushed coal from Crushed Coal Stockpiles # CCS-1/1A will be dosed into underground RCC hoppers of Reclaim Hopper Complex # ERH-1 using dozers. Using Reclaim Conveyor # RC-1 (located in tunnel below ERH-1) crushed coal will be delivered into Coal Bunkers of Unit 1&2 via. Reclaim Belt # RC-1 and connected conveyor system to Coal Bunkers including bunker filling Tripper conveyor # TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D.
14.3	Stockpiling / Reclaiming / Blending Operation [See Fig.-1 & 2]
14.3.1	Six (6) Stockpiles # CCS-1/2/3 & CCS- 1A/2A/3A have been provided for storage of crushed coal.
14.3.2	There are six (6) possible methods of coal blending and subsequent transport of blended coal to Coal Bunkers of Unit-1 & 2.
A.0	Method -1:
A.1	Machine # SR-1A will stack Coal “A” on left side (i.e. into stockpile# CCS -1) & Coal “B” on right side (i.e. into stockpile# CCS -2) of yard belt # YBC-1A. Coal Blending will be carried out as under. Machine # SR-1A will reclaim Coal “A” from left side and coal will be transported to M/C # SR-1C (via yard belt #YBC-1A) which in turn will make stockpile of Coal “A” on left side of yard belt. Now Machine # SR-1A will reclaim Coal “B” from right side of yard belt and via yard belt and M/C # SR-1C, Coal “B” will again be stockpiled (on left side of Yard belt) on the already laid layer of Coal “A”. Thus M/C # SR-1C will stockpile alternate layers of Coal “A” / Coal “B” / Coal “A” / Coal “B”……..and so on until reaching the full height of stockpile. Thus Coal “A” + Coal “B” stock will be made on left side of yard belt # YBC-1A by M/C # SR-1C. The same process will be repeated so that stock of Coal “A”+ Coal “B” is made on right side of yard belt # YBC-1A.
A.2	Now M/C # SR-1C will reclaim coal via its bucket wheel from the stock of Coal “A” + Coal “B” similar to cake cutting operation whereby blending operation of Coal “A” & Coal “B” occurs and blended coal will be delivered onto the yard belt # YBC-1A for onwards transportation of coal to Coal Bunker of Unit-1 / 2 (as noted above)
B.0	Method -2:
B.1	The above blending process can also be carried out similarly by M/C # SR-1B & SR-1D.
C.0	Method -3:
C.1	Crushed coal will be stacked by using M/C# SR-1A such that coal “A” is stacked into stockpile# CCS-1 and coal “B” is stacked into stockpile# CCS-2. Similarly using M/C# SR-1B coal “A” is stacked into stockpile# CCS-2 and coal “B” is stacked into stockpile# CCS-3.
C.2	Assuming Blending ratio: 30% OF Coal “A” (Imported Coal) + 70% of Coal “B” (Domestic Coal).
C.3	Coal “A” will be reclaimed @ 30% of required tph by M/C# SR-1B and fed onto Conv# BC-3A/ 3B using Yard Belt Conv# YBC-1B.

C.4	Coal "B" will be reclaimed @ 70% of required tph by M/C# SR-1A and fed onto Conv# BC-3A/ 3B using Yard Belt Conv# YBC-1A. Conv# BC-3A/ 3B already has a layer of Coal "A" on its belt. Thus Conv# YBC-1A will deposit layer of Coal "B" onto already existent layer of Coal "A". Thus, a mixture of Coal "A" & "B" will be formed on belt Conv# BC-3A/ 3B.
C.5	Thus a mixture of Coal "A" & "B" will be transported to bunkers via connected conveyor system and while passing thru chutes/ bunkers etc Blended Coal will be fed to the Coal Bunkers of Unit-1/ 2
D.0	Method -4:
D.1	Crushed coal will be stacked by using M/C# SR-1A such that coal "A" is stacked into stockpile# CCS-1 and coal "B" is stacked into stockpile# CCS-2. Similarly using M/C# SR-1B coal "A" is stacked into stockpile# CCS-2 and coal "B" is stacked into stockpile# CCS-3.
D.2	Assuming Blending ratio: 30% OF Coal "A" (Imported Coal) + 70% of Coal "B" (Domestic Coal).
D.3	Coal "B" will be reclaimed @ 70% of required tph by M/C# SR-1B and fed onto Conv# BC-3A/ 3B using Yard Belt Conv# YBC-1B.
D.4	Coal "A" will be reclaimed @ 30% of required tph by M/C# SR-1A and fed onto Conv# BC-3A/ 3B using Yard Belt Conv# YBC-1A. Conv# BC-3A/ 3B already has a layer of Coal "B" on its belt. Thus Conv# YBC-1A will deposit layer of Coal "A" onto already existent layer of Coal B". Thus, a mixture of Coal "A" & "B" will be formed on belt Conv# BC-3A/ 3B.
D.5	Thus a mixture of Coal "A" & "B" will be transported to bunkers via connected conveyor system and while passing thru chutes/ bunkers etc Blended Coal will be fed to the Coal Bunkers of Unit-1/ 2
E.0	Method -5:
E.1	Crushed coal will be stacked by using M/C# SR-1A such that coal "A" is stacked into stockpile# CCS-1 and coal "B" is stacked into stockpile# CCS-2. Similarly using M/C# SR-1B coal "A" is stacked into stockpile# CCS-2 and coal "B" is stacked into stockpile# CCS-3.
E.2	Assuming Blending ratio: 30% OF Coal "A" (Imported Coal) + 70% of Coal "B" (Domestic Coal).
E.3	Coal "B" will be reclaimed @ 70% of required tph by M/C# SR-1A and fed onto Conv# BC-3A/ 3B using Yard Belt Conv# YBC-1A.
E.4	Piles of Coal "A" (~30%) will be dozed onto reclaim hoppers of ERH-1 & subsequently Coal "A" will be fed onto reclaim belt #RC-1 for onwards transportation of Coal "A" to Conv# BC-3A/ 3B. Conv# BC-3A/ 3B already has a layer of Coal "B" on its belt. Thus reclaim belt #RC-1 will deposit layer of Coal "A" onto already existent layer of Coal B". Thus, a mixture of Coal "A" & "B" will be formed on belt Conv# BC-3A/ 3B.
E.5	Thus a mixture of Coal "A" & "B" will be transported to bunkers via connected conveyor system and while passing thru chutes/ bunkers etc Blended Coal will be fed to the Coal Bunkers of Unit-1/ 2
F.0	Method -6:
F.1	Crushed coal will be stacked by using M/C# SR-1A such that coal "A" is stacked into stockpile# CCS-1 and coal "B" is stacked into stockpile# CCS-2. Similarly using M/C# SR-1B coal "A" is stacked into stockpile# CCS-2 and coal "B" is stacked into stockpile# CCS-3.

F.2	Assuming Blending ratio: 30% OF Coal "A" (Imported Coal) + 70% of Coal "B" (Domestic Coal).	
F.3	Coal "B" will be reclaimed @ 70% of required tph by M/C# SR-1B and fed onto Conv# BC-3A/ 3B using Yard Belt Conv# YBC-1B.	
F.4	Piles of Coal "A" (~30%) will be dozed onto reclaim hoppers of ERH-1 & subsequently Coal "A" will be fed onto reclaim belt #RC-1 for onwards transportation of Coal "A" to Conv# BC-3A/ 3B. Conv# BC-3A/ 3B already has a layer of Coal "B" on its belt. Thus reclaim belt #RC-1 will deposit layer of Coal "A" onto already existent layer of Coal B". Thus, a mixture of Coal "A" & "B" will be formed on belt Conv# BC-3A/ 3B.	
F.5	Thus a mixture of Coal "A" & "B" will be transported to bunkers via connected conveyor system and while passing thru chutes/ bunkers etc Blended Coal will be fed to the Coal Bunkers of Unit-1/ 2	
14.4	Terminal Points of ICHP	
a)	Receipt point of Belt Conveyor # BCZ-1A/1B in Transfer Tower # JTB-3	
b)	Coal Bunker of Unit -1 &2	
c)	Piping, valves etc. for Service water, Potable water, Dust suppression water shall be laid upto JTB-3. Necessary blind flange shall be incorporated so that water can be supplied to ECHP Package items / systems / equipments etc.	
14.5	Performance Guarantee Requirements: Following capacities / ratings etc. shall be guaranteed:-	
1	Pipe conveyor # PC-1A /1B	2000tph each
2	Belt Conveyors	a) 4000tph each for Belt Conveyor # BCZ-1A/1B b) 2300 tph each for all belt conveyors (excluding Conv. # BC-1A / 1B, 2A / 2B) c) 2000 tph each for belt conveyor# BC-1A/1B / 2A/2B and belt conveyor# SFC-1A/1B d) 1000 tph for reclaim belt conveyor # RC-1
3	Belt feeder # BFB-1A/1B	2000 tph each with accuracy of ±0.5% of full weigh range
4	Reversible Belt feeder # RBF-1A/1B & Belt Feeder # BF-1A/1B/1C/1D	2000 tph each.
5	Vibrating Grizzly Feeder	2000 tph at separation size of (-) 20mm.
6	Ring Granulator	2000 tph Feed size (-) 100 mm coal (Nominal) Product size: Minimum 98% through (-) 20mm.
7	Stacker cum Reclaimer	a) 2000 tph (Stacking capacity) b) 2300 tph (Peak Reclaim capacity) c) 2000 tph (Av. Reclaim Capacity over 4 hrs. block cutting operation)
8	Travelling Tripper	2300 tph each

9	In Line Magnetic Separator	It shall pick 20mm size MS cube & up to 50 kg, rail piece from the specified conveyor. (at specified operating height)
10	Suspended Electro magnet	It shall pick 20mm size MS cube & up to 50 kg, rail piece from the specified conveyor. (at specified operating height)
11	Metal Detector	It shall detect 30mm dia. aluminum sphere and also MS cube of 20mm from the specified conveyor.
12	Belt Weigher	Accuracy : ±0.25% (excluding boom belt) Accuracy : ±1% (boom belt weigher)
13	Vibrating Feeder in Emergency Reclaim Hopper Complex.	200 tph each of crushed coal (-) 20 mm size coal.
14	Dry Fog Dust Suppression System	Dust emission level shall not exceed 5mg / m^3 within 3m radius of DS application point or as per stipulations of Pollution Control Board whichever is lower.
15	Dust Extraction System	Dust emission level shall not exceed 50mg / m^3 or as per stipulations of Pollution Control Board whichever is lower. Bag 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 of equipments at bearings shall not exceed the following limits for different equipment. It shall conform to the limits specified below & shall be measured as per VDI 2056 / BS 4675.	
	Equipment	Peak to peak limit
a)	At the bearing of drive pulley, motor and gear box for the following equipment	
	Boom conveyor of stacker/reclaimer	115 microns
	All other equipment / conveyors / feeders etc.	75 micron
b)	On the floors and columns of TTs, crusher houses and conveyor gallery walkways	200 microns
c)	Crusher	160 microns for corresponding rated speed of 750 rpm. For any other lower speeds, the vibration limit shall be calculated as per VDI 2056 / BS 4675.
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 ICHP earthing system from main grid.
20	Endurance Test a) Each stream and each path shall be tested at rated capacity for 24 hours to prove that the system functions satisfactorily without any trip due to overload or system fault. b) Similarly, Both streams/any combination thereof shall be tested at rated capacity for 24 hours to prove that the system functions satisfactorily without any trip due to overload or system fault. c) All necessary instruments including wakie-talkies etc. for carrying out performance testing of coal handling system shall be provided by the Contractor. d) The specified performance figures of the equipment shall be proved by the vendor during the performance tests. Should the results of the tests show any variation from the specified values, the vendor shall modify the equipment as required to enable it to meet the requirements.	
14.6	Service / Maintenance Facility (for CHP Building / Bunker Building)	
14.6.1	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 separator 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. This is strictly subject to approval of TANGEDCO / DESEIN.	
14.6.2	Monorail beam with Electric / Manual Hoist shall be provided as specified at all locations where equipment like conveyor drives, pumps or other heavy equipment / component are located. The monorail shall be extended to outside the buildings by minimum 2.5m. 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 Transfer Towers/Crusher House/other CHP Buildings etc as found necessary during detailed engineering. This is strictly subject to approval of TANGEDCO / DESEIN.	
14.6.3	Approach with a platform to each Electric Hoist shall be provided on one side for maintenance purpose.	
14.6.4	Monorail beam with manual hoist shall be provided above Cwt. of HGTU.	
14.6.5	Monorail Beam with Manual Hoist shall be fixed above T.U. pulley of all vertical gravity take-up arrangements for belt conveyors so as to lift the take-up pulley at the time of belt joining to get the required loop. Also beam piece with hook shall be provided above each bend pulley of all Gravity take up unit	
14.6.6	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.	
14.6.7	Each Floor cleaning chute (in Transfer Tower/Crusher House) shall terminate at about 1.5 m above ground level. Floor cleaning chute shall be connected to tramp metal chute wherever feasible.	

14.6.8	Adequate maintenance space (minimum 1.2m clear) around equipment and the drives, suitable operating & maintenance platforms as necessary with access for equipment, gates, pumps & other equipment etc. shall be provided.	
14.6.9	Monorails, inserts, handrails [32 NB (M) pipe with toe guards] stairs/ ladders (as applicable) and angle protection for cutouts in floors shall be provided wherever required.	
14.7	Design Criteria & Specific Technical Features for ICHP	
14.7.1	Physical Characteristic of Coal / Other Technical Parameters	
a.	Material handled	Indian Coal /Imported
b.	Max. lump size of Coal received at Power Plant	(-) 100 mm Indian /Imported Coal.
c.	Hard Grove Index (HGI)	48-65
d.	Bulk Density of Coal for equipment sizing	800 kg/m^3 (for volumetric calculation) & 1050 kg/m^3 [for structural design]
e.	Max. Moisture Content	Upto 20 %[for design purpose]
f.	Angle of surcharge	20 degree
g.	Max. Height of Stockpile by Stacker Reclaimer (For crushed coal storage)	12.5 m (from Ground level)
h.	Size of Crushed Coal	(-) 20 mm
i.	Angle of repose of crushed coal	37 degree
14.7.2	No. of stream	Two (2)
14.7.3	No. of stream operating simultaneously	Two (2) Note: System shall be strictly designed to ensure that both streams are operated simultaneously
14.7.4	Stockpile Details	
a.	No. of Stockpiles provided for crushed coal storage	Six (6); Designated as CCS-1/2/3 & CCS-1A/2A/3A
b.	Type of cross section of stockpile	Trapezoidal
c.	Height of each stockpile	12.5 m
d.	Total Stockyard capacity for Crushed Coal Storage (Open Type), under Stockpile # CCS-1/2/3	~525000 tonne
e.	Total Stockyard capacity for Crushed Coal Storage (Under Covered shed), under Stockpile # CCS-1A/2A/3A	~75000 tonne

14.7.5	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.
14.7.6	Each equipment & conveyor including pipe belt conveyor drive except Crusher shall be capable to start under fully loaded condition.
14.7.7	The Transfer Tower/ Crusher House shall be designed for:
a)	• In steel frame construction 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. Moreover, ample space shall be provided around each equipment for maintenance purpose. Floors / Roof of all Transfer Tower / Crusher House shall be in RCC. Independent staircase shall be provided to all Transfer Tower / Crusher House with landing facility at all floors. Steel doors and windows fitted with glazed glass, access, doors, staircase having minimum 1000 mm (clear) width, platforms, equipment hatch, monorails etc as necessary shall be provided. Clearance for maintenance around drive unit / equipment shall be minimum 1200mm. However local clearance of not less than 600 mm shall be available between equipment and any column (under special case only). • Edges of floor openings shall be protected by embedding ISA 75 x 75 x 6 around its periphery. Safety handrails shall be provided around the openings. Crusher House shall be provided with two Stair Cases. • Necessary rain water down comer minimum two (2) per Tower & minimum four (4) for CRH-1/JTB-4 shall be provided for all buildings.
b)	One (1) staircase to access / reach roof level for all buildings including ER-1/2/Pump House / Transfer Towers / Crusher House etc. shall be provided.
c)	All pent house shall be In RCC construction with brick wall cladding for above ground portion with necessary opening for doors etc.
d)	RCC staircases shall be provided for approach to Tail/other portion of Conveyor / equipment which is located in Pit / underground portion of Transfer Tower / reclaim hopper complex with landings facility on all floors.
e)	While designing Transfer Towers, /Crusher House 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 and/or cross-sectional area of the chute.
f)	Minimum clear headroom of 2.5m shall be available at all floors of transfer tower, crusher house & reclaim hopper complex etc.
g)	Bulldozers dozing coal from coal stockpile shall pass over the tunnel of conveyor # RC-1. Therefore civil & structural design of the tunnel shall be suitable to cater to all the loads due to passing of dozer which may weigh up to 36 tonnes. Similarly the bar grid & reclaim hopper shall be suitably designed to withstand load due to material heap & passage of bulldozer etc.
h)	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, ventilation ducts, control panels etc.
i)	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.
j)	Drains of minimum 250mm width shall be provided for drainage for tunnels. All sump pits will be minimum 1.8m wide x 1.8m long x 1.8m deep complete with steel grating to suit the pump mounting arrangement in underground tunnel & pit. Two (2) sump pumps (1W+1S) shall be provided in each sump pit.
14.7.8	Machinery hatch and monorail arrangement etc as per TANGEDCO Engineer/Consultant's approval shall be provided so as to ensure trouble free handling of equipment / material for maintenance purposes.
14.7.9	Minimum number of Crossover (as shown in tender drawings) shall be provided. Minimum no. of four legged trestle as shown on tender drawings shall be provided. Trestle spacing shown are indicative only and are subject to change during detailed engineering & to suit site conditions.
14.7.10	Fire hydrant lines shall be laid along with the yard belt conveyor structure and other conveyor structures as applicable
14.7.11	Coal Yard Drainage Around the coal stockyard, drainage channels shall be constructed to take all the effluent from the coal stockyard (Rain / leach water) which shall be ultimately led to a pond. Coal particles shall settle down in this pond and clear water shall be fed to D.S Water Tank # WTK-2A/2B meant for Plain Water D.S System of stockpiles. Two (2) pumps (1W+1S) shall be provided to feed clear water from settling pond to water tank. Suitable filters at pump inlet & outlet shall be provided so that clear water is fed to D.S Water Tank # WTK-2A/2B.
14.8	Standards, Codes and Regulations
14.8.1	The work under the scope of this specification shall be carried out in accordance with latest applicable Indian standards& codes / recognized international standards i.e. BS/ISO/DIN/ASTM/ASME/JIS.
14.8.2	Contractor shall indicate the particulars of standard/code that has 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 Tangedco/ Consultant
14.8.3	Internal 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.
14.9	Painting & Surface Treatment
14.9.1	General All structural steel components / site welding joints of equipment / structure / pipe work etc. shall be effectively protected by painting. Before packing & transportation, all equipment/items/ fabricated or shop manufactured items shall be painted. Approved quality / make of primer & finish paint shall be used. An approved color scheme shall be followed for Painting.
14.9.2	Preparation of Surfaces for Painting
i)	All surfaces of components to be painted shall be thoroughly cleaned of all foreign matters and / or scales adhering to the steel surface to Swedish Standard specification SA 2 ½ by means of blasting with sand or shot. Use of scraper

	wire brush and pig hammer is acceptable wherever blasting with sand/shot is not possible due to lack of access.
ii)	The thoroughly cleaned surfaces shall receive the paint within four [4] hours following the removal of rust. If this period of four [4] hours is not observed, due to any reasons whatsoever, the surfaces intended to be painted shall have to receive a new cleaning by Sand/Shot blasting before the coat of paint is applied.
14.9.3	Specifications of Painting
i)	One (1) coat of inorganic zinc silicate rich primer (85% zinc on dry film) shall be applied by airless spray. The dry film thickness (DFT) of the coat shall be 1x75 micron = 75 micron (minimum).Internal surfaces of box girders shall also be painted with one (1) coat of zinc silicate rich (85% zinc on dry film) primer. The dry film thickness (DFT) shall be 1x75 micron = 75 micron (minimum). Subsequently, one (1) intermediate coat of Lamellar MIO shall be applied having dry film thickness (DFT) of 1x100 micron = 100 micron (minimum).
ii)	After application of intermediate coat, all surfaces shall receive two (2) coats of Acrylic Aliphatic P.U. Paint (full glossy) having dry film thickness of 2x50 micron = 100 micron (minimum). It shall be resistant to atmospheric heat, reflect heat & rays, and withstand mechanical stresses without crumbling. The colours for the finishing coats shall be as approved by TANGEDCO Engineer / Consultant.
iii)	The total dry film thickness of the system shall be 1x75 + 1x100 +2x50 = 275 microns (minimum).
14.9.4	For structural steel items / components fabricated at Workshop, painting as specified below shall be carried out before dispatch to site. a) Sand/Shot blasting at Works to Swedish Standard SA 2 ½. b) Within four (4) hours apply One (1) coat of inorganic zinc silicate rich primer having dry film thickness of 1x75 micron = 75 micron (minimum). c) Apply intermediate Coat of Lamellar MIO having dry film thickness: 1x100 micron = 100 micron (minimum). Followed by one (1) coat of Acrylic Aliphatic P.U. Paint (full glossy) of dry film thickness: 1x50 micron = 50 micron (minimum). d) Post transport to site and erection at site of the above item, apply one (1) coal of Acrylic Aliphatic P.U. Paint (full glossy) of dry film thickness: 1x50 micron = 50 micron (minimum).
14.9.5	Components having machined surfaces shall be coated with rust preventive compound & shall be carefully wrapped & packed so as to protect it from corrosion / abrasion during transport to site.
14.9.6	All external surfaces of reinforced cement concrete work, after removing & rubbing out all form marks / uneven surfaces and cleaning, the surface shall be finished with two (2) coats of cement wash to give a neat & tidy appearance.
14.10	Buildings for Electricals & Control Equipment (Electrical Building).
14.10.1	ICHP shall be provided with following buildings which shall house the necessary electrical/control equipments etc. The required 415V / 3.3KV / 11KV switchgear/MCC's etc. shall be located suitably. These are strictly subject to Tangedco approval.
i.	Main Switchgear cum Central Control Room Building for ICHP (designated as Bldg. # ER-1) located near Crusher

	House#CRH-1
ii.	One Operator's cabin in each building no Crusher House#CRH-1/DH-1/JTB-4
iii.	MCC Room Building (designated as Bldg. # ER-2).
iv.	Electric House & operator cabin (on board) for Rail mounted Travelling Machine #SR-1A / 1B / 1C / 1D
v.	Building # ERZ-1/2[outside power plant boundary] for relevant electrical & control equipments / items.
14.10.2	Broad constructional features of above buildings are indicated below :
a)	Building # ER-1
i.	Complete ICHP shall be operated from this building. Operator work station(OWS) & Engineer Work Station(EWS) having 24 " monitor with black & white laser printer/Control Desk/other panels etc showing all equipments including indicating lamps for equipments/conveyor lit profile etc shall be provided at first floor of this building. OWS & EWS area shall be provided with false ceiling suitable for air conditioning by A.C Units. This control room area shall be provided with Split Type A.C Units & wall mounted fans. Air curtain with auto door facility shall be provided at entrance of this Central Control Room. Also one "Maintenance Cum Coal Yard Office" shall be provided at first floor complete with false ceiling/Split Type A.C Units/ wall mounted fans and Air curtain with auto door facility.
ii.	On the ground floor of ER-1:- MCC's/Switchgear and other electrical and cable trenches shall be located. Necessary unitary type pressure ventilation system shall be provided for MCC area. Suitable partition shall be provided as per requirements.
iii.	Battery room shall be provided with exhaust ventilation system using exhaust fans
b)	MCC room Building (Building # ER-2): This building shall house the appropriate MCC's & other related electricals of the equipment of ICHP.
c)	Electric House and Operator's Cabin (onboard of Rail mounted Travelling M/C): Electric House shall house the necessary electrical / MCC of machine and shall be located on the trailer of the machine itself. The operator's cabin shall be provided with A.C. Unit. Vent Fan shall be provided for Electric House.
d)	Building # ERZ-1/2: Central Control Desk / EWS / OWS etc [To Suit Tangedco Requirements] - for equipment outside power plant boundary]-shall be provided in these building. Necessary false ceiling & air conditioning by split A.C Units & wall mounted fans shall be provided for above area. Air curtain with auto door facility shall be provided at entrance of this Control Room. Also one "Maintenance Cum ICHP Office" shall be provided at first floor complete with false ceiling/Split Type A.C Units/ wall mounted fans and Air curtain with auto door facility.
14.11	Drawings & Documents
	Broad list of drawings/documents (Soft & hard copies) to be furnished during design& engineering stage are given below

14.11.1	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/Pipe conveyor working point / location of Crusher House/ transfer towers/ emergency reclaim hopper complex/stockpile area/ pump house /electrical buildings/other CHP buildings etc
b.	GA drawings of Transfer Towers/Crusher House/Sampling Tower/ Emergency Reclaim Hopper complex/Pent House/other CHP buildings etc complete with load data/sectional view/typical details of equipment fixing arrgt and showing monorails/ staircases/handrails/hatch/machinery well /rain water down comer etc.
c.	GA drawing of all conveyors/belt feeders/pipe conveyor /other equipments of CHP
d.	GA drawing of Crusher/ vibrating grizzly feeder/vibrating feeders/Gates/ Belt Weigher/ /weigh belt feeder/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 etc along with load data/technical particulars/ technical data sheet etc
e.	GA /Plan/ crossectional 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 / Dry Type Dust Extraction System / Ventilation Systems / Unitary Type Pressurized Ventilation & Water System / Coal Sampling 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 Curve/coasting down time/Load data Calculation etc.
	ii. Design calculation / Load data for conveyor gallery, tunnel, trestle, reclaim hopper, transfer house, 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 Tangedco /Consultant.
14.11.2	Drawings/documents to be submitted for Information Category/Record/ Reference.
a.	Electric load list/Hoist Schedule (manual &electric)
b.	Idler/Pulley /belting/drive components Schedule & other applicable schedule for conveyors
c.	Motor data sheet including Characteristic curves/Coupling Gearbox/other items & components for all equipment &

	systems.
d.	Calculations for number of buckets, bucket sizing, reclaim capacity for stacker/reclaimer
e.	Calculation in support of strength of magnet of ILMS/SEM.
f.	Specification/Catalogues of all standard bought-out-items/components etc.
g.	Conveyor Component drawings, such as idlers, pulleys, skirt boards, safety switches etc.
h.	As built drawings for equipments/system/building/structures etc for the coal handling plant.
i.	Operation / Maintenance /Spare Parts Manuals.
j.	Vendor/Supplier's drawings for all electrical/electro-mechanical/Instrumentation items etc
k.	Any other drawing/document required by Tangedco/Consultant.
14.11.3	Information/ Guarantee data to be furnished along with the Bid.
a.	Guaranteed capacity for Pipe belt / Belt conveyors/ belt feeders/crusher/grizzly feeder/vibrating feeder/stacker cum reclaimer/tripper conveyor/gates etc
b.	Average reclaiming capacity over four (4) hours block cutting operation of Stacker cum Reclaimer M/C and also peak capacity.
c.	Capacity of stockpiles for crushed coal storage
d.	Guaranteed power consumption in different paths(KW)
e.	Water Consumption.
f.	Motor list for all Equipment.
g.	Conveyor profile drawing/flow diagram /other drawings etc
14.12	Technical Specification
M-1A	BELT CONVEYORS & FEEDERS (CONVENTIONAL TYPE)
1	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	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 Practice for conveyor safety
3	Design basis:
a)	Belt sag on the carrying side shall not exceed 1.5 % 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 (EP Belt). Factor of safety for steel cord belt selection shall be minimum six (6).
b)	Wrap angle shall be generally 200°/400° [minimum] for single snub drive / dual drive pulley respectively. 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.
c)	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 15% shall be kept on the calculated radius of curvature. Further suitable holding down pulley shall be provided at concave curve of all conveyors.
d)	All Conveyors & feeders 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. Brakes shall also be provided on conveyors where coasting time is to be adjusted.
e)	Guaranteed capacity of each conveyor shall be as per data sheet. The guaranteed capacity shall be considered for the selection of belting, idlers, pulleys and drive etc. However, the drive motor of each belt conveyor shall be rated for minimum 120% of actual requirement of driven equipment at motor output shaft at the specified guaranteed tph of a conveyor. CEMA (5th Edition) shall be used for KW rating calculation / selection of drive motor, belting etc. Minimum value of Ky to be considered shall not be less than 0.023 in the above calculations.
f)	Clearance between top of road and bottom of conveyor gallery shall be kept at least (6) meter for conveyor gallery crossing over road. The clearance shall be minimum 8m or as per Railways Rules / Codes (whichever is higher) for conveyor galley crossing railway track.
g)	Structural steel, covered conveyor galleries with steel trestles as required shall be provided for all above ground conveyors. 600mm wide, Crossovers shall be provided.
h)	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	CONVEYOR COMPONENTS
[A]	Belting:
i)	Belting shall be EP (Polyester Nylon) type suitable for heavy duty application and of Fire Resistant Grade. The Belting shall be of cut edge construction. Belting shall conform to IS: 1891 (Part-I). However, Steel cord belting shall

	be provided for Yard Belt Conv. # YBC-1A / 1B, Conv. # BC-2A/2B, BC-3A/3B (inside Power Plant Boundary) & Conv. BCZ-1A/1B,SFC-1A/1B (outside Power Plant Boundary) having F.R Grade cover. Electronic Rip detection system shall be provided for steel cord belting. F.R. properties of cover shall conform to CAN/CSA-M422-M87 TYPE –C.
[B]	Idler Units
i)	All idlers shall be made out of ERW tube [IS: 9295] and shall conform to IS: 8598. 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. Diameteral run out of Roll shall not exceed 0.8mm for all Conveyors & feeders.
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 Groove ball bearing of SKF/ FAG make only shall be used. The bearings shall be chosen for life L-10 of 60,000 hours minimum.
iii)	Normal Spacing of idler shall be 1.0m for carrying side and 2.4m on return side However at convex curve; spacing shall not exceed 50% of the above idler spacing.
iv)	Impact type idlers shall be provided with number of tough rubber discs with minimum shore hardness of 55 to 60 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 500 mm. For Belt Feeder # BF-1A/1B/1C/1D & RBF-1A/1B continuous skirt board along with impact idler @ 500mm spacing shall be provided for full length on carrying side.
v)	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.
vi)	All Return idlers shall be 2 Equal roll V-type x 10^0 Troughing. However, for Feeder # BF-1A/1B/1C/1D & RBF-1A/1B 2-roll flat idlers shall be provided on return side. Further suitable guide rolls in pair shall be provided on carrying side.
vii)	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.
viii)	Suitable deflector roller of at least 250 mm OD x 12 thk shell on 90mm dia. [min.] shaft at hub mounted on Plummer block and lagged with 6mm thk neoprene rubber lagging shall be provided for each conveyor / feeder
ix)	Non-magnetic idlers made of aluminum tube lagged with 5mm neoprene rubber lagging shall be provided in conveyor portion over which magnetic separator (Suspended Electromagnet) is mounted.
x)	All roller brackets shall be fabricated from steel plate sections of adequate strength & provided with necessary stiffners. 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.
xi)	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 having continuous rim and two end discs fitted with hubs and the required internal stiffeners. However, finished shell thickness shall not be less than 16 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 of reputed & approved make.
iii)	All pulley shafts shall be designed in accordance with CEMA (5th Edition) considering minimum service factor of 1.5 for bending and 1.0 for torsion. Shaft deflection shall not exceed seven (7) minutes for non drive pulley and five (5) minute for drive 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.
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 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 50 to 60 degree hardness on shore "A" scale.
c)	Lagging material / application shall be of proven and reputed make such as Forech / Jyoti Ceramics / equal approved.
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)	All 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) finished shell thickness.
viii)	Bend / Tail / T.U pulley shall be kept identical in all respects including bearing centers 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)	Conveyor Technological Structure: Stringer size: ISMC-200 (Minimum); Short support: ISMC-150 (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 / Tiscral shall be provided at each loading point. Skirt board minimum length shall be as per drawing enclosed . Minimum height of skirt plate shall be 1000 mm for all conveyors & feeders. Inside Clear width between skirt boards shall be 70% of belt width for all conveyors & feeders. Skirt-boards shall terminate above an idler preferably. For Belt feeder # BF-1A/1B/1C/1D & RBF-1A/1B continuous skirt board shall be provided.
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 minimum 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 50-60 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 20 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 conveyor & feeders shall be provided. Suitable ribs for adequate stiffness of deck plate shall be provided.
[F]	Belt Take-ups
i)	Each belt conveyor / feeder shall be provided with a gravity / screw take-up 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)	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.
iii)	Each gravity take-up unit shall have a 0.8 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.

iv)	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%.
v)	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. In HGTU, suitable buffers at both ends of travel of pulley carriage shall be provided.
vi)	The pulley slide frame shall be self-cleaning type. Cast steel wheels [for carriage] running on rail sections shall be provided for HGTU. Sq bar rails are not acceptable.
vii)	End Travel limit switch shall be provided at both ends of take-up travel.
[G]	Seal Plate
	5mm thk. MS (IS:2062) seal plate shall be provided throughout conveyor gallery for all conveyor & feeders
[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 45°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.
iii)	Only high tensile bolts shall be used for fixing drive component to base frame and base frame to the concrete block or steel surface.
iv)	External Holdbacks: - For all inclined conveyors, External Holdbacks shall be provided at the shaft extension of discharge pulley or tripper pulley.
v)	Gear Box:
a)	Only bevel-helical or helical gearbox, natural/fan cooled and of reputed & approved make shall be provided for conveyor drive.
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.
c)	Gear Box Casing shall be of closed grained cast iron of grade FG-260 of IS-210 or equivalent and stress relieved. 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)	Following Tests shall be performed:-

	1. Noise Level 2. Guaranteed Efficiency 3. Guaranteed Reduction Ratio 4. Max. Temperature Rise. 5. All test as per relevant codes and standard		
vi)	Coupling (High Speed / Low speed)		
a)	All couplings shall provide for lateral, angular and longitudinal misalignment of shafts. Only reputed, proven & approved make coupling shall be used.		
b)	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 22 kw	Geared type	Pin bush type
2.	22 kw and above but less than 110 kw	Geared type	Delay Filled Chamber (DFC) type fluid coupling
3.	110 kw and above	Geared type	Actuator operated Scoop type fluid coupling (air cooled design)
4.	Dual Drive	Geared type	Actuator operated Scoop type fluid coupling (air cooled design)
vii)	Brakes		
a)	Hydraulically operated Thrustor brake only mounted on brake drum coupling shall be provided. Degree of protection Class-B Insulation, IP-55.		
b)	Brakes shall generally be mounted outside either on motor shaft or on high speed shaft of reducer.		
c)	The thermal capacity shall be adequate to limit the contact surface temperature within the permissible limit recommended by brake liner manufacturer for similar application.		
d)	Suitable devices/limit switches shall be incorporated to ensure that motor does not start before the brake is released.		
[l]	Belt Cleaner/ Scrapers [For Unidirectional Conveyors & Feeders]		
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 coal as specified.		
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. Separate dribble chute shall be provided, if required, so that there is no accumulation of scrapped material on floor. Main chute shall enclose the snub pulley to the extent possible.		

	Qty: one (1) per discharge pulley (located between discharge and snub pulley).
c)	Primary Belt Cleaner: Construction of this type of cleaner shall generally be similar to Multi-bladed Type cleaner but the blade-shall be made out of polyurethane material for such application. Qty: a) One (1) no. 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. Qty: 1 no on return side near tail pulley + 1 no. on first bend pulley of each VGTU & HGTU / 1no. on bend pulley (return side) of fixed tripper.
e)	For reversible conveyor / belt feeders: Single Blade, slanted (diagonal) plow cleaner having construction (as noted above) shall be provided. Qty: two (2) no [@1no at each end]
f)	For reversible conveyor / belt feeders: Only Secondary Cleaner shall be provided. Secondary Cleaner design & construction shall be suitable for reversible belt. Qty: one (1) no. located at each terminal cum discharge pulley of reversible belt feeder.
[J]	Belt Protection Switches
a)	Pull Cord Switches (in pair): Addressable Type with built on Terminal Box Manual reset type x 10 Amp rating, pull cord type emergency stop switches (in pairs) shall be provided at 30 m intervals for all Conveyors longer than 30m. Minimum one pair of switch shall be provided for conveyor of 30m length or shorter than 30m length. Each switch shall have Cast aluminium field mounting enclosure epoxy painted, IP-65, 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.
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, IP-65, 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
c)	Zero Speed (Electronic, Non-Contact Type) One Zero speed switch with cast aluminum 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,IP-65, electronic speed monitor having output contact two (2) change over contact , complete with initial bypass time delay

M-1B	PIPE CONVEYOR # PC-1A/1B	
S.No.	Item	Technical spec. / Requirement

1	Equipment Designation no	PC-1A/1B
2	Quantity	2 no., mounted on common gallery / gantry, open type
3	Location	From Transfer house #TH-1 to Crusher house # CRH-1
4	Feeding conveyor	Sacrificial conveyor # SFC-1A/1B (3-equal roll x 35° tr. x 2000tph) - under ECHP package by others
5	Material handled	(-) 100mm, Coal
6	Guaranteed Capacity	2000tph each
7	Length & lift	To suit
8	Nominal Pipe Dia.	Φ 600mm
9	Fill factor	Not more than 75%
10	Belt speed	250 m/min (approx.)
11	Seal Plate	5mm thk, M.S at transition length at head end & tail end
12	Deck plate	3.15mm thk, M.S for transition length at head end & tail end[construction as above .. article M-1A]
13	Skirt board	Minimum 12m long, [construction as above .. article M-1A]
14	Scrapers{ External/Internal}	To be provided as noted above for conventional conveyors
15	T.U device	To be provided as per sound engg. practice complete with maintenance facility.
16	Belt Type	Steel cord with Rip Detection System
17	Belting Cover Thickness / Grade	Min. 8mm Top / Min.6mm Bottom & of FR Grade cover [as noted above.. article M-1A]
18	Factor of safety for belt selection	Minimum six (6)
19	Idlers[carrying side/return side]	Idler roll construction in general shall be same as specified under article M-1A above complete with necessary feature to suit pipe belt Idler configuration. Eccentricity ≤ 0.8mm (IS.8598)
19.1	In Transition length	Configuration generally similar to conventional conveyor with features to suit. However, necessary finger roll station/adjustable idler shall be provided to suit. Transition idlers shall be provided as per requirement near terminal pulleys.
19.2	Pipe section	Hexagonal Configuration, 3rolls on one side of panel, and three rolls on other side of panel. Panel spacing to suit.
19.3	Roll size	a) ERW tube [IS 9295] x 152.4mm O.D x 5.4mm (Nominal) thk / with (minimum) 35mm size deep groove ball bearing / Interchangeable rolls and bracket. b)Impact idler set/ roll size/ construction/ spacing etc : As noted above under article M-1A
19.4	Self cleaning Rubber disc idler	One no. at head end

20.0	Pulley construction	Generally same as specified under article M-1A above. However, face width/concentricity etc. shall be to suit high-speed belt application.
20.1	Face width for pulley	Minimum 100mm more than recommended by I.S. for conventional belt conveyor
21.0	Pipe conveyor Drive	VFD drive complete in all respect shall be provided
21.1	Selection of kW rating (of Motor)	Minimum 20% extra margin to be kept on power consumed at motor shaft
21.2	Service Factor for Gear Box selection	Minimum 1.8 on Belt kW
22	Vertical / Horizontal Radius	To suit
23	Safety switch	Belt Sway Switch @30m (Max.) spacing / P.C switch in pair @ 45m (Max.) spacing / Zero speed switches shall be provided to suit.
24	Maintenance Trolley	Payload:-5tonne, Diesel driven, Qty: 2 no
25	Trestle	T- Shaped RCC Trestle shall be provided. Span of trestle shall not be more than 40m on water body & not more than 30m on other area.
26	Walkway	Central walkway of 1000mm wide (clear), side walkway not required.
27	Access ladder with safety cage (Minimum 600mm wide) from ground level to walkway level of pipe belt gallery	To be provided at every 200m interval. Actual location is strictly subject to TANGEDCO requirements/ Approval.
28	Illumination	Adequate illumination in gallery shall be provided along conveyor route
29	MAINTENANCE TROLLEY (For Pipe Belt # PC-1A/1B),	
a)	Self propelled [Covered] Maintenance Trolley shall be provided to service the entire length of the Pipe Conveyor # PC-1A/1B.	
b)	Trolleys will be specifically designed to allow complete access to all parts of the conveyor structure and conveyor components. Trolley will be designed to operate up to 8 km/hr.	
c)	Terminal stations will be provided at each end of the conveyor for one vehicle, to allow parking, loading and unloading of personnel & equipment and for maintenance.	
d)	The maintenance trolley will run along the top chord of conveyor structure. Drive will be transmitted to two wheels through differential gear drive to negotiate horizontal curves.	
e)	Bogie type non-drive wheels will be provided for load support and to take care of undulation of conveyor structure.	
f)	During high wind conditions rail clamps will be manually engaged to secure the vehicle to the conveyor structure.	
g)	The main long travel drive unit will be a compact water-cooled diesel engine with automatic speed transmission system comprising of gear box, torque converter and differential unit.	
h)	The trolley will be operated at any desired speed through the accelerator control. Hydraulic brake system will be provided with master cylinder and foot pedal.	

i)	The maintenance trolley will be controlled via an operator console / dash panel. The dash panel will consist of hour meter, temperature gauge, oil pressure gauge, ammeter, voltmeter, fuel level gauge, starting switch, forward / reverse hand lever, etc.
j)	The hand lever will be kept in the neutral position during parking. For weather protection, the trolley will be provided with suitable covers to protect the equipment and personnel.
k)	Provision will be made in the trolley to carry the operator, assistants and spares along with other tools & tackles as required for maintenance & repair activities.
l)	The operator will have clear visibility during forward and also backward movement of the trolley.
m)	The vehicle will be fitted with driving lights to facilitate operation during dark / night conditions.
n)	The operation of the trolley will be done through the dash panel. The start switch will be first operated and the operating lever will be moved to the forward / reverse direction as required. Thereafter, the accelerator will be gradually pressed to move the trolley and then the trolley will be driven at any desired speed up to the destination.
o)	On reaching the destination, the stop button in the dash panel will be operated and the brake will be applied for bringing the trolley to a stop position.
p)	For any emergency stopping operation during the travel the hand brake will also be used.
q)	A separate 3 kVA capacity diesel generator set will be provided in the trolley to generate 230 volts single phase 50 cycles AC supply to meet requirement for lighting and auxiliary powers.
r)	Maintenance access to the underside of the conveyor belt will be achieved from side platforms and make shift intermediate bridge platform.
s)	Voice communication facility, through mobile sets, in between maintenance trolley and the control room will be provided.
t)	Radio frequency communication between trolley and control room shall be provided.
29.0	Design/ layout requirements for Pipe Belt/other related items of work:
29.1	The length / route of pipe conveyors shown in the layout drawing are tentative.
29.2	Generally, the pipe conveyor gallery bottom shall be kept about 8.0 m from the ground level. Wherever required, the angle of inclination of the pipe conveyors shall be kept to suit the ground clearance required where it has to cross the roads, water body, other crossings etc, and keeping in mind the elevation where it has to discharge the material.
29.3	However, the Bidder/ vendor should ensure that the routing is kept within the specified corridor and the curvature is within the design limits permitted for the system.
29.4	In view of above, Bidder shall survey the actual route, assess the likely route, assess the quantum of work, gather/ acquire the necessary data/ parameters/ documents and accordingly submit the bid
29.5	However, for proper engineering, the Contractor shall carry out detailed survey for accurate location of the trestles, gravity take-up tower, pipe /connected belt conveyors routing/ Crusher House, profile of land, existing structures, roads, water body/ water channel, tracks, pipelines etc. before finalizing the layout / system.
29.6	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.	
M-2	CHUTES including Surge Bin # SB-1A/1B	
i)	All Chutes / Bin shall be of welded steel construction. The material of construction shall be as per Data Sheet. Surge Bin # SB-1A/1B shall be of adequate capacity to receive coasted material from pipe belt.	
ii)	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.	
iii)	Each chute shall be made in a suitable number of units complete with matching flanges. These units shall be suitably bolt jointed. 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.	
iv)	Chute / Bin brackets shall be welded to the main plate and suitably anchored to the floors/platforms	
v)	Chute Blockage Switch:-Radio Frequency Type Chute Blockage Switch shall be provided for various chutes. Minimum one (1) no. for each one-way chute & Minimum Two (2) nos. for each two-way chute shall be provided.	
vi)	Technical Data:	
A.0	Main Discharge Chutes / Bin / Hopper	
a)	Location	Lot / As per flow scheme
b)	Belt conv. Details	Ref. Conveyor Spec. / Data Sheet
c)	Material of Hood above C.L drive/head pulley	6 mm thk MS plate (IS: 2062)
d)	Material of Parent Plate for main Chute / Bin / Hopper (excluding pulley hood)	15 mm thk. SS-409M
B.0	Tramp iron / floor cleaning chutes	
a)	Location	At various floor of crusher House / Transfer Towers.
b)	Number of chutes	Lot
c)	Material of chute (tramp iron)	400mm Dia. x 5 mm thk MS plate (IS:2062) with grid at top for safety
d)	Material of chute (Floor cleaning)	250NB x 5.9mm thk x 273mm OD Pipe (IS: 1161) with 25thk grating at top
e)	Type of construction / Configuration	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. One (1) no. Mobile Trolley shall be provided for collection of tramp metal for each Magnetic Separator to dispose of tramp metal into tramp metal chute whose mouth is flushed with floor.
Note # 1: In chute layout- inspection door, poking holes etc. shall be provided suitably and main discharge chute shall enclose		

the snub pulley to the extent possible.		
Note # 2: Where inline magnetic separator is provided, chute made out of non magnetic material (parent plate) of minimum 12mm thk SS-304 steel for a distance of 1.5m [minimum] from magnet face shall be provided		
C.0	Surge Bin	
1.0	Surge Bin shall be of welded steel construction & installed below discharge end of conveyor # BCB-3A/3B. The material of construction shall be as per Data Sheet.	
1.1	Sloping angle of side plates shall be minimum 60degree or more to the horizontal so as to ensure non plugging discharge/ flow of material to the belt feeders installed below.	
1.2	Suitable mouth piece shall be provided at the bottom of the bin complete with flange which shall be bolted to the flanges of the skirt board of the belt feeder and bolted joint shall be made dust leak proof by providing neoprene rubber gaskets minimum 3mm thk. One (1) rod gate shall be provided suitably at bin bottom so that belt feeder can be isolated for maintenance work.	
2.0	Technical Data:	
a)	Equipment designation no/ Qty. / Location	SBB-1/ One(1) no / See Flow Diagram
b)	Type of construction	Steel Fabricated, MS [IS: 2062]
c)	Capacity [minimum]	290 m^3 (water filled volume)
d)	Material handled	Coal, (-) 100mm (Nominal). Other characteristics of coal specified elsewhere in this document.
e)	Feeding Belt conveyor details	Ref. Conveyor Spec. / Data Sheet
f)	Material of Parent Plate[vertical portion]	12 mm thk. (min.) SS-409M plate
g)	Material of Construction [inclined portion]	15mm thk (min.) SS-409M plate
h)	Bin Level Indicator	(Min.)Four (4), 3-D Type Bin Level indicators shall be provided for level sensoring / Coal Qty measurements etc.
M-3	Travelling Tripper	
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 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 300mm 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 including motor shall be suitable for minimum fifteen (15) starts/hr and with minimum five (5) 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.	
1.19	Technical Data	
a)	Type	Motor operated travelling tripper
b)	Qty./Location	Lot / As per flow diagram.
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	Tripper installed on TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D having 3 Equal Roll x1800 mm belt x 35^0 Tr. X 2300 tph.

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
M-4	Fixed Tripper	
1.1	The fixed belt tripper shall be provided on Conveyor # BC-1A/1B, BC-4A/4B & 5A/5B	
1.2	Tripper head (discharge) pulley shall be identical to conveyor drive pulley for pulley dia, bearing size and bearing centers. Similarly bend pulley of fixed tripper shall also be identical to bend pulley of Conveyor.	
1.3	3.15 mm thk Deck Plate to suit 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.	
1.4	The tripper chute shall be provided with two-way chute having Divertor gate. Access platform complete with hand railing & access ladder shall be provided for operation of divertor gate.	
1.5	One primary cleaner (external type) shall be provided at tripper discharge pulley. One internal V-plow cleaner shall be provided on the lower return side bend pulley of fixed tripper.	
1.6	Necessary belt guide rollers for belt shall be provided near to the discharge pulley for carrying side belt.	
1.7	Belt cleaners, chutes, divertor gates, 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 to conveyor itself.	
2.0	Technical Data	
a)	Type of Tripper	Fixed Type
b)	Qty/Location	Lot/As per flow diagram
c)	Type of belt cleaner required	Primary cleaner at discharge pulley and V-plow cleaner at lower return side bend pulley.

d)	Belt width	1800 mm x 35° Tr. X 3-Eq.Roll
e)	Hinged inspection door on the chute	Provided
f)	Skirt board	Refer spec. for conveyors
g)	Type of operation	Local operation. However necessary indication on central control panel of divertor gate position shall be incorporated.
M-5	MONORAIL & HOISTS	
A.0	General	
a)	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.	
b)	Ropes, pulleys hoist blocks and other accessories shall have liberal factor of safety. All steel wire ropes shall be flexible 6 x 37 construction with UTS of 160 to180 kgf/sq mm. Safety factor of minimum Six (6) or as specified in IS shall be used to select the rope.	
c)	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.	
d)	Hook shall be of swiveling 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.	
e)	All hoists shall be tested for minimum 125 percent of the rated load.	
f)	Type/Location/Capacity/Lift: Refer Schedule of hoist.	
B.0	Electric Hoists:	
i)	Type	Electrically operated Hoist & Trolley with Pendant switch
ii)	Class/ Duty	Class 2, Indoor, IS: 3938
iii)	Hoist Speed	4 M/Min (max.)
iv)	Carriage travel speed	12 M/Min (max.)
v)	Material of Construction	
a.	Drum & Sheave	M.S./Cast steel as per IS:3938
b.	Load Hook	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
vi)	Brake type	To suit duty and of adequate rating
vii)	Brake for Hoist & Trolley	To be provided
viii)	Bearing: Ball/ Roller of reputed make viz.	SKF/FAG/NTN

ix)	Lubrication	Oil/Grease
x)	Motor	Suitable for hoist duty, 415V+/- 10%, 50Hz+/- 5%.,3 phase AC supply
xi)	Type of power feeding arrangement	Festoon cabling.
xii)	Type of limit switch	Over lowering and over hoisting and for Over travel at end position
xiii)	Control Station	Weather and dust proof with specified degree of protection in electrical specification
xix)	Necessary Electrical Protective devices provided : : Yes, to be provided	
xv)	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.	
C.0	Chain Operated Hoist (Manual Hoist).	
a)	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 medium steel pinion with Hob cut teeth shall be provided.	
b)	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.	
c)	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.	
d)	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.	
e)	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 lubricating arrangement shall be provided for bearings and pinions	

HOIST SCHEDULE

Sr. No	Location	Minimum Capacity ,t	Approx Lift, m	Qty. (No.)	Type	Building
1.	Monorail only for Drive Pulley/Drive Unit of Conv. #BCP-3A/3B	6	-----	2	-----	JTB-3
2.	Diverter Gate	2	10	1	CPB	JTB-3
3.	Tail Pulley of conv. # BCZ-1A/1B	2	7	1	CPB	JTB-3
4.	Head Pulley / Drive unit of Conv # BCZ-1A/1B	7	35	2	EH	JTB-4
5.	Diverter Gate [for BCZ-1A/1B]	2	5	1	CPB	JTB-4
6.	Head Pulley / Drive unit of Conv # BFB-1A	2	20	1	EH	JTB-4

HOIST SCHEDULE						
Sr. No	Location	Minimum Capacity ,t	Approx Lift, m	Qty. (No.)	Type	Building
7.	Head Pulley / Drive unit of Conv # BFB-1B	2	5	1	CPB	JTB-4
8.	Tail Pulley of Belt Feeder # BFB-1A/1B	2	20	1	EH	JTB-4
9.	Diverter Gate [for BFB-1A/1B]	2	5	1	CPB	JTB-4
10.	Tail Pulley of conv. # SFC-1A/1B	2	6	1	CPB	JTB-4
11.	Suspended Electro Magnet # SEMB-1A/1B [above conv. SFC-1A/1B]	20	15	2	MHE	JTB-4
12.	Drive Pulley/Drive Unit of Conv. #SFC-1A/1B	6	8	2	CPB	TH-1
13.	ILMSB-1A/1B [above Drive Pulley of Conv. #SFC-1A/1B]	20	21	2	EH	TH-1
14.	Tail Pulley of pipe Belt #PC-1A/1B	3	12	1	CPB	TH-1
15.	Drive Pulley/ Drive Unit of Pipe conv. # PC-1A/1B	7.5	42	2	EH	CRH-1
16.	Drive Pulley of conv. #RBF-1A/1B	3	36	2	EH	CRH-1
17.	Tail Pulley of conv. # RBF-1A/1B	2	10	1	CPB	CRH-1
18.	Vibrating Grizzly Feeder # VGF-1A/2A	10	28	1	EH	CRH-1
19.	Vibrating Grizzly Feeder # VGF-1B/2B	10	28	1	EH	CRH-1
20.	Crusher # CR-1A/1B	15	22	1	EH	CRH-1
21.	Crusher # CR-2A/2B	15	22	1	EH	CRH-1
22.	Drive Pulley / Drive Unit of conv. # BF-1A/1B	3	16	2	CPB	CRH-1
23.	Tail Pulley of conv. # BF-1A/1B	2	7	1	CPB	CRH-1
24.	Drive Pulley / Drive Unit of conv. # BF-1C/1D	3	21	1	EH	CRH-1
25.	Drive Pulley / Drive Unit of conv. # BF-1C/1D	3	7	1	CPB	CRH-1
26.	Tail Pulley of conv. # BF-1C/1D	2	22	1	CPB	CRH-1
27.	Diverter Gate[for RBF-1A/1B]	2	29	1	CPB	CRH-1
28.	Diverter Gate [for BF-1C/1D]	2	16	1	CPB	CRH-1
29.	Tail Pulley of conv. # BC-1A/1B	2	9	1	CPB	CRH-1
30.	Fixed Tripper # FT-1A/1B (Discharge Pulley)	2	18	1	CPB	TT-1
31.	Diverter Gate	2	13	1	CPB	TT-1
32.	Fixed Tripper # FT-1A/1B (Bend Pulley)	2	8	2	CPB	TT-1
33.	Tail Pulley of Conv. # BC-2A/2B	2	5	1	CPB	TT-1

HOIST SCHEDULE						
Sr. No	Location	Minimum Capacity ,t	Approx Lift, m	Qty. (No.)	Type	Building
34.	Fixed Tripper # FT-2A/2B (Discharge Pulley)	2	18	1	CPB	TT-2
35.	Divertor Gate	2	13	1	CPB	TT-2
36.	Fixed Tripper # FT-2A/2B (Bend Pulley)	2	8	1	CPB	TT-2
37.	Tail Pulley of Yard Belt Conv. # YBC-1A	2	5	1	CPB	TT-2
38.	Drive Pulley / Drive Unit of conv. # BC-1A/1B	5	10	1	EH	TT-3
39.	Drive Pulley / Drive Unit of conv. # BC-1A/1B	5	5	1	CPB	TT-3
40.	Tail Pulley of Yard Belt Conv. # YBC-1B	2	5	1	CPB	TT-3
41.	Drive Pulley / Drive Unit of Yard Belt Conv. # YBC-1B	5	8	1	EH	TT-4
42.	ILMS above Drive Pulley of Conv. # YBC-1B	20	15	1	EH	TT4
43.	Divertor Gate	2	7	1	CPB	TT-4
44.	Tail Pulley of Yard Belt Conv. # BC-3A/3B	2	9	1	CPB	TT-4
45.	Drive Pulley / Drive Unit of Yard Belt Conv. # YBC-1A	5	8	1	EH	TT-5
46.	ILMS above Drive Pulley of Conv. # YBC-1A	20	15	1	EH	TT-5
47.	Divertor Gate	2	7	1	CPB	TT-5
48.	Drive Pulley / Drive Unit of conv. # RC-1	5	15	1	EH	TT-6
49.	Divertor Gate	2	10	1	CPB	TT-6
50.	Drive Pulley / Drive Unit of Conv. # BC-2A/2B	7	15	1	EH	TT-7
51.	Drive Pulley / Drive Unit of Conv. # BC-2A/2B	7	8	1	CPB	TT-7
52.	Divertor Gate	2	10	1	CPB	TT-7
53.	Suspended Electro Magnet # SEM-1	20	10	1	MHE	PH-1
54.	Equipment Hatch at ERH-1	5	18	1	EH	ERH-1
55.	Vibrating Feeder / RG / RPG	5	8	5	CPB	ERH-1
56.	CPB located along length [at one side of ERH-1]	5	8	1	CPB	ERH-1
57.	Tail Pulley of conv. # RC-1	2	6	1	CPB	ERH-1
58.	Drive Unit/Drive Pulley of Conv # BC-3A/3B [Dual Drive]	7	12	2	EH	DH-1
59.	ILMS above discharge pulley of BC-3A	20	75	1	EH	TT-8
60.	ILMS above discharge pulley of BC-3B	20	75	1	EH	TT-8
61.	Divertor Gate	2	5	1	CPB	TT-8

HOIST SCHEDULE						
Sr. No	Location	Minimum Capacity ,t	Approx Lift, m	Qty. (No.)	Type	Building
62.	Tail Pulley of conv. # BC-4A/4B	2	63	1	EH	TT-8
63.	Fix Tripper #FT-3A/3B (Discharge Pulley)	2	78	1	EH	TT-9
64.	Divertor Gate	2	5	1	CPB	TT-9
65.	Fix Tripper #3A/3B (Bend Pulley)	2	69	1	EH	TT-9
66.	Tail Pulley of Tripper conv. # TBC -1A/1B	2	63	1	EH	TT-9
67.	Fix Tripper #FT-4A/4B (Discharge Pulley)	2	78	1	EH	TT-11
68.	Divertor Gate	2	5	1	CPB	TT-11
69.	Fix Tripper #4A/4B (Bend Pulley)	2	69	1	EH	TT-11
70.	Tail Pulley of Tripper conv. # TBC -2A/2B	2	63	1	EH	TT-11
71.	Drive Unit / Drive Pulley of Conv. # BC-4A	5	79	1	EH	TT-10
72.	Drive Unit / Drive Pulley of Conv. # BC-4B	5	6	1	CPB	TT-10
73.	Divertor Gate	2	5	1	CPB	TT-10
74.	Tail Pulley of Conv. #BC-5A/5B	2	70	1	EH	TT-10
75.	Tail Pulley of Tripper conv. # TBC -1C/1D	2	63	1	EH	TT-10
76.	Drive Unit / Drive Pulley of Conv. # BC-5A	5	79	1	EH	TT-12
77.	Drive Unit / Drive Pulley of Conv. # BC-5B	5	6	1	CPB	TT-12
78.	Divertor Gate	2	5	1	CPB	TT-12
79.	Tail Pulley of Conv. #BC-6A/6B	2	70	1	EH	TT-12
80.	Tail Pulley of Tripper conv. # TBC -2C/2D	2	63	1	EH	TT-12
81.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-1A/1B	6	70	1	EH	Bunker[Unit-1]
82.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-1A/1B	6	10	1	CPB	Bunker[Unit-1]
83.	Above Tripper #TRT-1A/1B	2	7	1	CPB	Bunker[Unit-1]
84.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-1C/1D	6	70	1	EH	Bunker[Unit-1]
85.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-1C/1D	6	10	1	CPB	Bunker[Unit-1]
86.	Above Tripper #TRT-1C/1D	2	7	1	CPB	Bunker[Unit-1]
87.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-2A/2B	6	70	1	EH	Bunker[Unit-2]
88.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-2A/2B	6	10	1	CPB	Bunker[Unit-2]
89.	Above Tripper #TRT-2A/2B	2	7	1	CPB	Bunker[Unit-2]

HOIST SCHEDULE						
Sr. No	Location	Minimum Capacity ,t	Approx Lift, m	Qty. (No.)	Type	Building
90.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-2C/2D	6	70	1	EH	Bunker[Unit-2]
91.	Drive Unit /Drive Pulley of Tripper Conv. # TBC-2C/2D	6	10	1	CPB	Bunker[Unit-2]
92.	Above Tripper #TRT-2C/2D	2	7	1	CPB	Bunker[Unit-2]
• EH: Electric Hoist with Monorail						
• CPB: Chain Pulley Block with Manually operated Geared Trolley (Manual Hoist) complete with monorail						
• MHE: Manual Hoist with Electric Trolley complete with monorail						
1. For coal sampling system, provide monorail & hoist as specified elsewhere.						
2. Counter wt Tower of all HGTU: One(1)no manual hoist with monorail shall be provided above CWT box,Capacity:150% of wt of CWT						
3. Above Counter wt /TU pulley of all VGTU: One(1)no manual hoist with monorail shall be provided .Capacity:150% of wt of CWT						
EH or CPB shall be provided at any other location if found necessary during detail engineering. Subject to: a) If lift > 10metre provide Electric Hoist, If capacity ≥ 3 tonne provide Electric hoist (except for counter wt for conventional conveyors). b) CPB shall be provided above counter weight of conventional conveyors. c) If lift ≤10m & also load < 3 tonne provide manual hoist (CPB). d) Swiveling Hook with bearing : 20 Nos, SWL : 6 tonne shall be supplied by Vendor.						

M-6	GATES	
1.0	Flap Gate (FG)	
1.1.	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.	
1.2.	The gate leaf shall be fabricated out of SAILHARD / equal. Gate shaft 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.	
1.3.	The drive equipment of gate shall be capable of being operated for at least fifteen (15) switchings /hr with minimum five (5) consecutive starts.	
2.0	Technical Data:	
a)	Type	Motor operated linear Actuator with Flap Plate
b)	Equipment Designation / Location	As per flow Diagram
c)	Qty.	As per flow Diagram
d)	Travel range	To suit.

e)	Gate Body (Leaf)	2 Nos. of 12 mm thick plate of SAILHARD / TISCRAL welded together to form the desired shape.
f)	Type of bearing (Minimum)	Dust tight, antifriction, ball or roller bearings
g)	Gate shaft	EN-8 / Equal
h)	Bearing life (minimum)	50,000 hr (L-10)
i)	Flap gate position indication on control panel mimic	Two (2) position
B.0	Divertor Gate	
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.	
1.5	The gate shall be supported on the steel floor beams.	
1.6	Two (2) numbers inspection windows (hinged type and dust tight) shall be provided suitably for the casing.	
1.7	Technical Data	
a)	Type	Travelling type through rack & pinion arrangement
b)	Equipment Designation / Location/Qty.	As per flow Diagram
c)	Speed of the gate (approx)	30mm / sec
d)	Gate casing	10mm thk M.S plate with liners
e)	Conical portion of the diverter gate	16 mm thick plate of SAILHARD / TISCRAL
f)	Material of construction of the pinion and rack.	C45 or EN8
g)	Gate shaft	EN-8 / Equal
h)	Travel range	To suit.
i)	Motor	To conform to enclosed specification for motors.
j)	Type of bearing	Dust tight, antifriction, ball or roller bearings
k)	Bearing life (minimum)	50,000 hr (L-10)
l)	Provision of non reversal of gate during operation	To be provided
m)	Divertor gate position indication on control panel mimic	Two (2) position

n)	Limit switches	Heavy Duty type
o)	Provision for lubrication	To be provided
C.0	Rack & Pinion Gate	
1.0	Rack & Pinion feed gate shall be motor operated.	
1.1	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.	
1.2	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 slide gate shall be of 10 mm thick MS plate lined with 10 thk.SS304 liner and adequately reinforced. The gate plate is operated by double rack and pinion, the material of construction of rack and pinion being MS and alloy steel respectively.	
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 in case of emergency. The manual effort to operate gate shall not exceed 25kgs.	
1.4	Suitable Electromagnetic/Mechanical locking arrangement shall be provided for the gate.	
1.5	Pressure lubricated, dust tight, anti friction bearing shall be provided for shaft and rollers.	
1.6	The gates shall be provided with lapped or equivalent sealing on all four (4) sided and shall close/open through standing coal column.	
1.7	The limit switches shall be of dust proof type of approved make and gate opening and closing positions indication shall be provided on control panel mimic.	
1.8	Technical Data:	
a)	Type	Motor operated.
b)	Equipment Designation / Location / Qty.	As per flow Diagram
c)	Type of Bearing	Dust tight, anti friction bearings
d)	Bearing life (minimum)	50,000 hr (L-10)
e)	Method of lubrication	Single shot, pressure lubrication.
f)	Type of seal	Double labyrinth seal.
g)	Material of construction and thickness	
i)	Body	12 mm thk. M.S (I.S:2062)
ii)	Slide gate	12 mm thick M.S and lined with 10mm thk. SS-304 liner fixed by 12 mm CSK bolt
iii)	Rack	M.S. fabricated.
iv)	Pinion	Alloy Steel
v)	Shaft	EN-8 steel.
h)	Locking positions	Two extreme position

D.0	ROD GATE	
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. 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-7	IN LINE MAGNETIC SEPERATOR	
1.1	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	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	Magnetic pieces picked up by Magnetic Separator shall be discharged into tramp metal chute located suitably adjacent to main chute. Also another tramp metal cum floor cleaning chute shall be provided for disposal of Tramp Metal.	
1.4	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.	
1.5	Each magnetic Separator shall be suitable to lift the following tramp iron piece from the given belt:- • MS cube of 20mm size. • 250mmX250mmx50 kg MS plate. • MS round bar of 50 kg with L/D ratio of 5 (min.). • MS bolt of M12/M16, having minimum length equal to 5 times the size. • Shovel teeth & spikes.	
1.6	One (1) Tramp Metal Trolley shall be provided for each Inline Magnetic Separator (ILMS)	

1.7	Technical Data:	
a)	Type of Magnetic Separator	In Line Magnetic Separator, Oil cooled type electromagnet with self-cleaning arrangement.
b)	Equipment designation/ Location/Qty.	Refer Flow Scheme
c)	Capacity/belt width/belt speed/Troughing Angle	Refer Conveyor Data Sheet
d)	Operating height	450mm (Minimum)
e)	Flux density (Min.)	1000 Gauss at operating height specified above.
f)	Force Index	100000 Gauss (Minimum) at above operating height
g)	Degree of Protection	IP-65
h)	Magnet Core Material	Pure annealed iron/eq. having high magnetic permeability, IS-4491
i)	Coils	Aluminium wounded coils with class “H” insulation
j)	Rectifier	3ph, full wave bridge using Silicon diodes forming rectifier set
k)	Non-Magnetic Pulley	Non Magnetic Pulley as per Belt Conveyor specification shall be provided.
l)	Separator Belt	EP Type of F.R-Grade complete with built- in ribs and zero speed switch. Geared motor drive shall be provided
m)	Wear plate of Stainless steel SS-304 shall be provided at electromagnet surface.	
M-8	SUSPENDED ELECTROMAGNET	
1.1	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.	
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). Monorail shall extends minimum 3 mts on both side of pent house.	
1.4	Each magnetic Separator shall be suitable to lift the following tramp iron piece from the given belt:- • MS cube of 20mm size. • 250mmX250mmx50 kg MS plate. • MS round bar of 50 kg with L/D ratio of 5 (min.). • MS bolt of M12/M16, having minimum length equal to 5 times the size.	

	• Shovel teeth & spikes.	
1.5	One (1) Tramp Metal Trolley shall be provided for each Suspended Electromagnet (SEM) to receive tramp metal.	
1.6	Technical Data:	
a)	Type of Magnetic Separator	Oil cooled type Electromagnet
b)	Equipment Designation	SEM-1
c)	Location / Qty	In Pent House # PH-1: Above conveyor # RC-1 / Qty: 1 No
d)	Capacity of conveyor (TPH)	Ref. Belt Conveyor Specification / Datasheet
e)	Belt speed (m/sec)	Ref. Belt Conveyor Specification / Datasheet
f)	Belt width	1800mm
g)	Troughing Angle	35°
h)	Operating height	450mm (Minimum)
i)	Flux density (Min.)	1000 Gauss at operating height specified above.
j)	Force Index	100000 Gauss (Minimum) at above operating height
k)	Degree of Protection	IP-65
l)	Magnet Core Material	Pure annealed iron/eq. having high magnetic permeability, IS-4491
m)	Coils	Aluminium wounded coils with class “H” insulation
n)	Rectifier	3ph, full wave bridge using Silicon diodes forming rectifier set
o)	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
p)	Wear plate of Stainless steel SS-304 shall be provided at electromagnet surface.	
M-9	Vibrating Grizzly Feeder	
1.0	Feeder shall feed the crusher uniformly and also separate (-) 20 mm material & fines from the feed to the crusher.	
1.1	Feeder shall be fitted with unbalance drive assembly complete with drive motors for effective screening out of under size material from feeder deck. Continuous solid deck section of feeder under impact zone shall be provided with liner plates. Remaining deck will be fitted with grizzly plates. Inclination of feeder shall be adjustable.	
1.2	Suitable sealing arrangement shall be provided between the vibrating frame and the chute work to avoid dust nuisance in the surrounding area.	
1.3	Each Vibrating Grizzly Feeder shall be complete with Vibrating Deck with sidewalls, frame, Liners, Grizzly bars /plates. Unbalance drive assembly, spring supports, Vibrator guards etc	

1.4	The equipment shall be of reputed, proven & approved make	
2.0	Technical Data	
a)	Capacity.	2000 tph each.
b)	Type	Vibrating Grizzly Feeder of heavy duty design, Spring supported, Floor mounted.
c)	Qty, no	Four(4)
d)	Equipment Designation No.	VGF-1A/1B &, VGF-2A/2B.
e)	Feed material.	Imported /Indigenous Coal
f)	Feed size.	(-) 100 mm
g)	Separation size.	(-) 20 mm
h)	Bulk density.	0.8 t/m³ for Volumetric Calculation. 1.05 t/m³ for Stress on Structure.
i)	Hard grove index.	48 to 65
j)	Moisture content.	Upto 20 %
k)	Material of construction	
i.	Solid deck.	ST – 42, IS:2062
ii.	Liner plates.	Sailhard / Tiscral
iii.	Grizzly Screen Plates.	Sailhard / Tiscral
iv.	Support Springs.	Spring Steel
M-10	CRUSHER	
1.0	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 shall be mounted on its own RCC deck with vibration isolation system. [in the crusher house]	
1.1	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.	
1.2	The rotor speed shall be in the range of 600-750 rpm	
2.0	Constructional Features	
2.1	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. Also split bearing shall be provided for rotor shaft.	
2.2	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.	
2.3	Removal of tramp metal / Debris: - Tramp iron and other uncrushable 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.	
2.4	Drive Unit Scoop type fluid coupling with H.T. motor will drive crusher.	
3.0	Technical Data	
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.	Coal HGI	48-65
3.5.	Equipment Designation No.	CR-1A / 1B & CR-2A / 2B
3.6.	Qty.	Four (4)
3.7.	Guaranteed Crushing Capacity for above crusher	2000 tph each
3.8.	Max. Lump Size of feed (Input to Crusher)	(-) 100 mm (Nominal)
3.9.	Crushed Coal Size (Crusher Output) required	(-) 20 mm
3.10.	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 from feed to crusher (i.e. Ring Granulator)
3.11.	Anti Vibration Spring System of Gerb make for Supporting Crusher	To be provided
3.12.	Vibration Monitoring System	To be Provided one system per Crusher.
3.13.	Temperature Detector	To be Provided one system per Crusher.
3.14.	Zero speed switch	To be Provided for each Crusher.
3.15.	Material Of Construction	
[A]	Rotor Assembly.	
i)	Crusher Rings	MN Steel, (IS:276), Gr-III
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/Equal.
vi)	Suspension bars	Alloy Steel, 709M 40 (BS: 970)/equal.
[B]	Housing /Cage Frame.	
a)	Housing /Cage frame	IS: 2062 –Gr. B.
b)	Breaker Plate	Mn Cast steel (IS:270,Gr-III)
c)	Screen plate	Mn Cast steel (IS:270,Gr-III)
d)	Liner Plate	SAILHARD / Equal
e)	Tramp Iron door	IS: 2062,Gr.B.
3.16.	Bearing	Heavy Duty Antifriction
3.17.	Lubrication arrangement	Manual through grease gun.
3.18.	Product size adjustment	Manually operated worm screw jack for gap adjustment between cage & rotor.
3.19.	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.
M-11	Stacker cum Reclaimer # SR-1A/1B/1C/1D	
1.0	All components of each machine shall be designed & built to operate outdoor continuously at peak loads and under climate & ambient conditioned outlined in relevant sections. Stability of machine shall be guaranteed for all operating and non-operating loads. Each equipment (M/C) shall be stable and free on rails under all possible operating conditions.	
1.1.	Stacker cum Reclaimer (M/C) shall be rail mounted travelling, slewing and luffing machines. 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 equipment (M/C) shall be equipped with a self-leveling operator's cabin housing the control console for the machine. Stacker cum Reclaimer M/C will operate on unidirectional yard belt. Anti Collision device shall be provided for each M/C considering all possible operating conditions.	
1.2.	Dry Fog (Dual Fluid – air & water) Dust Suppression System shall be mounted on machine covering various transfer points for each Stacker cum Reclaimer M/C. All transfer points shall have dust tight enclosure to the extent possible & provided with dry fog type dust suppression application point.	
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 upto 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 upto of 50 m/sec. Further, for parking of boom suitable anchoring device shall be provided for each machine.	
1.4.	Technical Data:	

a)	Material Handled	(-) 20mm Crushed Coal
b)	Qty.	M/C # SR-1A (1no.), M/C # SR-1B (1no.), M/C # SR-1C (1no.) & M/C # SR-1D (1no.).
c)	Stacking Capacity (Guaranteed)	2000tph
d)	Reclaiming Capacity (Peak)	2300tph
e)	Guaranteed Avg. capacity over four(4) hr. block cutting operation	2000tph
f)	Long Travel Speed	0 – 40m/min infinitely variable in both 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.
g)	No. x Yard Rail Size and Rail Centres	2 x minimum CR 80 and 9m (approx.) centres
h)	Boom Length (distance between centre line of slew to centre line of bucket wheel)	41m (approx.) Boom belt shall be equipped with Hydraulic motor drive.
i)	Slewing Speed	0-0.2 rpm (Hydraulic)
j)	Slewing Range	± 110° from centerline of yard conveyor
k)	Luffing Range (approx.)	+12° above & -12° below horizontal
l)	Luffing Speed	3m/min @centre line of Bucket Wheel
m)	Boom Conveyor width & Speed	1800mm x 35° Tr. & speed to suit. Deck Plate at loading point only.
n)	Yard Conveyor width & Speed	1800mm x 35° Tr. x 2.7m/s (approx.)
o)	Long Travel (min.)	To suit
p)	Wheel Dia. (min.)	630 mm (Tread dia.)
q)	Max. Wheel Load	300 KN
r)	Operating wind velocity	20 m/sec
s)	Non-Operating wind velocity	50 m/sec
t)	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]
u)	Max. Stockpile Height	12.5m
1.5	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, tripper head section, counter weight etc. The structure (machine) shall be designed as statically determinate three (3) points supports system with four	

	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.
1.6	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. 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.
1.7	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.
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.
1.8	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 leveling 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.
1.9	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 blending operation.
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.
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 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 be designed in such a way as to ensure that the collision forces are distributed. Buffers installed on the equipment structure (Machine) 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, 546nnunciators panel etc. & provided with ergonomically designed 360 deg. Swiveling operator's seat. Cabin

	floor shall skid proof surface.
d)	Alarm units, indicators etc. shall be contained in an 547nnunciators 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, window wipers with wash unit and a swiveling ventilation 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)	Cable reeling drum for composite power and control cables shall be provided which shall be located on Machine Structure near the Electric House. 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	Belt Weigher
a)	A belt scale shall be mounted on the boom conveyor having following minimum specifications:

	• Belt width: 1800mm • 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.
1.16	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, thyristor 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.

1.17	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)	Anti-Collision Switch / Device: Such switches shall be provided on both sides of the boom to prevent accidental hitting of the boom with the pile-top while slewing and /or with boom of machines running on adjacent track on either of the machine track.
f)	Boom Belt Switches: Belt sway switch, pull cord switch and zero speed switch on boom belt conveyor shall be provided.
g)	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.
h)	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.
M-12	BELT WEIGHER
1.1	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.
1.2	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.

1.3	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.	
1.4	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. Cabinet shall be suitable for modbus, Ethernet TCP/ IP communication protocol.	
1.5	High precision load cell of strain gauge type / transducer fully temperature compensated shall be provided.	
1.6	The accuracy shall be guaranteed within (±) 0.25 percent for all belt weighers. 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	Technical Data:	
a)	Type of Belt Weigher	Electronic Load Cell Type, Microprocessor based
b)	Equipment designation/ Location/Qty.	Refer Flow Scheme
c)	Capacity/belt width/belt speed	Refer Conveyor Data Sheet
d)	Weighing range	20% to 120%
e)	Accuracy over full weighing Range	Within ± 0.25%
f)	Totalizing Unit	To be Provided
g)	Type	Eight digits, digital totalizer
h)	Location of Electronic Cabinet	Control Room
i)	Rate indicator	Both Local as well as remote to be provided
j)	Type	Digital type
k)	Location of display	Control Room / Local
l)	Calibrating instruments as required	To be Provided
M-13	METAL DETECTOR	
1.0	Constructional Features	
1.1	Each metal Detector would comprise of: • 1 No. Search Coil,	

	• 1 No. Electronic Cabinet, • 1 No. Signal Horn, • 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 ckt. This monostable ckt 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	Technical Data:	
a)	Equipment designation/ Location/Qty.	Refer Flow Scheme
b)	Capacity/belt width/belt speed	Refer Conveyor Data Sheet
c)	Material to be examined	(-) 20 mm Crushed Coal
d)	Detector type & capacity	Electronic solid-state type, single channel suitable to detect 30 mm dia. aluminium ball and MS nut of size M-20. Each unit shall be complete with search coil, electronic cabinet, signal lamp, signal horn, sand bag marker, and provision for testing the unit.
e)	Annunciation/Hooter provided	Yes
f)	Audible range of hooter	300 m
g)	Indication type	Audio and visual
h)	Power supply	230V ± 15%, 50 Hz ± 3%, Single phase, A C Supply
M-14	Coal Scooper	
1.1	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.	

1.2	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.	
1.3	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.	
1.4	Technical Data	
a.	Type	Automatic / Semiautomatic
b.	Qty. / Location	As per flow Diagram
c.	Construction	Steel fabricated, Necessary 5-Roll idler at scooper location shall be provided.
d.	Conveyor Data :	
i.	Belt Width / Capacity / Speed	Refer Flow Diagram & Conveyor Data sheet
ii.	Material to be handled	Crushed Coal
iii.	Lump Size	(-) 20mm
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-15	Emergency Reclaim Hopper / Bar Grid (in Emergency Reclaim Hopper Complex)	
1.1	Each hopper shall be in RCC Construction with minimum sloping angle of 60°.	
1.2	Steel grating as per Data Sheet shall be provided on the top of each hopper. Suitable slope shall be incorporated in the access ramp to RCC hopper & M.S. angle shall be embedded at edges of ramp for edge protection.	
1.3	M.S fabricated mouth pieces of suitable size shall be provided at the discharge openings of different hoppers to suit the feeder mounted below RCC hopper outlet.	
1.4	Emergency Reclaim Hopper Complex shall have access shaft with monorail and hoist to bring out equipment up to ground level & vice versa.	
1.5	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.	
1.6	Floor mounted feeders shall be provided below each hopper.	

2.0	Technical Data (Reclaim Hopper)	
a)	Type & Construction of hopper	Underground RCC Construction complete with steel fabricated bar grid at top.
b)	Number	As per flow Diagram
c)	Material Handled	(-) 20 mm Coal
d)	Hopper Liner	50 thk Guniting
e)	Capacity of each RCC underground hopper	Not less than 50cum.
f)	Structural steel shed above Reclaim hopper complex # ERH-1	Not required
g)	Type of Feeder below RCC Hopper	Vibrating feeder, variable capacity
h)	General Constructional features	The top & sides of all RCC girders (at top of hopper) shall be lined with 20 mm thk. SAILHARD / TISCRAL liner.
i)	Bar Grid	
i.	Type & Construction	Welded Steel Construction made out of M.S. plate (IS:2062)
ii.	Qty.	Lot
iii.	Clear opening size	150mm x 150mm
iv.	Bar Grid / Grating Material	Made out of 200 mm x 20 mm thk MS flat
M-16	Vibrating Feeder	
1.1	Vibrating feeder shall be installed below RCC hoppers in Emergency reclaim hopper complex. These feeders shall be used for drawing coal at uniform rate and discharging the same onto the Reclaim conveyor#RC-1.	
1.2	All vibrating feeders shall be of electro – mechanical (brute force) type. Each feeder is driven by 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	Technical Data	
a)	Capacity.	200 tph, Variable capacity
b)	Type	Electromechanical, floor mounted
c)	Equipment Designation / Location / Qty.	VF / As per Flow Diagram
d)	Material handled	Crushed coal
e)	Lump size, mm	(-)20
f)	Moisture content	Up to 20%
g)	Bulk density.	0.8 t/m³ for Volumetric Calculation. 1.05 t/m³ for Stress on Structure.

h)	Trough	12 mm thk M.S Lined with 12 thk SAILHARD/ TISCRAL.
i)	Trough Inclination	Adjustable, 8 to 10 degree downslop.
j)	Amplitude	3mm to 8mm
k)	No. of vibrations per minute	950 (approx)
l)	Type of drive	Unbalanced motor.
M-17A	COAL SAMPLING SYSTEM (Inside Power Plant Boundary)	
1.0	Crushed Coal Sampling System (designation no. CSU-1A/1B) shall be located on incoming Conv. # BC-3A/3B in Sampling Tower # ST-1 & shall conform to the requirements of ASTM-D-2234 & ASTM-D-2013. Design Basis:- a) Lot Size: Storage capacity of Coal Bunkers for one (1) Unit. b) No. of conveyor operating to fill above Coal Bunker : One (1) c) The bidder may offer alternative sampling system, if necessary.	
1.1.	Independent Sampling System # CSU-1A will be provided on conveyor # BC-3A & Independent Sampling System CSU-1B shall be provided for conveyor # BC-3B. Each Sampling System shall be complete with necessary samplers, belt feeders, chutes, sample crusher, rejects system etc. & designed to extract representative sample from the specified belt conveyor.	
1.2.	Coal sampling system shall be automatic using PLC based control system. However the system shall be capable to run under Semi Automatic/manual mode also. Local push button station shall be provided to operate each machine individually.	
1.3.	The different Equipment selected for coal sampling system shall be such that there shall be no loss of fines and moisture from the samples.	
1.4.	PVC cans for sample collection from belt feeders shall be identical. Each can shall be of adequate capacity and of high durability and complete with suitable cover/lid.	
1.5.	Primary samplers (separate for each conveyor) shall be of rugged design and capable to withstand severe shock loads and operate trouble free.	
1.6.	Belt feeders shall be provided for the sampling path up to sample collector. The feeders shall meter the flow accurately, produce a non-plugging condition and resist sticky and wet coal.	
1.7.	Single stage with V- belt drive –Sample crusher shall be provided for reducing the input feed coal to desired product size. Crusher base/support structure shall be designed so that vibrations are within the safe permissible limits.	
1.8.	The traversing mechanism and all electric parts for samplers shall have dust tight protection. Geared motor drive shall be provided for all belt feeders, bucket elevators etc. Rain protection canopy to be provided for motors at outdoor location.	
1.9.	Each sampling system shall be complete with MCC / electric motor / panels / push button stations and the necessary control and instrumentation system.	

1.10.	Minimum 1tonne Monorail along with Manual hoist shall be provided above each floor on which sampling Equipment are located.	
1.11.	Technical Specification	
A.0	Primary Sampler # PSC-1A/1B	
A.1	Qty	Two(2)
A.2	Location	Conv. # BC-3A / 3B in Sampling Tower # ST-1.
A.3	Type	Swing Hammer Type collecting sample from belt. Machine shall be self contained and dust tight unit.
A.4	No of Cuts / hr.	Not less than 28 [per conveyor].
A.5	Cutter opening	It shall not be less than 75mm. However it shall be capable to scoop out / discharge primary sample (as per ASTM).
A.6	Construction	The M/C consists of steel fabricated assembly with dust covers within which is located sweep arm sample cutter. The sample cutter is fabricated from SS-304 stainless steel or better with replaceable SS-304 stainless steel or better cutter lips. Mounted to the assembly is the drive motor with electric brake which drives and stops the sample cutter. The M/C shall be designed to discharge sample at the terminus of each stroke. Proximity switch shall be provided to control the terminus of the travel.
B.0	Secondary Sampler # SSC-1A/1B	
B.1	Qty	Two(2)
B.2	Location	SBF-2A/2B
B.3	Type	Swing Hammer Type collecting sample from belt. Machine shall be self contained and dust tight unit.
B.4	No of Cuts / hr.	Not less than six times the primary cut/hr.
B.5	Cutter opening	It shall not be less than 50mm
B.6	Construction	The M/C consists of steel fabricated assembly with dust covers within which is located sweep arm sample cutter. The sample cutter is fabricated from SS-304 stainless steel or better with replaceable SS-304 stainless steel or better cutter lips. Mounted to the assembly is the drive motor with electric brake which drives and stops the sample cutter. The M/C shall be designed to discharge sample at the terminus of each stroke. Proximity switch shall be provided to control the terminus of the travel.
C.0	Primary Sample Belt Feeder # SBF-1A/1B & Secondary Sample Belt Feeder # SBF-2A/2B	
C.1	Type	Reversible Type
C.2	Qty	Two (2)+ Two (2)
C.3	Capacity	Not less than 1tph per Belt Feeder.

C.4	Belting	Standard duty x 315/3 x EP belt, Covers: 3mm topx1.5mm bottom, F.R grade. Belt Width = 400mm(min.), Speed(VARIABLE): 0.2m/s to 0.5m/s
C.5	Idler	76.2mmOD x 4thk x ERW tube(IS:9295) x 20Φ bright bar shaft, life lubricated design x deep grooved ball bearing having Bearing life (L-10) of minimum 60000hrs.
C.6	Pulleys	5mm thk(min) shell (MS, IS:2062) x EN-8 shaft with antifriction bearings having Brg. life (L-10) of minimum 60000hrs.Neoprene rubber lagged head and tail pulley, lagging thk; 6mm thk(minimum). Shaft/ hub connection: key fitted.
C.7	Other Details	Feeder shall be designed to suit Sampling System Application and shall be complete with gate/take up device/safety switches etc and suitably encased in dust tight MS enclosure having snugly fitted inspection doors with good quality sealing arrangement. Each feeder shall be positively self cleaning. It shall be provided with Geared motor drive.
C.8	Can # C-1A / 1B & C-2A / 2B	Four (4) cans to suit shall be provided
D.0	Sample crusher # SC-1A/1B	
D.1	Qty	Two (2)
D.2	Location	Refer Flow diagram
D.3	Type	Impact type hammer mill /equal, single stage crushing required
D.4	Feed & its size	(-) 20mm (Nominal)/ Crushed Coal.
D.5	Product size	100% (-) 6mm and 95% (-)8 mesh/ As per ASTM.
D.6	Capacity each (min.)	1 tonne/hr
D.7	Construction	Crusher shall be of steel plate construction with replaceable hammers, adjustable grate bars, tramp iron collector etc and shall be complete with V-belt drive & electric motor and suitable vibration isolation system.
E.0	Rotary Sample Collector # RSC-1A/1B	
E.1	Qty	Two (2)
E.2	Location	Refer Flow diagram
E.3	Type	8- Station, Rotary Sample Collector[for collection of final sample]
E.4	Construction	Main frame fabricated from MS plate(IS:2062) and complete with MS fabricated turn table with bearings, plastic seal plate, sample can attachments, limit switches, drive unit with motor suitable for 415Vx3phx50 Hz A.C Power Supply
E.5	No of can per Rotary Collector	8
E.6	MOC of Cans	P V C
E.7	Additional can	10 no

	required	
F.0	Rejects Bucket Elevator # BE-1A/1B	
F.1	Qty	Two (2)
F.2	Location	Refer Flow diagram
F.3	Capacity each(min.)	2 tonne/hr
F.4	Type	Centrifugal type / belt, Minimum 5thk SS-409M bucket. (Type A1 to IS: 6833), Free standing. Minimum 650mm wide Access ladder [to drive unit] complete with cage shall be provided.
F.5	Belting	Minimum 4ply / EP / HD suitable for Elevator duty.FR grade cover, Minimum Cover thk:1.5mm[pulley side] and 1.5mm [bucket].
F.6	Construction	Bucket Elevator shall be complete with head and boot sections, T.U device and elevator casing, clean out door etc .Casing made out of minimum 8mmthk MS (IS:2062).Stiffener of ISA 75 x 75 x 6 thk (minimum) shall be used to provide a rugged structure of the Elevator Body. Drive unit with geared motor and holdback shall be provided. Head & Boot Pulley lagged with 6mm thk Neoprene rubber Lagging
G.0	Chute Work	
G.1	Qty	As per Flow Diagram
G.2	Material of Construction	5mm thk SS-304 plate for Sample Discharge Chute & 5mm thk SS-409 M for Rejects Chute.
G.3	Slope angle (approx.)	60 degree to horizontal
G.4	Cross-section	Preferably round section or square/ rectangular with rounded corners.
G.5	Construction	Welding of chutes shall be done externally only. Radius at corners is not less than 25mm shall be provided for the chute work. The chute shall be made in suitable number of sections, flanged bolted using standard grade neoprene gasket of minimum 3mm thick. Dust tight inspection doors shall be provided at strategic locations for the above chute work.
M-17B	COAL SAMPLING SYSTEM (Outside Power Plant Boundary)	
1.0	Coal Sampling System (designation no. CSUB-1A/1B) shall be located on incoming Conv. # BCZ-1A/1B in Junction Tower # JTB-4 & shall conform to the requirements of ASTM-D-2234 & ASTM-D-2013. Design Basis:- a) Lot Size: 20000 t (One- Fourth of Ship 80000 DWT). b) No. of conveyor operating/Capacity: One (1)/4000 tph each, Run Time: 5 hr. c) The bidder may offer alternative sampling system, if necessary.	
1.1.	Independent Sampling System # CSUB-1A will be provided on conveyor # BCZ-1A & Independent Sampling System CSUB-1B shall be provided for conveyor # BCZ-1B. Each Sampling System shall be complete with necessary samplers, belt feeders, chutes, sample crusher, rejects system etc. & designed to extract	

	representative sample from the specified belt conveyor.	
1.2.	Coal sampling system shall be automatic using PLC based control system. However the system shall be capable to run under Semi Automatic/manual mode also. Local push button station shall be provided to operate each machine individually.	
1.3.	The different equipment selected for coal sampling system shall be such that there shall be no loss of fines and moisture from the samples.	
1.4.	PVC cans for sample collection from belt feeders shall be identical. Each can shall be of adequate capacity and of high durability and complete with suitable cover/lid.	
1.5.	Primary samplers (separate for each conveyor) shall be of rugged design and capable to withstand severe shock loads and operate trouble free.	
1.6.	Belt feeders shall be provided for the sampling path up to sample collector. The feeders shall meter the flow accurately, produce a non-plugging condition and resist sticky and wet coal.	
1.7.	Single stage with V- belt drive -Sample crusher shall be provided for reducing the input feed coal to desired product size. Crusher base/support structure shall be designed so that vibrations are within the safe permissible limits.	
1.8.	The traversing mechanism and all electric parts for samplers shall have dust tight protection. Geared motor drive shall be provided for all belt feeders etc. Rain protection canopy to be provided for motors at outdoor location.	
1.9.	Each sampling system shall be complete with MCC / electric motor / panels / push button stations and the necessary control and instrumentation system.	
1.10.	Minimum 1tonne Monorail along with Manual hoist shall be provided above each floor on which sampling Equipment are located.	
1.11.	Technical Specification	
A.0	Primary Sampler # PSCB-1A/1B	
A.1	Qty	Two(2)
A.2	Location	Conv. # BCZ-1A/1B
A.3	Type	Swing Hammer Type collecting sample from belt. Machine shall be self contained and dust tight unit.
A.4	No of Cuts / hr.	Not less than 33 [per conveyor].
A.5	Cutter opening	It shall not be less than 300mm. However it shall be capable to scoop out / discharge primary sample (as per ASTM).
A.6	Construction	The M/C consists of steel fabricated assembly with dust covers within which is located sweep arm sample cutter. The sample cutter is fabricated from SS-304 stainless steel or better with replaceable SS-304 stainless steel or better cutter lips. Mounted to the assembly is the drive motor with electric brake which drives and stops the sample cutter. The M/C shall be designed to discharge sample at the terminus of each stroke. Proximity switch shall be provided to control the terminus of the travel.

B.0	Secondary Sampler # SSCB-1A/1B	
B.1	Qty	Two(2)
B.2	Location	Refer Flow diagram
B.3	Type	Rotary type or equal. Machine shall be self contained and dust tight unit. It shall be robust design suitable for the most arduous application with one moving part facilitating easy maintenance
B.4	No of Cuts / hr.	Not less than six times the primary cut/hr.
B.5	Cutter opening	It shall not be less than 457.2 mm (18")
B.6	Construction	The M/C consists of steel fabricated assembly with dust covers within which is located sample cutter. The sample cutter is fabricated from SS-304 stainless steel or better with replaceable SS-304 stainless steel or better cutter lips. Rotating cutter travels at constant speed through falling stream. Travel is initiated at predetermined intervals. Limit switch operated braked motor shall be provided suitably. Cutter angle shall be adequate to ensure full discharge of sample.
C.0	Tertiary Sampler # TSCB-1A/1B	
C.1	Qty	Two(2)
C.2	Location	Refer Flow diagram
C.3	Type	Rotary type or equal. Machine shall be self contained and dust tight unit. It shall be robust design suitable for the most arduous application with one moving part facilitating easy maintenance
C.4	No of Cuts / hr.	Not less than 86 [per conveyor].
C.5	Cutter opening	It shall not be less than 31.75mm(1.25")
C.6	Construction	The M/C consists of steel fabricated assembly with dust covers within which is located sample cutter. The sample cutter is fabricated from SS-304 stainless steel or better with replaceable SS-304 stainless steel or better cutter lips. Rotating cutter travels at constant speed through falling stream. Travel is initiated at predetermined intervals. Limit switch operated braked motor shall be provided suitably. Cutter angle shall be adequate to ensure full discharge of sample.
D.0	Primary Sample Belt Feeder # SBFB-1A/1B & Secondary Sample Belt Feeder # SBFB-2A/2B	
D.1	Type	Reversible Type
D.2	Qty	Two (2)+ Two (2)
D.3	Capacity	a) SBFB-1A/1B: Not less than 5 tph each. b) SBFB-2A/2B: Not less than 1 tph each.
D.4	Belting	Standard duty x 315/3 x EP belt, Covers: 3mm topx1.5mm bottom, F.R grade.

		Belt Width = 400 mm(min.), Speed(VARIABLE): 0.2m/s to 0.5m/s & to suit.
D.5	Idler	76.2mmOD x 4thk x ERW tube(IS:9295) x 20Φ bright bar shaft, life lubricated design x deep grooved ball bearing having Bearing life (L-10) of minimum 60000hrs.
D.6	Pulleys	5mm thk(min) shell (MS, IS:2062) x EN-8 shaft with antifriction bearings having Brg. life (L-10) of minimum 60000hrs.Neoprene rubber lagged head and tail pulley, lagging thk; 6mm thk(minimum). Shaft/ hub connection: key fitted.
D.7	Other Details	Feeder shall be designed to suit Sampling System Application and shall be complete with gate/take up device/safety switches etc and suitably encased in dust tight MS enclosure having snugly fitted inspection doors with good quality sealing arrangement. Each feeder shall be positively self cleaning. It shall be provided with Geared motor drive.
D.8	Can # CB-1A / 1B & CB-2A / 2B	Four (4) cans to suit shall be provided
E.0	Sample crusher # SCB-1A/1B	
E.1	Qty	Two (2)
E.2	Location	Refer Flow diagram
E.3	Type	Impact type hammer mill /equal, single stage crushing required
E.4	Feed & its size	(-) 100mm (Nominal)/ Uncrushed Coal.
E.5	Product size	100% (-) 6mm and 95% (-)8 mesh/ As per ASTM.
E.6	Capacity each	5 tonne/hr (Minimum)
E.7	Construction	Crusher shall be of steel plate construction with replaceable hammers, adjustable grate bars, tramp iron collector etc and shall be complete with V-belt drive & electric motor and suitable vibration isolation system.
F.0	Rotary Sample Collector # RSCB-1A/1B	
F.1	Qty	Two (2)
F.2	Location	Refer Flow diagram
F.3	Type	8- Station, Rotary Sample Collector[for collection of final sample]
F.4	Construction	Main frame fabricated from MS plate(IS:2062) and complete with MS fabricated turn table with bearings, plastic seal plate, sample can attachments, limit switches, drive unit with motor suitable for 415Vx3phx50 Hz A.C Power Supply
F.5	No of can per Rotary Collector	8
F.6	MOC of Cans	P VC
F.7	Additional can required	10 no

G.0	Chute Work	
G.1	Qty	As per Flow Diagram
G.2	Material of Construction	5mm thk SS-304 plate for Sample Discharge Chute & 5mm thk SS-409 M for Rejects Chute.
G.3	Slope angle	Not less than 60 degree to horizontal
G.4	Cross-section	Preferably round section or square/ rectangular with rounded corners.
G.5	Construction	Welding of chutes shall be done externally only. Radius at corners is not less than 25mm shall be provided for the chute work. The chute shall be made in suitable number of sections, flanged bolted using standard grade neoprene gasket of minimum 3mm thick. Dust tight inspection doors shall be provided at strategic locations for the above chute work.
M-18	Sump Pump	
1.1	In each Sump Pit two(2) (1W+1S) sump pump shall be provided The pump shall be of vertical submersible 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.	
1.2	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. All the sump pumps shall be provided with suitable strainers at the inlet side of the impeller.	
1.3	The pumps shall be driven by a suitable motor located at proper position for smooth, safe, and efficient operation.	
1.4	The piping system shall be designed to suit simultaneous operation of both pumps (i.e. working pump + standby pump). Discharge pipe upto the nearest drain/pond shall be provided.	
2.0	Technical Data	
a)	Type	Vertical submersible non-clog type
b)	Equipment Designation / Location / Qty.	Located in Sump Pit as per flow diagram.
c)	Type of fluid handled	Coal dust laden water having solids upto (–) 20mm size.
d)	Type of drive	Motor operated, flanged mounted motor
e)	Type of mechanism for automatic starting / stopping	Level switches
f)	Type of bearing	Antifriction
g)	Method of lubrication	Grease
h)	Strainer at the inlet side of impeller provided	Yes
i)	Piping valve and accessories	MS ERW pipe , conforming to IS: 1239 / IS: 3589
j)	Local start / stop control	From next higher floor or away from sump where

		water accumulation does not occur.
k)	Local Panel, necessary start/stop push button, auto / manual selector switch etc. provided	Yes, Indication of ON / OFF at Central Control Room to be provided.
l)	Type of mechanism for automatic starting / stopping	ELECTRODE TYPE / EQVT.
m)	Material of construction	
i)	Casing	CI
ii)	Impeller	ALLOY CI
iii)	Pump shaft	EN-8/Equal
iv)	Line Shaft	EN-8/Equal
v)	Support Pipe	MS
vi)	Cover Plate	MS
vii)	Strainer (basket type)	CI
M-19	Belt Sealing Arrangement	
1.0	For Belt Sealing Arrgmt, 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 slot opening shall be of adequate width.	
1.4	The belt sealing arrangement shall be provided along the bunker filling tripper conveyors.	
2.0	Technical Data	
a)	Type	Single flat belt sealing
b)	Qty/Location	Lot/Over Coal bunkers slots for tripper conveyor
c)	Sealing belt specification	
i)	Rating & type	Heavy Duty,630 / 3, EP belt
ii)	Width of belt(minimum)	1200 mm
iii)	Number of piles	3
iv)	Cover Grade	F.R. Grade
v)	Cover Thickness	3 mm x 3 mm

d)	Bunker slot grating	
i)	Material of construction	MS Fabricated, out of MS flats & Ø 20 MS rods
ii)	Opening size(minimum)	1150 mm continuous
M-20	Bunker Level Indicators/Transmitter	
1.0	3D scanner type level indicator shall be provided for each bunker of Coal Bunker & shall be fitted on bunker floor. 3D scanner shall be capable of successful operation under harshness of storage environment & shall provide accurate measurement of the level, volumetric and mass of the stored Coal. It shall have adequate diagonal measuring range.	
2.0	Technical Data:	
i.	Type of Level Indicator	Non Contact Volumetric 3-D Scanner for use on coal bunkers for continuous level measurement with alarm points.
ii.	Coal size	Crushed Coal ; (-) 20 mm Uncrushed Coal ; (-) 100 mm
iii.	No. of Indicators required	a) Two(2) no. required for each bunker for Unit-1 & 2 b) Four (4) no. for Surge Bin # SBB-1 c) One (1) no. for each Surge Bin # SB-1A/1B
iv.	Housing	Rugged and robust
v.	Integral laser Pointer	To be provided
vi.	Totalizer for real time mass Calculation	To be provided
vii.	Integral Dust Tube for alignment	To be provided
viii.	Laser Safety	Class 3R or better
ix.	Locations for Bunker Level Indication & Alarm	a) In ICHP Control Room in Building # ER-1 & Tripper floor (local) b) In ICHP Control Room in Building # ER-1 & JTB-4 (local) & Bldg. # ERZ-2 c) In ICHP Control Room in Building # ER-1 & Crusher House floor (local)
x.	Alarm Outputs	high, high/high ,low ,low/low
M-21	Belt Vulcanizing Equipment	
1.1	The equipment furnished shall be suitable for vulcanizing Steel Cord type belt / EP Belt as specified for Pipe Belt Conveyor / Belt Conveyor / Conveyor Data.	
1.2	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.		
1.3	The equipment shall be light in construction so that it can be transported easily to the desired location.		
1.4	One (1) set of complete repair kit shall be furnished along with each equipment.		
1.5	The equipment shall be of reputed, proven & approved make.		
2.0	Technical Data:		
a)	Designation no.	BVM-1 (Steel Cord Belt)	BVM-2 (EP Belt)
b)	Type of belting to be vulcanized	a)Upto 2000mm wide steel cord belting for conventional conveyor b) Minimum 2200mm wide steel cord belting for pipe belt conveyor	upto 2200mm wide EP belting for conventional conveyor
c)	Type	Hydro-mechanical type, pressure generated by Hydraulic pump	Hydro-mechanical type, pressure generated by Hydraulic pump
d)	Quantity	One(1)	One(1)
e)	Type temperature controller	Thermostat	Thermostat
f)	Operating pressure	8kgf/sq.cm./ to suit	8kgf/sq.cm./ to suit
g)	Operating temperature(approx range)	145-155°C	145-155°C
h)	Method of heating	Electrically heated	Electrically heated
i)	Connected load	30 KW (Approx.)	30 KW (Approx.)
j)	Power receiving plug, switch & cable	To be provided	To be provided
k)	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
l)	Operating voltage	415V x 3-Ph. x 50 Hz. A-C. Supply	415V x 3-Ph. x 50 Hz. A-C. Supply
m)	Minimum Vulcanization accessories to be supplied.		
n)	Tool kit	One (1) set	One (1) set
o)	Measuring tool	One (1) set	One (1) set
p)	Belt Clamping device	Two (2) pair	Two (2) pair
q)	Roughing Machine	One(1) set	One(1) set
r)	Edge Bars	Two(2) pair	Two(2) pair
s)	Portable motorized Winch 5 tonne	One(1) no. to be furnished	One(1) no. to be furnished

	capacity complete with accessories		
M-22	Ventilation System		
[A.0]	Tunnel Ventilation System		
1.1	Ventilation system shall be provided for Underground area of all Emergency Reclaim Hopper Complex & tunnel for Reclaim conveyor #RC-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.		
1.2	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. Room with window, door etc. shall be provided for Fan/Filter units etc to house exhaust fan & supply air fans etc.		
1.3	Tunnel ventilation shall be complete with Supply 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	Technical Data		
a)	Type	Dry Fresh filtered air supply type	
b)	Designation no.	VS-1	
c)	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.	
d)	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)	
e)	Air Velocity shall not exceed	a) 10 m/sec through fan outlet and in ducting b) 3 m/sec through grills c) 1.8 m/sec through filter face	
f)	No. of air changes	15 air changes /hr (for supply) and 7 air changes / hr (for exhaust)	
g)	Fan	Centrifugal, Backward Curved Type.	
h)	Ducting	GI sheet ducting (IS:655 & IS:277)	
i)	Grills	Aluminium sheet construction with volume control dampers and double directional louvers. Spacing of grills: 5m (max.)	
[B.0]	Unitary Type Pressurized Ventilation System		
1.0	Unitary type pressure ventilation system shall have evaporative cooling system. The pressure ventilation system shall include air supply fan unit, air intake louver, air filtration unit water repellent nylon filters, water collecting trough, GI piping, water pump, moisture eliminators, GI ducting & grills, pressure relief dampers, electrical for		

	local control operation etc., foundation bolt nuts etc. for fixing. Rain protection canopy shall be provided suitably. All equipment shall be of reputed, proven & approved make	
2.0	Technical Data	
a)	Type	Unitary type pressure ventilation system with evaporative cooling
b)	Designation no.	MCC Room Area of Electrical Building # ER-1/ 2 &ERZ-1/2
c)	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.
d)	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)
e)	Air Velocity shall not exceed	2.5 m/sec in Air washer section 10 m/sec (through fan outlet and in ducting) 3 m/sec (through grills) 1.8 m/sec (filter face)
f)	No. of air changes	15 air changes /hr.
g)	Positive pressure to be maintained within the area	+ 3 mm WC
h)	Fan	Axial
i)	Water spray system	Evaporative pad type with saturation efficiency of 80%.
j)	Ducting	GI sheet ducting (IS:655 & IS:277)
k)	Grills	Aluminium sheet construction with volume control dampers and double directional louvers. Spacing of grills: 5m (max.)
M-23	Dust Suppression System [Dry Fog Type & Plain Water Type]	
A.0	Dry Fog Type Dust Suppression System.	
1.0	Dual fluid type [water& air] Dry Fog Dust Suppression System (DFDS) shall be provided for all transfer points in Crusher House (excluding Grizzly feeder # VGF-1A/1B/2A/2B, Crusher # CR—1A/1B/2A/2B & receipt point of belt feeder # BF-1A/1B) / Transfer /Junction Towers / Coal Bunkers etc. Each 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 DFDS system shall include following items & shall be complete in all respect.	
a)	Air compressor with accessories, 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.	
b)	Spray header assembly, dual fluid air atomized dry fog nozzles, pipes & fittings, hosepipe, bracket & clamps, flow activation cum regulating station 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.	
d)	Suitable nozzles/sprinklers in sufficient numbers shall be provided for dust suppression for dust control for coal heaps above reclaim hoppers.	
2.0	Technical Data	
a	Type of dust suppression system	Dry Fog
b	Location	At all transfer points in Crusher House(excluding Grizzly feeder # VGF-1A/1B/2A/2B, Crusher # CR—1A/1B/2A/2B & receipt point of belt feeder # BF-1A/1B) / all Transfer Tower / Junction Towers/Coal Bunkers of Unit-1 & 2
c	System Designation no.	i) DFDS-1A for CRH-1& TT-1/2/3 (Pump House # PMH-1A). ii) DFDS-1B for TT-4 / TT-5 / TT-6 / TT-7 / ERH-1 / Transfer points at bottom of all reclaim hoppers (Pump House#PMH-1B). iii) DFDS-1C for TT-8 / TT-9 / TT-10/ TT-11 / TT-12 / Coal Bunkers of Unit-1 & 2 (Pump House#PMH-1C). iv) DFDSB-1 for JTB-3/4 and TH-1 (Pump House # PMHZ-1)
d	Location Of Pump House	Refer Layout Plan of ICHP
e	Guaranteed Dust Level (Air Cleanliness)	Dust emission level shall not exceed 5mg / m^3 within 3m radius of DS application point or as per stipulations of Pollution Control Board whichever is lower.
f	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 100 microns. Common to 2Nos. (1W+1S) pumps.
g	Air Compressor	
i	Type	Rotary Screw type, air-cooled directly coupled to electric motor.
ii	Qty.	2 no. (1W+ 1S) for each Dry Fog D S 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.		
h	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.		
i	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 air line etc. fitted within a corrosion proof powder coated metallic enclosure.		
j	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.		
k	Necessary field Instrumentation	To be provided as per requirement.		
l	Water Tanks			
Sr. No.	Tank Desgn. no.	Min. Water Holding capacity, litre.	Pump House No.	Construction
i)	WTK-1A	Min. capacity to suit 1 hrs operation of DS system or 15000 lit. whichever is higher	PMH-1A	PVC water tank of Sintex / Equal Make, mounted on RCC pedestal, insulated water Tank, white. Tank shall be complete with all the fittings etc.
ii)	WTK-1B	Min. capacity to suit 1 hrs operation of DS system or 15000 lit. whichever is higher	PMH-1B	
	WTK-1C	Min. capacity to suit 1 hrs operation of DS system or 20000 lit. whichever is higher	PMH-1C	
iii)	WTK-1Z	Min. capacity to suit 1 hrs operation of DS system or 15000 lit. whichever is higher	PMHZ-1	
Note: Water Supply to tank # WTK-1Z from Power Plant Pump House				
B.0	Dry Fog Type Dust Suppression System for machine # SR-1A/1B/1C/1D			
1.0	Dual fluid type [water& air] Dry Fog Dust Suppression System (on board) shall be provided for all transfer points on Machine# SR-1A/1B/1C/1D. Each DFDS system shall be complete in all respects including water hose reel/quick release coupling/main water header [along machine long travel] etc applicable for travelling machines in addition to items specified above for DFDS system. Only one air compressor shall be provided together with one (1) Sintex / Equal approved water tank having water holding capacity of 10000 litres (Minimum).			
C.0	Plain Water Type Dust Suppression System.			
1.0	Suppression System (PWDS) shall be provided for Crushed Coal Stockpiles i.e. CCS-1/2/3 & CCS-1A/2A/3A.			
1.1	lling 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.	
1.2	Each PWDS system shall be complete with water supply tank (RCC) with pumps with drive motor, duplex strainer and, pipe work with valves & fittings 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 respective pump house. Monorail & chain pulley block of suitable capacity shall be provided at Pump House# PMH-2A/2B. Each PWDS system shall be complete in all respect including necessary electrical/Civil & Structural works.	
1.3	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.	
2.0	Technical Data	
a)	Type of dust suppression system	Plain water Spray on stockpile.
b)	System Designation # PWDS-1A	For Crushed Coal Stockpile # CCS-1/1A & CCS-2/2A (longitudinal side near Yard Belt Conv. # YBC-1A).
c)	System Designation # PWDS-1B	For Crushed Coal Stockpile # CCS-3/3A & CCS-2/2A (longitudinal side near Yard Belt Conv. # YBC-1B).
d)	Location of Pump House	Refer Layout Plan of ICHP.
e)	Location of PWDS storage tank	Tank # WTK-2A: Near Pump House # PMH-2A (for PWDS-1A). Tank#WTK-2B: Near Pump House # PMH-2B (for PWDS-1B).
f)	Capacity of Water Tank# WTK-2A/2B	Minimum 80 Cum. each. Construction: circular, RCC construction
g)	Centrifugal Water Pump	
i.	Qty	2 Nos. (1W + 1S) for each PWDS System.
ii.	Duty	Continuous Duty of 24 hr/day.
iii.	Pump RPM	1500 (Max.)
h)	Filter	Duplex filter with stainless steel filter element. Capable to remove suspended particles exceeding 100 microns.
i)	Sprinkler	
i.	Type	180° automatic swiveling type. Section headers with butterfly valves shall be used to group the sprinklers operating at a time so as to enable sectionalized spraying of water over selected areas of stockpile
ii.	Throw/Spacing	35 m (minimum), Spacing : Maximum 45m
iii.	Mounting arrangement	Mounted on post complete with pedestal, provided along the periphery of each stockpile.
iv.	Pressure	3-5 kg/cm^2
v.	Discharge Capacity	Min 250-300 lpm.

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
j)	Necessary field Instrumentation	To be provided as per requirement.
M-24	Air Conditioning Unit	
1.1	Room Air Conditioner Unit shall be complete with compressor, evaporator, condenser, blower fan, fan motor, filter, and controls etc. The unit shall be suitable for wall mounting with suitable frame; Compressor shall be of hermetically sealed type suitable for continuous service and mounted on vibration isolators. Blower fan shall be of centrifugal type. The condenser fan shall be of propeller type directly coupled to the electric motor. Cabinet shall be made of hot dipped galvanized steel, zinc phosphate treated, finished with baked enamel, and well insulated. Each unit shall be provided with suitable voltage stabilizer and a minimum 5 meters long power cable terminating on DP switch. The controls shall include fan speed selection, thermostat and fresh air louver etc.	
1.2	The condenser and the cooling coils shall be made of minimum 10 mm diameter copper tubes with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of airflow. Refrigerant piping shall be complete with capillary expansion tube, liquid line strainer, and dehydrator. The cooling coil shall be provided with a drain pan made of minimum 18 (g) galvanized sheet steel.	
1.3	The air filters shall be of dry air type. The filters medium shall be of fibrous material (e.g. coir, extruded section of polyethylene etc.) packed into a frame. The fibre shall be bonded together suitably to prevent fraying or loosening under normal operation. The velocity of air through the filters shall not exceed 1.75 m/sec.	
1.4	The Qty. of A.C. Unit (Split Type) shall be determined based on Room size / heat load etc. Necessary calculations shall be furnished for Approval.	
1.5	All A.C. Units shall be identical.	
2.0	Technical Data	
a)	Location	a) Control Room Area / Maintenance office at Building # ER-1/ERZ-1 /ERZ-2 b) Operator cabin in JTB-4/CRH-1/DH-1
b)	Qty	To suit
c)	Type	Split Type, Wall mounted
d)	Outdoor air temperature	Refer Project Data – Annexure I

e)	Indoor air temperature		24.5 deg. C dry bulb, Max. 60% R.H.
f)	Capacity of each unit		1.5 TR (Minimum)
g)	Air Handling Fan type		Centrifugal
h)	First fill of all refrigerant and other consumables		To be provided by Bidder
i)	Cooling thermostat range		18°C to 28°C
j)	Type of Compressor		Hermitically sealed type
k)	Make		Approved Make.
M-25	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	Propeller Type	
1.3	Location	- Battery Room [if applicable] located in Electrical Building # ER-1,ERZ-1/2 - All Pump House & all toilets. -Electric House located on board Machine #SR-1A / 1B / 1C / 1D	
1.4	Air changes / hr	20 (For Battery Room & All Toilets) 15 (For all Pump House & Electric House located on board Machine #SR-1A / 1B / 1C / 1D)	
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 upto 457 mm size can be of fabricated type. Impeller size greater than 457 mm shall be of cast aluminium construction. Louver shutter/wall cowl as applicable shall be made out of MS epoxy painted sheet steel/expanded metal 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.	
M-26	Passenger cum Good Lift (Elevator)		
1.0	Passenger cum Goods lift shall be provided for Crusher House #CRH-1, Transfer Tower Building #TT-8 (within Power Plant Boundary), & Junction Tower # JTB-4 (outside Power Plant Boundary). Lift shall be installed at location where least dust generation occurs & is subject to approval of TANGEDCO.		
2.0	Technical Data:		
a)	Type of Lift		Goods cum Passenger Lift
b)	Type of Drive System		VVVF
c)	No. of passengers		Bidder to indicate
d)	Payload Capacity		3000 kg

e)	Quantity required	Three (3)
f)	Travel speed, m/s	Minimum 0.7m/s upto 1.5m/s
g)	Total Travel	To suit
h)	No. of floor to be served	To suit
i)	Entrance	To suit
j)	Controller	Micro Computer Based.Simplex Collective Down.
k)	Motor Protection Class	IP-55
l)	Car operating panel	Micropush buttons in SS face plate. Floor position indicator
m)	Car enclosure	Powder coated
n)	Car Flooring	Steel Chequered plate, 5thk
o)	Car ceiling	Powder coated
p)	Car light	Fluorescent Light
q)	Car & landing doors	Powder coated
r)	Minimum floor size of cage	2100 x 3000mm
s)	Ventilation	To be provided
t)	Miscellaneous provisions	(i) Emergency light (ii) Emergency alarm (iii) Phase failure & Reversal protection (iv) Automatic landing call by pass on full load (v) Half length car operating panel (vi) Pre-announcing direction indicator with gong (vii) Automatic rescue device (viii) Fireman operation (ix) Position & Direction indicator on all floor. (x) Vision panel in Car & Landing doors (xi) Infra-red beam/ Infra-red screen door safety (xii) Overload device with indicator (xiii) Intercom in Car & Machine room (xiv) Digital temperature indicator in Car (xv) Digital clock in Car
M-27	Bull Dozer	
1.1	Four (4) 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.
1.2	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.
1.3	Each Machine shall be provided with matching large Coal Blade for stockpile management. Further one earth blade shall also be supplied for each machine.
1.4	Each dozer 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
M-28	Water System[Service water & Potable water]

[A.0]	Service water system(SW)	
1.0	Each Service water distribution system shall consist of: one (1) main SW water supply tank (PVC) with pumps with drive motor, duplex strainer and, pipe work with valves & fittings etc upto the various Overhead (SW) PVC water storage tank (above ICHP building) including pipe work with valves& fittings etc from OH tank upto the SW outlet/tap point complete with quick release coupling, hose pipe with nozzle & globe valve etc. Necessary electrical / civil & structural steel works for above SW distribution system shall be carried out to suit.	
1.1	Each SW water outlet /tap point in ICHP buildings shall be provided with one (1) no. 32 NB globe valve and quick release coupling and One (1) no. hose pipe(minimum 15m long) with nozzle. One(1) no tap point (SW) shall be provided for each floor including ground floor of all transfer towers/pump houses/electrical buildings and two(2) no tap point (SW) shall be provided for each floor including ground floor of crusher house building #CRH-1	
1.2	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. For pipe belt gallery no service water is required.	
1.3	On each ICHP building, one (1) no. Sintex/equal approved insulated PVC (SW) storage water tank, white, of minimum 2500 litres capacity shall be provided complete with piping work& fitting/valves etc. Necessary access ladder shall be provided for cleaning of tank.	
1.4	All pipes, valves & fittings etc shall be of M.S. (ERW) medium conforming to IS: 1239, Part I & II.	
1.5	Flow at each service water outlet /tap point : 5 m^3/hr Minimum discharge pressure : 2 kg/cm^2 No. of valves operated simultaneously : 3 no (for each service water system#SWS-1/2/3/4) RCC Pedestal : To be provided to support each Overhead (SW) Tank	
2.0	Technical Data	
a)	SW System Designation no. SWS-1 [Location of main SW supply tank#SWT-1: Near pump house #PMH-1A]	For building # ER-1/CRH-1/TT-1/TT-2/TT-3/pump house# PMH-1A [Note: For pump house#PMH-2A service water system including OH tank shall be arranged in this building itself using DS water supply tank/pump etc.]
b)	SW System Designation no. SWS-2 [Location of main SW supply tank#SWT-2: Near pump house #PMH-1B]	For building # ERH-1 / TT-4 / TT-5 / TT-6 / TT-7 / Pump House# PMH-1B. [Note: For pump house#PMH-2B,service water system including OH tank shall be arranged in this building itself using DS water supply tank/pump etc.]
c)	SW System Designation no. SWS-3 [Location of main SW supply tank#SWT-3: Near pump house #PMH-1C]	For building # ER-2 / TT-8 / TT-9 / TT-10 / TT-11 / TT-12 / pump house # PMH-1C
d)	SW System Designation no. SWS-4 [Location of main SW supply tank#SWT-4:	For building # ERZ-1/2 / TH-1 / JTB-3/4 / pump house # PMHZ-1

	Near pump house #PMHZ-1]		
e)	Centrifugal Water Pump		
i.	Qty		2 Nos. (1W+1S).
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. Common to 2 Nos. (1W+1S) pumps.
Sr. No.	SW Tank Designation no.	Min. Water Holding capacity, litre.	Construction
i)	SWT-1	20000	PVC (Sintex / Equal) water tank shall be complete with inlet, outlet, overflow, drain and necessary instrument / switches / valve / level indicator / manhole / access ladder etc., Mounted on RCC Pedestal.
ii)	SWT-2	20000	
iii)	SWT-3	20000	
iv)	SWT-4	20000	
Note: For service water storage tank # SWT-4 water will be fed from Power Plant pump house			
[B.0]	Potable water system(PW)		
1.0	Each Potable water distribution system shall consist of: one (1) main PW water supply tank (Sintex/equal approved make) with pumps with drive motor, duplex strainer and, pipe work with valves & fittings etc upto the various Overhead (PW) water storage tank (above CHP building) including pipe work with valves& fittings etc from OH tank upto the PW outlet/tap point Necessary electrical / civil & structural steel works for above PW distribution system shall be carried out to suit.		
1.1	One (1) no. PVC Sintex / equal approved insulated PW water tank (Main supply), white of minimum 2500 litres capacity complete with piping work& fitting/valves etc. shall be provided for pump house # PMH-1A / 1B / 1C & PMHZ-1. Tank shall be complete with inlet, outlet, overflow, drain & necessary instrument / switches / valve / level indicator / manhole / access ladder etc & mounted on RCC Pedestal.		
1.2	One (1) no. Sintex / equal approved insulated PW water tank, white of minimum 500 litres capacity 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.		
1.3	All pipes & fittings shall be of ERW carbon steel, galvanised pipe conforming to relevant Indian standard.		
1.4	Each potable water outlet/tap point complete with suitable filter and one RO water purifier unit shall be provided at Buildings given below.		
2.0	Technical Data		
a)	PW System Designation no. PWS-1 [Location of main PW supply tank#PWT-1:In pump house #PMH-1A]	For building # ER-1/CRH-1/pump house# PMH-1A/2A	

b)	PW System Designation no. PWS-2 [Location of main PW supply tank#PWT-2:In pump house #PMH-1B]	For building # TT-5 / pump house # PMH-1B / 2B
c)	PW System Designation no. PWS-3 [Location of main PW supply tank#PWT-3:In pump house #PMH-1C]	For building # ER-2 / DH-1 / TT-10 / TT-12 / pump house # PMH-1C
d)	PW System Designation no. PWS-4 [Location of main PW supply tank#PWT-4:In pump house #PMHZ-1]	For building # ERZ-1/2 / JTB-4 / pump house # PMHZ-1
e)	Centrifugal Water Pump	
i.	Qty	2 Nos. (1W+1S).
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 10 microns. Common to 2 Nos. (1W+1S) pumps.
f)	Location of PW storage tank (Overhead PW Storage Tank shall rest on RCC Pedestral)	On building # ER-1/CRH-1/pump house# PMH-1A/2A On building # TT-5 / pump house# PMH-1B/2B On building # ER-2 / DH-1 / TT-10 / TT-12 / pump house# PMH-1C On Building # ERZ-1/2 / JTB-4 / pump house # PMHZ-1
g)	Location/qty of PW tap point	
i.	Building # ER-1	Minimum two (2) no at 1st floor
ii.	Building # ER-2	Minimum two (2) no
iii.	Building # PMH-1A/1B/1C/2A/2B & PMHZ-1	Minimum one (1) no for each building
iv.	Crusher house # CRH-1	Minimum one (1) no
v.	Transfer tower#TT-5 / DH-1 / TT-10 / TT-12	Minimum one (1) no for each building
vi.	ERZ-1/2	Minimum two (2) no at 1st floor
vii.	Junction Tower # JTB-4	Minimum one (1) no
Note: Portable Water to 2500 litre P.W. storage Tank (Pump House # PMHZ-1) shall be supplied from Power Plant pump house		
M-29	Dust Extraction System	
1.1	Dry type Dust Extraction (DE) System shall be provided for Crusher House # CRH-1. 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).
1.2	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.
1.3	All material / items required for system completion are to supplied and installed by the vendor.
1.4	All equipments and components shall be designed & selected considering ambient temperature of 45deg. C (max).
1.5	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 Polyester 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 120 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.
1.6	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)	The stack shall be made out of minimum 3.15mm thk MS plate and shall be provided with clean out door at bottom.
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)
1.7	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 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 DESEIN/RRVUNL	
1.8	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	
1.9	Datasheet: Dust Extraction System	
a)	Type	Dry Type having Pulse Air Jet Type bag Filter Unit, having "ONLINE" cleaning arrangement.
b)	Designation No.	DE-1A [for stream A] and DE-1B [for stream B]
		Each DE system shall be independent. However a common compressor shall be provided to cater to DE-1A/DE-1B
c)	Location / Qty.	For Crusher House # CRH-1 / Lot
d)	Equipment operation	a) Either Eqpt. # VGF-1A / CR-1A shall operate or Eqpt. # VGF-2A / CR-2A shall operate b) Either Eqpt. # VGF-1B / CR-1B shall operate or Eqpt. # VGF-2B / CR-2B shall operate
e)	Location of D.E Point	a) On hood of Grizzly feeder b) On Discharge chute from Grizzly feeder to Crusher c) Receipt points (skirt) of Conveyor below Crusher. [One D.E. point shall be provided for each loading point of above conveyor]
f)	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
g)	Dust Content in clean air exhaust	Less than 50 mg/cum or as per stipulation of Pollution Control Board whichever is less.
14.13	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 ICHP. 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
62	Any other special tools & tackles, if required [for equipment/ machinery under Scope Of Supply of ICHP contractor] shall also by supplied by ICHP contractor.	Lot

Table # 1 : Conveyor Data Sheet (Inside Power Plant Boundary)

Sr. No.	Conv. No.	BF-1A/1B	BF-1C/1D	RBF-1A/1B (Reversible)	BC-1A/1B	BC-4A/4B	YBC-1A/1B	BC-2A/2B	TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D	RC-1	BC-3A/3B	BC-5A/5B
1.0	Qty,no.	2	2	2	2	2	2	2	8	1	2	2
2.0	Material Handled	Crushed Coal	Uncrushed Coal	Uncrushed Coal	Crushed Coal	Crushed Coal	Crushed Coal	Crushed Coal	Crushed Coal	Crushed Coal	Crushed Coal	Crushed Coal
3.0	Max. Lump size,mm	(-)20	(-)100	(-)100	(-) 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
5.0	Surcharge Angle,degree	20	20	20	20	20	20	20	20	20	20	20
6.0	Guaranteed Capacity,tph.	2000	2000	2000	2000	2300	2300	2000	2300	1000	2300	2300
7.0	Belt Width, mm	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
8.0	Troughing angle,degree	3-equal roll x 35° tr.										
9.0	Troughing angle, return side	2-equal roll x 0° tr.			2-equal roll x 10° tr.							
10.0	Belt Speed(approx.),m/s	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
11.0	Length / Lift,m	Refer Drawings										
12.0	Type of Take-up.	GTU	GTU	Screw	GTU	GTU	GTU	GTU	GTU	GTU	GTU	GTU
13.0	T.U.travel,m (Minimum)	a) For Gravity Take Up:- 1.5 % of C/C Pulley (mm)+ 600mm for EP Belts & 0.5 % of pulley CRS,mm for Steel Chord Belts b) For Screw Take Up:- 500mm with SS-304 screw										
14.0	Type of Drive / Location	Single snub drive at Head cum Discharge end		Single snub drive at one of the Discharge ends	◄----------Single snub drive at Head cum Discharge end ----------►						Dual Drive at Drive House # DH-1	Single snub drive at Head cum Discharge

Sr. No.	Conv. No.	BF-1A/1B	BF-1C/1D	RBF-1A/1B (Reversible)	BC-1A/1B	BC-4A/4B	YBC-1A/1B	BC-2A/2B	TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D	RC-1	BC-3A/3B	BC-5A/5B
												end
15.0	Remarks	a) Complete Drive unit including drive drum shall be identical. Highest kw shall be considered for this purpose. b) Belting shall be identical whichever is of higest rating. c) Non drive pulley of one conveyor shall be identical with corresponding non drive pulley of other conveyors.			a) Complete Drive unit including drive drum shall be identical. Highest kw shall be considered for this purpose. b) Belting shall be identical whichever is of higest rating. c) Non dive pulley of one conveyor shall be identical with corresponding non drive pulley of other conveyors.		a) Belting shall be identical whichever is of higest rating. b) Non dive pulley of one conveyor shall be identical with corresponding non drive pulley of other conveyors.		a) Complete Drive unit including drive drum shall be identical. Highest kw shall be considered for this purpose. b) Belting shall be identical whichever is of higest rating. c) Non drive pulley of one conveyor shall be identical with corresponding non drive pulley of other conveyors.		----------	----------
16.0	Motor speed, RPM	1500 RPM (Syn.)										
17.0	Belting.											
17.1	Type	Heavy Duty,EP (Polyester Nylon) with cut edge construction having FR grade, Minimum 4-ply, Belting conform to IS:1891 (for all conv. except Conv. #YBC-1A/1B & Conv. # BC-2A/2B/3A/3B) and Heavy Duty Steel Cord belting having F.R. Grade for Conv. #YBC-1A/1B & Conv. # BC-2A/2B/3A/3B										
17.2	Operating Tension,kN/m (T_1) [EP] & FOS [Steel Cord]	Not to exceed 80% of Recommended Max Belt working tension for EP Belt & Factor of safety shall be minimum six (6) for steel cord belt for belt selection										
17.3	Min.Cover thk,mm (Top x Bottom)	8 x 3			6 x 3		6 x 4		6 x 3		6 x 4	6 x 3
18.0	Pulleys											

Sr. No.	Conv. No.	BF-1A/1B	BF-1C/1D	RBF-1A/1B (Reversible)	BC-1A/1B	BC-4A/4B	YBC-1A/1B	BC-2A/2B	TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D	RC-1	BC-3A/3B	BC-5A/5B
18.1	Type of construction x Face Width of Pulley	Welded steel construction, Face Width: 2000mm (Minimum) for all pulleys.										
18.2	Minimum Drive pulley Dia.,mm	630	630	630	800	800	630	630	630	630	800	630
18.3	Non drive pulley Dia. excluding tripper pulleys, mm (Minimum)	500	500	500	630	630	500	500	500	500	630	500
18.4	Dia. of Tripper Head & Bend Pulley (carrying side), mm (Minimum)	N/A	N/A	N/A	800	800	630	N/A	630	N/A	N/A	630
18.5	Dia. of Tripper Bend Pulley (return side), mm (Minimum)	N/A	N/A	N/A	630	630	N/A	N/A	N/A	N/A	N/A	500
18.6	Snub pulley dia., mm (Minimum)	400	400	400	500	500	400	400	400	400	500	400
18.7	Bearing centres,mm (minimum)	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550
19.0	Troughing & Self aligning troughing idler											
19.1	No. of Rolls	3 Equal rolls x 35 degree troughing										
19.2	Roll dia[OD],mm	Provide Impact Idlers @ 500mm spacing for full length including suitable Transition Type Impact idlers			159	159	159	159	159	159	159	159
19.3	Shell thk,mm[nominal]				5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
19.4	Type& size of bearings	35Φ Deep Grooved Ball Bearing with C-3 Clearance										
19.5	Self Aligning Tr. Idler	Necessary Self Aligning arrangement Swiveling type shall be provided										

Sr. No.	Conv. No.	BF-1A/1B	BF-1C/1D	RBF-1A/1B (Reversible)	BC-1A/1B	BC-4A/4B	YBC-1A/1B	BC-2A/2B	TBC-1A/1B/1C/1D & TBC-2A/2B/2C/2D	RC-1	BC-3A/3B	BC-5A/5B
20.0	Return Idlers & Self aligning return idler											
20.1	No. of Rolls	2 Equal roll x 0° tr.			2 Equal roll V-type x 10° tr.							
20.2	Roll dia[OD],mm	159	159	159	159	159	159	159	159	159	159	159
20.3	Shell thk,mm[nominal]	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
20.4	Type& size of bearings	35Φ Deep Grooved Ball Bearing with C-3 Clearance										
20.5	Self Aligning return Idler	Necessary Self Aligning arrangement Swiveling type shall be provided										
21.0	Transition Idler	These shall be identical in construction to Troughing Idler except for troughing angle, Tr. Angle range : 10-35 Deg. Qty to suit										
22.0	Rubber Disc Type Impact Idlers											
22.1	Roll Dia with Rubber Discs on, mm	190	190	190	190	190	190	190	190	190	190	190
22.2	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
22.3	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
22.4	Type& size of bearings	35Φ Deep Grooved Ball Bearing with C-3 Clearance										
22.5	MOC rubber	Resilient Rubber ring										
23.0	Brakes	N/A	N/A	N/A	Brake shall be provided as specified							
23.1	Type	N/A	N/A	N/A	Thrustor, operated hydraulic brake							
23.2	Rating	N/A	N/A	N/A	As per Design requirement							
23.3	Thrustor Protection	N/A	N/A	N/A	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.												

Table # 2: Conveyor Data Sheet (Outside Power Plant Boundary)

Sr. No.	Conv. No.	BCZ-1A/1B	SFC-1A/1B	BFB-1A/1B (Weigh Belt feeder)
1.0	Qty,no.	2	2	2
2.0	Material Handled	Coal	Coal	Coal
3.0	Max. Lump size,mm (Nominal)	100	100	100
4.0	Bulk Density,t/cum	0.8	0.8	0.8
5.0	Surcharge Angle,degree	20	20	20
6.0	Guaranteed Capacity,tph.	4000	2000	Variable cap. : 1000 tph to 2000 tph
7.0	Belt Width, mm	2000	2000	2200
8.0	Troughing angle,degree	3-equal roll x 35° tr.		3-Roll x 10° tr. X Long Central Roll
9.0	Troughing angle, return side	2-equal roll x 15° tr.		2-equal roll x 0° tr.
10.0	Belt Speed(approx.),m/s	3.5	3.5	To suit variable capacity rerquirements
11.0	Length / Lift,m	Refer Drawings		
12.0	Type of Take-up.	GTU	GTU	Screw
13.0	T.U.travel,m (Minimum)	For Gravity Take Up:- 0.5 % of pulley CRS,mm for Steel Chord Belts & For Screw Take Up:- 500mm with SS-304 screw		
14.0	Type of Drive / Location	Dual drive near head cum Discharge end	Single snub drive at Head cum Discharge end	Single snub drive at Head cum Discharge end
15.0	Motor speed, RPM	1500 RPM (Syn.)		To suit
16.0	Belting.			
16.1	Type	Heavy Duty Steel Cord belting having F.R. Grade Cover (for all conveyors except Belt Feeder #BFB-1A/1B), & HD,EP (Polyester Nylon) with cut edge construction having FR grade cover, Mini. 4-ply, for Belt Feeder # BFB-1A/1B , Belting conform to IS:1891		

Sr. No.	Conv. No.	BCZ-1A/1B	SFC-1A/1B	BFB-1A/1B (Weigh Belt feeder)
16.2	Operating Tension,FOS / kN/m (T_1)	Factor of safety shall be minimum six (6) for steel cord belt selection & For EP Belt Max. operating tension shall not exceed 80% of Recommended Max Belt working Tension.		
16.3	Min.Cover thk,mm (Top x Bottom)	6 x 4	6 x 4	8 x 3
16.4	Belt Rating	Belting shall be identical for above conveyors whichever is of highest rating		------
17.0	Pulleys			
17.1	Type of construction	Welded steel construction		
17.2	Face width,mm	2250	2250	2400
17.3	Drive pulley	◄----------Drum of above conveyors shall be identical in all respects----------►		------
17.4	Non drive pulley	◄----------Drum of above conveyors shall be identical in all respects----------►		------
17.5	Snub pulley drum	◄----------Drum of above conveyors shall be identical in all respects----------►		------
17.6	Bearing centres,mm (minimum)	2800	2800	2900
18.0	Troughing & Self aligning troughing idler			
18.1	No. of Rolls	3-equal roll x 35° tr.		3-Roll x 10° tr. X Long Central Roll
18.2	Roll dia[OD],mm.....minimum	159	159	159
18.3	Shell thk,mm[nominal]	5.4	5.4	5.4
18.4	Type & size of bearings			
18.5	Self Aligning Tr. Idler	Necessary Self Aligning arrangement Swiveling type shall be provided		Guide roll in pair shall be provided
19.0	Return Idlers & Self aligning return idler			
19.1	No. of Rolls	2-equal roll x 15° tr.		2 Equal roll Flat-type x 0° tr.
19.2	Roll dia[OD],mm.....minimum	159	159	159
19.3	Shell thk,mm[nominal]	5.4	5.4	5.4

Sr. No.	Conv. No.	BCZ-1A/1B	SFC-1A/1B	BFB-1A/1B (Weigh Belt feeder)
19.4	Type& size of bearings	35Φ Deep Grooved Ball Bearing with C-3 Clearance		
19.5	Self Aligning return Idler	Necessary Self Aligning arrangement Swiveling type shall be provided		----------
20.0	Transition Idler	These shall be identical in construction to Troughing Idler except for troughing angle, Tr. Angle range : 10-35 Deg. Qty to suit		
21.0	Rubber Disc Type Impact Idlers			
21.1	Roll Dia with Rubber Discs on,mm	190	190	190
21.2	Shell Outer Dia, mm[OD steel]	139.7	139.7	139.7
21.3	Shell thk,mm[nominal]	6.3	6.3	6.3
21.4	Type & size of bearings	35Φ Deep Grooved Ball Bearing with C-3 Clearance		
21.5	MOC rubber	Resilient Rubber ring		
22.0	Brakes	Brake shall be provided as specified		N/A
22.1	Type	Thrustor, operated hydraulic brake		N/A
22.2	Rating	As per Design requirement		N/A
22.3	Thrustor Protection	Class-B Insulation, IP-55		N/A

Note.1 : -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.

Note.2 : - Belt feeder # BFB-1A/1B shall have following Technical features:

a) It shall operate satisfactorily in conjunction with Surge Bin# SBB-1/Conv. SFC 1A/1B. Also Normal Troughing idlers / Impact idler to suit shall be provided

b) Belt Feeder shall be of Weigh Belt type

c) Drive motor shall be provided with VVVF control unit.

d) Necessary shear load of Coal column above feeder shalll be considered in belt kW

e) Motor powerr(kW rating) shall be selected considering minimum 35% extra margin on power consumed at motor shaft.

Sr. No.	Conv. No.	BCZ-1A/1B	SFC-1A/1B	BFB-1A/1B (Weigh Belt feeder)
	f) Weighing mechanism/speed control system shall be provided to suit system requirement. g) Capacity : variable (1000 tph - 2000 tph) h) Accuracy : ± 0.5 % over full weighing range i) All the necessary Electrical /Control/ devices, Microprocessor based shall be provided to suit.			

CHAPTER 15

15.0 FUEL OIL HANDLING SYSTEM

15.1 SCOPE

The scope covers the design, engineering, manufacture, supply, assembly and testing at manufacturer's works, inspection, packing, forwarding, delivery FOR site and handling with storage at site (i.e. taking delivery of materials from carriers, transportation to site), fabrication (as needed), erection, trial run, testing and commissioning including painting protection of fuel oil handling system covering oil storage tanks with unloading pump sets and associated oil, water and air pipe work materials, electricals & control instrumentation as well as civil works as needed for the plant facilities complete in all respects within the boundary limits.

The statutory approval for fuel oil unloading, transfer and storage system from Chief Controller of Explosives shall be obtained by the bidder. It shall be a part of scope of this specification along with any fees/ inspection charges and Bidder shall be responsible for obtaining the necessary approval. Owner shall furnish the required assistance for filing application/ documents.

15.2 SYSTEM DESCRIPTION

a) The fuel oil will be transported to the plant site by road tankers; and unloading pumps shall be used for unloading of oil and storing it in tanks. Before unloading the heavy fuel oil, it shall be heated by electric heaters in the road tankers as considered necessary to make it flowable. Fuel oil decanting pumphouse is also included in scope of bidder.

b) The heavy fuel oil shall be heated in the storage tanks to maintain a suitable temperature by supplying steam through floor coil heaters. The steam shall be provided from auxiliary Boiler. Heavy fuel oil tanks shall also be provided with suction heaters with steam as the heating source to heat the oil before sending it to pressuring units.

c) There shall be pipe nozzle provisions on the storage tanks in regard to heavy fuel oil recirculation from the boiler front. An adequately sized non-return valve shall be provided in each line connecting the fuel oil unloading headers and unloading pump suction header.

d) The heavy fuel oil will be pumped from the storage tanks to boilers front by pressuring units. The heavy fuel oil return from pressurizing units and burner headers will be brought back to respective storage tanks. Similarly, the light diesel oil will be pumped from HSD storage tank to boiler; and to hot gas generator by pressurizing units.

e) An oil water separator (to separate oil to the extent of max. 10 ppm oil left in the water) shall be provided close to the dyke area and unloading oil headers area to receive oil from the drain trenches, dyke area and unloading area. Oil from the oil water separator shall be returned back to the heavy fuel oil tanks by the help of two (2) 100 percent capacity oil recovery pumps. The water after suitable treatment shall be discharged to the surface drain.

f) All the heavy fuel oil lines, oil pumps and strainers shall be electric traced.

g) One (1) – 150 NB (min.) heavy fuel oil unloading manifold complete with eight (8) stand pipes with flexible hoses of 8 M length [each provided with universal type couplings, isolation valves and matching pieces as required for connecting to road tankers isolation valves and caps as required for connecting to road tankers. Tapping points on the oil header shall be suitably located.

h) Heavy fuel oil road tankers shall be fitted with electric heating coils so that oil may be heated to reduce its viscosity. When the oil temperature in tanker rises to about 50°C, oil shall be drained to the oil-unloading header. When the oil unloading header and the piping at the unloading pump suction is filled up with oil and steady oil supply is ensured, the unloading pumps shall be started.

i) One (1) 150 NB HSD unloading manifold completed with eight (8) stand pipes with flexible hoses of 8 M length each shall be provided with universal type couplings and matching pieces as required for connecting to road tankers. Tapping points on the oil header shall be suitably located.

15.3 REQUIRED EQUIPMENT AND SERVICES

The fuel oil handling system facilities to be supplied and furnished with all accessories and services under this specification shall include but be not limited to the following:

15.3.1 Oil Unloading Pump sets

15.3.1.1 a) Three (3) - 100 cum per hour capacity (2W+1S), 4 kg/cm2(g) discharge pressure, direct AC driven horizontal twin screw type heavy fuel oil unloading pump sets complete with AC electric motor drives and all other accessories as necessary. The pumps shall be electrically traced.

b) Two (2) – 50 cum per hour capacity (1W+1S), 4 kg/cm2(g) discharge pressure, direct AC driven horizontal twin screw type HSD unloading pump sets complete with drive motor with accessories for unloading road tankers.

c) Simplex type strainers (one for each pump) each having a capacity equal to that of the pump with isolating valves, drain valves, vent valves with goose neck piping and other accessories.

15.3.1.2 Common base frame skid for the pump sets, strainers and valves etc drain rim type with drip tray arrangement; and valved outlet connection, foundation bolts & nuts etc. Anchor bolts, sleeves, inserts, sole plates, lifting lugs, eye-bolts etc shall be supplied.

15.3.1.3 Bidder shall offer all parts, components etc which are necessary for efficient economic and safe operation of the pump sets skid irrespective of whether specifically mentioned herein or not.

15.3.2 Tanks & other equipment

a) Two (2) – 3000 KL capacity vertical cylindrical heavy fuel oil storage tanks with accessories located in the oil tank dyke area. The HFO tanks shall be insulated.

b) One (1) – 1000 KL capacity vertical cylindrical High Speed Diesel oil storage tank with accessories located in the oil tank dyke area.

c) The heavy fuel oil storage tanks shall be complete with floor coil heaters and fuel oil suction heaters and other accessories as necessary.

d) One (1) oil water separator along with pumps as mentioned in this specification for the fuel oil unloading and storage area shall be provided with all needed accessories.

e) One (1) drain oil tank of 10 M^3 cap with 2 x 100% capacity pumpsets.

f) One (1) condensate tank of suitable capacity for main tank area.

g) Two (2) nos. drain oil pumps, each of capacity 5 M3/hr

h) Two (2) nos water pumps, each of capacity 30 M3/hr.

i) Two (2) Nos. sump pump set, each of capacity 30 M3/hr complete with all accessories of drive and mounting in FO Unloading pump house.

j) One (1) nos. pressure reducing and de-superheating station for reducing steam pressure to 4 kg/cm2.

15.3.2.1 Float type level indicators complete with accessories for each tank. All tanks should be calibrated and level indicator with scale shall be provided.

15.3.2.2 Adequately sized steel spiral staircases complete with grated stair treads, hand railing, etc for storage tanks for each tank.

15.3.2.3 Lot - Oil, water, and air pipe work materials including oil unloading heaters, pipe nozzles, stand pipes, fittings, flanges [including blind flanges as needed], bolts, nuts and gaskets for installation on tanks. This includes oil lines, valves, specialties, panels, accessories, thermal insulation materials etc as needed for satisfactory installation pipe work, valves etc.

15.3.2.4 Preparation of detailed fabrication & arrangement drawings.

15.3.2.5 The dead storage in the HSD storage tank should not exceed 30 KL.

15.3.2.6 The dead storage in the HFO storage tank should not exceed 100 KL.

15.3.2.7 Spare nozzles for suction and recirculation shall be provided in each HFO/ HSD tank for future use.

15.3.2.8 Lot - Pipe work materials, valves, specialties, motor operators, hangers & supports etc for -

- Connecting oil unloading headers upto oil pump sets; pumps discharge to oil tanks etc.

- Potable/ service water pipework to overhead rectangular tank and further distribution thereof.

- Providing adequately sized pipe nozzle connections on tanks for foam fire protection system.

- Service/instrument air pipe work inside the pump house and dyke area.

15.3.2.9 Heavy oil pipework, pumpsets, valves, strainers and storage tanks shall be provided with thermal insulation to prevent heat loss and safety of personnel. Thermal insulation shall be designed such that the skin temperature shall not more than 60^{o}C under all conditions.

15.3.2.10 The waste oil/drain oil collected from various points such as unloading points, drains, strainers, tank form area etc. shall be led to waste oil tank for further transferring to ETP.

15.4 EQUIPMENT DESCRIPTION

15.4.1 Pump Sets

15.4.1.1 The fuel oil pumps shall be rotary positive displacement self-priming horizontal type, twin screw with mechanical seals. The pumps shall be direct AC motor driven through flexible coupling without any gear box.

15.4.1.2 The pump construction shall incorporate two (2) inter-meshing screws ensuring pulsation free continuous axial flow; having their thread surfaces forming a tight seal to each other as well as the surrounding stator. When the screws rotate, the seals move axially forcing the liquid between them to move forward for smooth uniform pulsation free flow.

15.4.1.3 Suction and discharge connections shall be flanged raised faced and drilled to ASA standards or approved equal.

15.4.1.4 Heavy fuel oil pumps shall have stable head capacity characteristics continuously rising towards shut-off with the highest head at shut-off.

15.4.1.5 Approved type flexible couplings shall be provided for connecting the pumps with the driving motor. A common base plate with drain pan of drain rim type for pump & motor shall be in one piece in fabricated steel construction.

15.4.1.6 The pumpsets shall be electrically traced along with the associated suction and discharge pipework, valves and specialities to avoid solidification of oil and maintain continuous flow of fuel oil.

15.4.1.7 **Pumpset Motors**

Each pump shall be driven by direct coupled horizontal, 415 Volts, 3-phase, 50 hertz, AC squirrel cage, single speed, totally enclosed Explosion/Flame proof fan cooled construction induction motor to IS: 2148. The nameplate KW rating of the pump motor including service factor shall be at least 115 percent of the motor power

required to drive the pump at the duty operating point, or the maximum power consumed on the characteristic curve, whichever is higher.

15.4.1.8 **Accessories**

All accessories required for smooth and safe operation shall be provided along with pumpsets. Approved make pressure gauges shall be furnished having 150 mm dial with black figures on white dial or range 0 to 5 kg/cm^2(g); graduations 0.5 kg/cm^2; and inter-graduation 0.05 kg/cm^2(g), complete with isolating valves, piping and fittings as required. Approved make vacuum/pressure gauges on the pump suction side shall be provided similar to those on the discharge side having suitable range.

15.4.2 **Vertical Storage Tanks**

15.4.2.1 The vertical cylindrical oil storage non-pressure tanks shall be of mild steel to IS: 2062 Gr.B or approved equal welded construction designed, fabricated and installed in accordance with IS: 803. The tanks shall have sloping bottom 1 in 100 towards an adequately sized sump inside the tank to enable complete draining of the contents. Sufficient number of plugged holes shall be provided in the bottom plate of the tanks for bottom testing as per IS: 803.

Conical roof with a slope of not less than 1 in 16 to ensure drainage of rain water shall be provided supported over the tank wall periphery; and the tank shall have single central column. The roof shall be designed for a live load of 250 kg/m^2. Needed roof rafters and purlins shall be provided adequately designed.

15.4.2.2 All shell course plates shall be accurately bent at required radius. Care shall be taken during bending to prevent plate skewing. For butt-weld joints, edges shall be prepared which shall be uniform and smooth throughout.

Each shell course shall be of uniform height throughout longitudinal weld in any plate. Makeup for the course width shall not be permitted. Shell plates in each course width shall be so arranged that all vertical joints are staggered having a minimum of 600 mm stagger.

15.4.3 **Floor Coil Heater**

15.4.3.1 Each heavy fuel oil tank shall be provided with floor coil heater in one or more tiers at the bottom of the heavy fuel oil storage tanks to maintain oil within the tank at specified temperature with electricity as the heating medium. The tubes shall be seamless steel to A106 Gr. B supporting the coil within the tank bottom.

15.4.3.2 The floor heater shall be installed inside the tank such that oil is uniformly heated without possibility of local overheating and over-straining the tank body. All connection flanges shall be outside the tank. The coils shall be guaranteed to be submerged under sufficient level of oil to avoid flashing of oil.

15.4.4 **Fuel Oil Suction Heater**

15.4.4.1 The heavy fuel oil suction heater as per the duty conditions indicated below shall be furnished on the outlet of each fuel oil storage tank :

i) Type : Shell and U-tube type (to supply oil at pump suction)

ii)	Heating media	:	Electric
iii)	Initial temp of oil	:	50°C
iv)	Final temp of oil	:	70°C
v)	Oil temperature rise	:	20°C
vi)	Materials:		
	- Shell; shell head; and tube sheet	:	Steel IS:2002 Gr. 2A
	- Tubes & nozzles	:	Seamless carbon steel to A106 Gr.B

15.4.4.2 The heater shall be designed as per applicable code. The heater shall be mounted on the side wall of the tank and properly supported. The heater shall have oil in the shell side and steam tracing in the tube side.

15.4.4.3 The bidder shall furnish the design calculations for

- arriving at electric tracing consumption, coil heat transfer area;
- maximum time required (72 hrs) to liquify the stored oil and bring it to the storing temperature under the extreme condition when the heating coil is turned on after prolonged shutdown with material stored in the tank, at the lowest ambient temperature.

15.4.5 **Tank Accessories**

Accessories for the tanks shall be furnished as necessary. All spare/unused flanged connections and manholes shall be provided with matching blind flanges, gaskets, bolts and nuts.

15.4.6 **Flame arrestor**: Each vent connection on oil tanks (HFO/HSD) shall be provided with a flame arrestor, design of which shall meet the approval of the Inspector of Explosives.

15.4.7 **Conservation vent valve**: Where continuous venting to atmosphere directly is not permitted for the stored fuel oil, a conservation vent valve or a breather of approved make and design shall be provided.

15.4.8 **Level Indicators & Level Switches**

The oil storage tanks shall be provided with flame proof float type level indicators & switches. The float type level indicators shall comprise of stainless steel enclosed float filled with approved light weight materials.

The flexible stainless steel wire attached to the float at one end and to the cast iron target at the other end shall freely roll on the bakelite pulley housed in a cast iron housing provided with bolted covers, as shown on the drawing.

The guide wire spring assembly shall be furnished complete with compression springs, pipe nipples and caps to provide required tension in the stainless steel wire connected to the float.

15.4.9 **Electricals and Control Instrumentation**

15.4.9.1 One (1) - Motor control centre/ switchgear; one lot of motor starters & push button stations for unloading pump sets with spare feeders including accessories for the heavy fuel oil pipework.

15.4.9.2 Power & control cabling with accessories for satisfactory installation of the facilities including needed interlocking facilities etc. All electrical equipments and instrumentation works including cables, cable laying, jointing, making connections from equipment to panels shall be furnished by the bidder. All the cables used shall be of FRLS type.

a) One (1) local control panel housing switches, annunciation, alarms, remote indicators etc as specified for the offered fuel oil handling facilities for control, operation and annunciation purpose of the offered plant shall be furnished. All control valves on electric and oil lines as considered necessary for safe and satisfactory operation of the system.

b) Lot - Local indicators such as pressure and temperature gauges, flow measuring indicators etc; level controlling equipment including level switches, level transmitters and other needed accessories not only for local control & indication but also for remote control operation & indication in the main plant control room [for hooking up with main plant DCS] and oil pump house control room.

c) All equipments shall be flame proof

15.4.9.3 Lightning protection; earthing; cathodic protection (as required); illumination of oil unloading pump house oil forwarding pumphouse & oil tank farm area; cable trays, conduits etc for satisfactory installation of the electrical system for the offered plant.

15.4.10 **Construction materials: Pipes, Valves & Hoses**

		Fuel Oil	**Steam/ Condensate**
15.4.10.1	Pipes - 65 mm NB & larger	API-5L Gr.B or A106 Gr.B BW ends ANSI B16.25	A106 Gr.B BW ends ANSI-B-16.25
	- 50 mm NB & below	A106 Gr.B Socket weld ends ANSI-B-16.11	-do-
15.4.10.2	Pipe fittings: - 65 mm NB & larger	A-234 or WPB BW ends ANSI-B-16.25	A-234 or WPB BW ends ANSI-B-16.25
	- 50 mm NB & below	A105 socket weld ends ANSI-B16.11	A105 socket weld ends ANSI-B16.11
15.4.10.3	Gate Valves	**←Fuel Oil/Steam/Condensate-→**	
		50 mm NB & large	Below 50 mm NB
	- Code	API-600	API-602
	- Body & bonnet	A-216 Gr. WCB	A 181 Gr. II

		Fuel Oil	**Steam/ Condensate**
	- Seat/trim	← 11 to 13% chrome steel -----→	
	- Bolts for bonnet	←---------- A 193 Gr. B7 ----------→	
	- Nuts for bonnet	←---------- A 194 Gr. 2H ----------→	
15.4.10.4	Globe valve		
	- Code	←----- BS-1873 ----------→	
	- Body & bonnet	A216 Gr. WCB	A 181 Gr.II
	- Trim	Chrome steel (Brinnel hardness B-250 min) as per AISI-431	
	- Bolts for bonnet	←----A 193 Gr. B7 ----------→	
	- Nuts for bonnet	←--- A 194 Gr. 2H ----------→	
15.4.10.5	Check valves:		
	- Code	←---------- BS-1868 ----------→	
	- Body & bonnet; Trim	←-Same as per globe valves above→	
	- Seating surfaces	←Same as per globe valves above →	
15.4.10.6	Ball valves:		
	- Code	BS-5351Teflon sealed full bore fire safe design	
	- Body	A216 Gr. WCB	A181 Gr. II
	- Ball	←Stainless Steel AISI-316------→	
15.4.10.7	Plug valves (oil service only)		
	- Code	API-599 self-lubricated wrench operated with an easy visible port position indicator	
	- Body	A216 Gr. WCB	A181 Gr.II
	- Plug	←Hardened carbon steel -------→	
15.4.10.8	Hoses:		
	- Oil service	Galvanised interlocked wire reinforced, type-S smooth bore with quick acting coupling fitting standard to suit road tanker/rail tanker.	

Oil Strainer: The strainers with flanged inlet and outlet connections shall have basket type straining elements permitting easy removal and replacement. The open area ratio (i.e. straining area to the inlet area ratio) shall be at least 10:1.

FUEL OIL UNLOADING SYSTEM

			HSD System	**HFO System**
1.0	a. Fuel Oil Transfer Pumps b. Pumps standard		Horizontal, Positive displacement, twin screw pumps VDMA/API 676	
1.1	Make		Approved vendor list subject to approval of Owner	
1.2	Quantity	Nr.	2 (1 W + 1 S)	3 (2 W + 1 S)
1.3	Capacity	TPH	50	100
1.4	Discharge Pressure	Bar	4.0	4.0
1.5	Speed (synchronous)	RPM	1500	1500
1.6	Material of construction Body Screws		 CI to IS 210 FG260 13 % Chrome steel	 CI to IS 210 FG 260 13 % Chrome steel
1.7	Accessories		Built in pressure relief valve	
			Pressure gauges	
			Coupling guards	
			Foundation bolts	
			Drip tray	
			FLP motors	
2.0	**Oil storage tanks**		Vertical, cylindrical, cone roof type as per IS:803	
2.1	Rated capacity	Kl	HSD-main: 1000	HFO main: 3000
2.2	Diameter	M	As per IS:803	
2.3	Height	M		
2.4	Material of construction		MS plate fabricated	
2.5	Accessories		Flame arrestor, float type level indicator, conservation vent valve, stand pipe with instruments	
2.6	Quantity of tanks	Nos.	1	2
3.0	Inter connecting piping, valves, specialties			
	Piping	For sizes 150mm NB and below	Oil: ERW CS pipes to IS:1239 with suitable fittings.	
			Aux. Steam and condensate: Seamless CS pipes to IS:1239 with suitable fittings	
	Valves	For sizes 65 mm NB and above	150 # Cast carbon steel flanged end ball, plug, gate, globe, check valves	

			HSD System	**HFO System**
		For sizes 50 mm NB and below	800 # Forged carbon steel socket welded end ball, plug, gate, globe, check valves	
	Strainers/Filters	At pumps suction	MS fabricated basket with SS screen mesh of less than 1mm openings	
	Insulation	For HFO and aux steam services	Mineral wool mattress type with 24 G Aluminium steel cladding	
4.0	Oil Storage Tank Farm dyke			
	Capacity		To contain one large tank contents.	
	Dyke wall		As per Statutory Guidelines – However min 2 m high RCC Wall above finished floor level + 1 m high barbed wire fencing over RCC wall.	

CHAPTER 16

ASH HANDLING SYSTEM

1.00.00 SYSTEM DESCRIPTION

The ash handling system under this specification to be provided by the Contractor will be complete & comprehensive for handling and removal of total ash in form of Bottom Ash, Coarse Ash & Fly Ash generated from pulverized Coal fired Steam generator (2 x 660 MW). The plant shall be designed to cater for 100% BMCR and ash content of coal in worst coal as indicated in Vol II.

1.01.00 BOTTOM ASH REMOVAL SYSTEM

Each unit shall be provided with one (1) refractory lined, dry type bottom ash hopper having a hold up volume to store bottom ash and Economiser ash generated for a period of minimum eight (8) hours. For each unit under the dry bottom ash hopper (V Type) there shall be 4 x 50% scraper chain conveyors followed by transition chutes for each scraper conveyor, four clinker grinders and four jet pumps. Each scraper chain conveyor shall have minimum rated capacity of 15 **TPH (Dry ash**). The transition chutes, clinker grinder and jet pumps after the scraper conveyor shall each have a rated capacity of minimum **15 TPH (Dry Ash**). Out of four outlets provided in each dry bottom ash hopper, two outlets shall feed one scraper conveyor. Each outlet shall have hydraulic slide gate with manual operation facility. Arrangement of slurry disposal from each BAH has been elaborated in corresponding flow diagram. The slurry thus formed shall be transported to the common slurry sump through pipes (running on pipe racks). Bottom ash system operation will be controlled from bottom ash local panel. Bottom ash and Economiser ash generation per unit will be calculated at 100% BMCR considering generation of bottom ash and economizer ash as 30% (25% BA+5% Eco Ash) of total ash with worst coal.

The generation of bottom ash with worst coal firing is approx **30 TPH** of dry Bottom ash. However bidder to work out the exact quantity.

Bottom ash shall be disposed off through combination of hopper and scrapper chain conveyor system and finally in slurry form to the ash dype.

Two (2) numbers dry type bottom ash hopper (each of 8 hours storage capacity) – One (1) for each 660 MW unit shall be provided. The hopper shall be of structural steel, each hopper complete with hydraulically/ operated hopper isolation gates with provision for manual operation, seal troughs with overflow connection, refractory lining, access doors, inspection glass windows, poke holes, quenching nozzles, supporting steel structures, platforms, stairs and accessories as specified and as required.

Eight (8) nos. of 50% capacity (two (2) no. working + two (2) no. standby for each 660 MW unit) submerged scrapper chain conveyors, complete with hydraulic drive with gear reduction unit (if necessary) of suitable design, as specified and as required. Standby scrapper conveyor shall be installed adjacent to the working scrapper conveyor units. The standby scrapper conveyor units shall not be connected to boiler and the same shall be brought under the boiler bottom, whenever the working scrapper conveyor unit is to be taken out for maintenance. The Scrapper units shall be provided with rails, wheels and suitable motorized self propulsion arrangement to facilitate their removal from under the boiler furnace and its replacement with the standby scrapper conveyor unit.

Four (4) nos. transition chute assembly (2 for each 660 MW unit) to channelize bottom ash from scraper conveyor to the clinker grinder. The transition chutes shall be installed at outlet of each working scraper conveyor to receive bottom ash from the scarper conveyor.

Eight (8) nos. clinker grinders of 50% duty (4 for each 660 MW unit) complete with drive motors, fluid couplings, gear reducers and accessories as specified and as required. Rails for grinder and water filled trough assembly.

Eight (8) nos. 50% duty jet pumps (4 for each 660 MW unit) with drive motors. and connections with HP water supply to dispose off 100% bottom generation in wet slurry form to ash slurry sump.

Bottom ash shall be collected in a trough having refractory and water storage. The bottom ash falling into the trough will get quenched and fall onto a scraper chain conveyer (SCC). The SCC continuously conveys the bottom ash into clinker grinders where the ash will be crushed to (-) 25 mm size.

Arrangement of slurry disposal from each BAH has been elaborated in corresponding flow diagram. The slurry thus formed shall be transported to the common slurry sump through pipes (running on pipe racks). Bottom ash system operation will be controlled from bottom ash local panel.

1.02.00 COARSE ASH REMOVAL SYSTEM

From economiser hoppers & economiser by-pass hoppers (if applicable) of each unit, coarse ash will flow to scraper chain conveyor (above maintained water level) by means of adequately sized sloping pipe (for transporting slurry by gravity) duly assisted by jets (nozzles) placed at strategic locations on the tank for easy slurry flow.

The individual slurry outlet pipes shall combine to form a header in sloped gradient and the header will connect to each scarper chain conveyor. Each individual economizer hopper shall be provided with manual isolation valve, water seal cum expansion trough, flushing apparatus having water supply from HP water pumps for slurry preparation

1.03.00 FLY ASH REMOVAL SYSTEM

Fly ash is considered to be collected in Air Pre-heater (APH) & Duct Hoppers (if any), & Electrostatic Precipitator (ESP). There will be requisite no. of hoppers in APH, ESP. Owing to highly efficient ESP, ash collection in stack hopper is expected to be negligibly small.

The fly ash handling system shall be of vacuum-cum-pressure type. The fly ash collected in several sets of ESP hoppers located in the flue gas path shall be evacuated pneumatically. The fly ash is sequentially extracted from these hoppers by creating vacuum in extraction piping. In this system, the vacuum shall be created using vacuum pumps. The total ash removal system shall be divided into parallel paths (4 Nos). In each path, clearance of ash from hoppers connected to common fly ash header shall be done one after another. Shifting of ash clearance cycle from one hopper to the next shall be automatic and based on vacuum level. The evacuation shall be done once in an eight (8) hours shift. Fly ash shall be conveyed in dry mode through bag filter to buffer hopper. There shall be 4W Nos. of buffer hoppers for each unit.

Ash from all these hoppers will be transported pneumatically under vacuum to Combination Filter separator cum buffer Hoppers provided for each unit. Vacuum will be created by Mechanical Exhauster (Vacuum Pump) suitably designed & placed downstream of the air washer on the air path. The total fly ash will be conveyed in four (4) vacuum streams operating simultaneously and in parallel. Each stream shall have a flow of around **minimum 42 TPH**. Mechanical exhausters shall be provided for creating necessary vacuum for this vacuum conveying system. Combination Filter separator cum buffer Hoppers will have a storage capacity (each) 25 cubic meter (minimum) (or 20 minutes accumulation of FA from one vacuum conveying stream, whatever is higher). From each Combination Filter separator cum buffer Hoppers, ash will be transported to any of the FA storage silos through four (4) Pressure conveying streams per unit each having a flow of around **minimum 42 TPH** with the aid of conveying compressors common for both units. Two (2) nos (1W+1S) Fluidizing blowers each of 100% capacity will be provided for each unit for easy dislodging of ash from all the fly ash hoppers. Fly ash generated per shift (8 hours) per unit will be calculated at 100% BMCR considering fly ash generation to be 95% (ESP ash + APH ash) of total ash with worst coal. Fly ash generated in eight (08) hours will be cleared about 4.5 Hrs (including time for line purging etc).

From FAstorage silo there will be provision for unloading directly on trucks from each silo. Each storage silo will be provided with the following:

a) One (1) Nos. Rotary Drum Conditioners cum unloaders for providing necessary water spray for dust suppression during loading of ash on open trucks. The ash unloading rate shall be minimum 165 T/hr.

b) Two (2) Nos. Telescopic spouts arrangement with scavenger fan complete with suction bag filter shall be provided for unloading of fly ash in closed tanker. Both the outlets for ash handling shall be provided with manual chain wheel operated plate valve and cylinder operated plate valve and feeder with control. The ash unloading rate shall be minimum 165 T/hr.

c) Two (2) Nos. jet pump connections with HP water supply to dispose off 50% flyash generation in wet slurry form to existing ash pond under emergency.

d) One (1) Nos. Additional blanked flange with isolating valves shall be provided considering probable future requirement for ash transportation directly to Ash Utilization Project

e) Silo fluidising arrangement comprising blowers for silos and all related accessories. One (1) blower should be able to fluidised ash of one (1) silo under full load condition.

f) Suitable no. of bag filter & vent fan for venting within the stipulated limits of ash emission (less than 50 mg/nm3).

g) Two (2) Nos. Access doors at suitable & strategic locations.

h) One (1) No. Ash level detection and Radio frequency type sensing device.

i) One (1) No. Vacuum- Pressure Relief valve to take care of any positive or negative excursion of pressure within the silo.

Emergency Disposal of Dry Flyash in Wet Form to Existing Ash Dyke.

There will be a wet disposal system wherein ash from the flyash silo where flyash can be diaposed off in wet slurry form to the existing ash dyke. This wet mode FA disposal system shall have a capacity to handle **50%** of the flyash generated. Concentration of fly ash slurry shall be about 30% while in cross-country transfer.

Jet pumps installed below the remote silo shall dispose off the wet flyash to the existing ash pond. In case it is not possible to dispose off the wet flyash to the existing ash pond by the jet pumps then separate 3 x 50% ash slurry pumps shall be installed in the sump pit near the flyash silos for pumping the 50% wet flyash slurry existing ash pond.

It is further to clarify that either the Silo Bye-Pass (Wet) mode will be operated OR Dry mode system up to remote Storage Silo shall be operated. Dry Mode will operate at 100% capacity while wet mode shall be designed for 50%.

1.04.00 BOTTOM ASH, COARSE ASH & FLY ASH (WET) SLURRY TRANSPORT

Bottom ash slurry from Bottom Ash hopper through feed gate, clinker grinder, feed sump & jet pump & Economizer ash are discharged to slurry sump. The sump will be rectangular pyramidal shape suitably compartmentalized. It will be of over ground construction & slurry pumps located on ground floor should have flooded suction from the sump. The emergency overflow of the sump will lead to the adjacent plant drain only in extreme case. There will be one slurry pump house.. Each series of slurry pumps will have individual compartment in slurry sump. There will be two (2) sets of slurry piping for discharging BA & Coarse ash slurry for each unit. Each BA slurry pipe shall be dedicated to a jet pump located below the transition chute under the scraper chain conveyor. All the four slurry pipes (for both units) will be operating simultaneously. Any type of slurry (BA & CA) of any unit will have the flexibility of being led to any compartment of the slurry sump.

There shall be three (3) series of slurry pumps (each series being multi stage) out of which two (2) series will be working, one (1) series will be standby. Each pump will be of identical duty conditions. In 1st stage there shall be scoop controlled Fluid Couplings to vary the duty point within + 20% to - 40% of design duty point. The bottom ash slurry pumphouse shall provision of installation of four additional ash slurry pumps in future for system augmentation and additional unit in future.

There shall be three (3) slurry pipes running cross country from slurry pump discharge to existing ash dyke area out of which two (2) will be working and one (1) will remain standby. The main valve at slurry pump series discharge shall be motor operated knife gate valve shall be installed for all slurry line branch isolations including ash pond discharge points to connect the selected slurry pump discharge to the selected slurry pipe. The slurry pumps shall be capable of delivering slurry to a dyke height (considering future raising of Dyke height) from existing grade level. All pipe/fittings & supports shall be suitable to take that load area at hydro-test condition.

Cross country slurry pipe pedestals, racks and supports are to be designed considering three slurry pipes..

All pipe/fittings & supports shall be suitable to take that load at hydro test condition. The slurry pump discharge head shall be selected considering the soil (as per longitudinal section) along pipe route. The slurry piping shall be analysed

for surge/ water hammer. Necessary protection measure shall be taken. However, backflow of slurry in pipe shall be prevented.

1.05.00 **FLY ASH (WET) SLURRY TRANSPORT**

50 % of Flyash from flyash silo in emergency case shall be disposed off in wet form from the flyash silo. Flyash from flyash silo through feed sump & jet pump is discharged to existing ash pond. Bidder to size the jet pumps accordingly considering raising of ash dyke in future and garlanding.

In case it is not possible to dispose the wet flyash to existing ash pond by the jet pumps then 4 x 50 % flyash ash slurry pumps shall be installed to dispose off the wet fly ash to the existing ash pond. Ash slurry pumphouse shall be constructed near the flyash silo for housing these ash slurry pumps. In such case slurry pumphouse is provided for disposing flyash then space provision shall be kept in the pumphouse for installing three additional pumps in future alongwith necessary sump. In such case there shall be four (4) sets of slurry pumps (each being multi stage) out of which three (3) sets will be working, one (1) set will be standby. Each pump will be of identical duty conditions. In 1st stage there shall be scoop controlled Fluid Couplings to vary the duty point within + 20% to - 40% of design duty point.

There shall be four **(4)** slurry pipes running cross country from slurry pump discharge to existing ash dyke area. The slurry pumps/ jet pumps shall be capable of delivering slurry to a dyke height (considering future raising of Dyke height) from existing grade level. All pipe/fittings & supports shall be suitable to take that load area at hydro-test condition.

Cross country slurry pipe pedestals, racks and supports are to be designed considering four slurry pipes.

All pipe/fittings & supports shall be suitable to take that load at hydro test condition. The slurry pump discharge head shall be selected considering the soil (as per longitudinal section) along pipe route. The slurry piping shall be analysed for surge/ water hammer. Necessary protection measure shall be taken. However, backflow of slurry in pipe shall be prevented.

1.06.00 **ASH DUMP AREA - EQUIPMENT AND FACILITIES**

The Ash pond area which is located adjacent to the plant is an existing ash pond.The slurry pump chain head shall be designed to enable discharge at farthest point in the dyke area up to ultimate dyke height. Bidder may visit site to ascertain quantum of work accurately.

The Ash slurry pipes will discharge into the ash pond and ash particles will settle inside the ash pond.

The Main slurry pond will gradually get filled up with deposited ash and provisions shall be there to shift the slurry discharge point(s) from time to time such that an efficient filling of the entire ash pond is ensured. Proper garlanding on the ash dyke shall be made for this purpose.

The entire Ash Slurry will be retained within this Ash Dump. It is also intended to retain the entire precipitation received by the Dyked area within the reservoir itself.

1.07.00 **BOTTOM ASH HOPPER OVERFLOW SYSTEM**

From the bottom ash hopper of each unit, overflow from Bottom Ash Hopper to Overflow Transfer sump and there from transferred to the BA overflow tank through Overflow transfer Pumps. There will be continuous supply of LP water for Bottom Ash water cooling to 60^0C. The overflow from BA hopper shall accumulate in BA hopper overflow sump having a buffer storage capacity of 20 minute. BA overflow transfer pumps of each unit shall be installed locally take suction from the BAOF tank to deliver the same to a set of clarifier system. Surge tank shall have 1 hr retention capacity and capacity shall be SS 316L.

1.08.00 **COMMON WATER SUPPLY SYSTEM**

The total requirement of water for the Ash Handling System shall be met from following sources namely:

a) AHP Seal Water of RO Stage I Permeate quality.

b) Guard pond water.

The Guard Pond Water shall be used for the HP, LP Water & Economizer water requirements of AHP whereas the supply of RO Stage I Permeate water determines the net Consumptive requirement. Make up from above sources will be fed to following:

a) Seal water requirement of clinker grinder, jet pump, ash slurry pumps, BA seal trough, vacuum pumps & rotary dust conditioner from the Ro Stage I Permeate source.
b) Ash Water sump for meeting the HP LP water requirement of AHP. This shall be supplied from the CTBD/ guard pond.

The AHP seal water pumps installed in filtered water tank (RO Stage I Permeate quality) provide all seal water requirements, seal trough requirement and water for rotary dust conditioner below silo.

Common slurry sump make up will be fed from Ash water sump through Ash Water Pumps. Each HP water pump set will be able to cater to the total requirement of HP water during Bottom Ash & Fly Ash removal .

There shall be LP water pumps to cater LP water to various requirements.

Economiser Water Pumps shall be provided for each unit to cater required water for removal of Economiser ash to BA Hopper in slurry form.

1.08.01 Consumers Requiring Ash Water

a) Jet pumps for Bottom Ash & Flyash Disposal
b) Intermittent demand for de-sludging, line flushing, jetting etc
c) High pressure requirements at different points of Bottom ash hopper.
d) Continuous make up for BA hopper.
e) Continuous demand for BA Hopper Quenching.
f) Slurry sump make up.

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1.08.02 Consumers Requiring DM Water

a) Cooling Water requirement for Flyash Conveying Compressors and Instrument Air Compressor & Fluid Couplings.

1.08.03 Consumers requiring Seal Water (RO Stage I Permeate)

a) Seal water reuirements
b) Seal trough make up
c) Intermittent demand for seal trough flushing.

1.08.04 Consumers requiring RO Stage II Reject

a) Spray water for rotary dust conditioner/ unloader

The above requirements will be met from TG DMCW pumps.

1.09.00 **COMMON COMPRESSED AIR SUPPLY SYSTEM**

Continuous duty oil free screw compressor with continuous duty Air Drying Plant will be installed in the Ash Handling Plant for supplying instrument air (I.A.) for different actuation purpose. Necessary tapping with suitable isolation valve will be provided on this Ash Handling Plant's I.A. header at strategic location so that same can be interconnected with Main Plant I.A. header, if it is feasible to do so. The instrument air supply for remote location e.g. silo shall have suitable air receiver along with moisture separator aided with maintenance free auto drain trap.

1.10.00 **DRAIN PUMPING SYSTEM**

The Drain Pit Sump Pumps will be provided in BA Hopper area (drain pit located near Bottom Ash Hopper Area of each unit).. They will pump the slurry back to the ash slurry sump.

Vertical, Centrifugal, single stage, semi-open or (open non-clogging) type impeller type drain pumps shall be provided in Slurry Sump area, Vacuum Pump House Area and near silo area.

Drains from BA hopper area, vacuum pump area and Bottom ash hopper overflow water shall normally be transported to the BA overflow tank and from thre to to the ash slurry sump.

There will be provision for all drains from various areas to be transported to common ash slurry sump or sludge sump whichever appears to be suitable during piping works.

2.00.00 **DESIGN CRITERIA**

2.01.00 Overall Design Criteria for the System

Following aspects are to be given primary consideration in selecting the Ash Handling Plant

a) Present system to be installed will have capability of handling entire ash produced during MCR operation considering worst coal firing and

with reasonable margin.

b) Selection of system configurations with minimum consumption of water

c) Quality of effluent outgoing from the plant (if at all) shall conform to latest norms of Environment Pollution Control.

d) Efficient system with high reliability & redundancy and low interaction & involvement of manpower.

e) While laying out the present phase of plant equipment it shall be borne in mind that there shall be provision for space for future extension.

f) Clinker Crusher, jet pump and other pumps & installation etc, if not specified otherwise will be on/above ground level.

g) Design of the Ash Handling Plant shall be carried out considering following ash generation rates (% of total ash):

- Bottom Ash & economizer ash generation per shift (8 hrs.) per unit considering worst coal at 100% PLF with (30) % of total ash generation.
- Fly Ash & Air pre-heater Hopper Ash generation per shift (8 hrs.) per unit considering worst coal at 100 % PLF with (95) % of total ash generation.

h) Bulk Density of ash & other General Design Guidelines & Standard Equipment Sizing Criteria may be considered as follows:

Density/ Concentration	
Density of Bottom Ash for volume Sizing	650 Kg/Cu.M
Density of Fly ash /Eco Ash for volumetric sizing	750 Kg/Cu.M
Density of Flyash for ash flow passages	750 kg/Cu.M
Density of bottom ash for structural sizing	1600 kg/ Cu.M
Density of Flyash for structural sizing	1600 kg/ Cu.M
Concentration of Ash slurry for bottom ash slurry	Upto 25% (w/w)
Concentration of Ash slurry for flyash slurry	Upto 30% (w/w)
Concentration of combined bottom ash & flyash slurry (in disposal pipeline)	Upto 25% (w/w)
Particle density of ash in water	2000 kg/Cu.M
Velocities	
Velocity in ash slurry through pipes	2.3 – 2.8 m/s
Velocity in flyash slurry through pipes (under gravity)	1.5-2.3 m/s
(Max.) Tip speed for Slurry duty pump	1676 m/min
Slurry Duty pump speed (max.)	1000 rpm
Frictional Factors	
Friction factor ‘C’ for Ash slurry lines	140
Friction factor ‘C’ for Sludge lines	130
Friction factor ‘C’ for Recovery Water lines	100
Friction factor ‘C’ for Bottom ash overflow lines	120
Friction factor ‘C’ for Water Lines	110
Basis for selection of capacities of various tanks/ sumps	

Bottom ash overflow sump	For 20 min
Slurry sump (each compartment)	For 5 min
Ash Water Sump	For 30 min
Drain sump (AD PH & Vacuum PH)	For 20 min
Recovery water sump	For 30 min
Recycle Water sump	For 30 min
Sludge pit	For 30 min
Ash handling plant shall be designed considering ash generated at 100% BMCR with worst coal firing within minimum removal rate as specified	
A margin of 10% shall be built up on the actual pump capacity and head for selection of all water and drain pumps & recovery water pump, BAOF Pump.	
A margin of 10% shall be provided on compressor capacity over & above maximum flow requirement for selection of all compressors (Conveying Air & Instrument Air).	
A margin of 10% to be considered on the actual friction drop for arriving at slurry pump, Sludge Pump, Drain Pump, BA overflow and recovery water pump head.	
Recovery water to be designed for 75% of total water outflow with slurry.	
Suspended solids in recovery water : 1000 ppm (normal)	
Maximum particle size of ash in recovery water from ash pond : 10 microns	
Maximum particle size of ash in bottom ash overflow to clarifier : bidder to decide	
Suspended solids in BA overflow water : bidder to decide. Min TSS to be considered 800 ppm.	
Sludge consistency : 2-3%	
Evacuation Time	
Bottom ash alongwith coarse ash	Continuous from Scraper Conveyor
Flyash (ESP & APH Ash)	4.5 hrs in a shift of 8 hrs

Maximum velocities in pipes	upto 50mm,	50-150 mm,	> 200mm
a) Water Pump Suction	0.9	1.5	1.8
b) Water Pump discharge	1.8	1.8 – 2.4	1.8 – 2.4
c) Compressed Air	15	20-25	25-35

OTHER DESIGN CONSIDERATION

a) Capacity of each clinker grinder & jet pump for bottom ash evacuation shall be minimum 15 **TPH** (dry ash basis) and all associated pipelines etc. leading to Common Slurry sump should be suitable for this. Since all these slurry lines of a unit run simultaneously, the effective BA/CA slurry conveying rate of each BA/ CA pipe shall be minimum 2**0 TPH to the** Bottom Ash slurry sump.

b) Fly ash of each unit will be evacuated through a vacuum conveying system of minimum **165** TPH (Dry Ash) Capacity consisting of four (4)

parallel streams each of minimum 42 **TPH** (Dry ash) capacity.

c) From the outlet of each Combination filter separator cum Buffer Hopper, there shall be four (4) pressure conveying streams per boiler Capacity of each stream shall be minimum **42** TPH (dry ash).

d) Four (4) nos. remote silo shall be provided. Each Fly ash Storage Silo (RCC construction) shall have a capacity to store 1000 T (dry ash basis). Free board of 1000 mm shall be maintained in the silo. Angle of repose in the flyash silo shall be 45 Deg.

e) In selection of slurry pumps (capacity vs head) at present , selection shall be made considering existing ash dyke height & discharging ash slurry at the remotest points of ash dyke with provision of foundation etc. for adding subsequent stages of pumps to enable rise of dyke height & conveying slurry at new ash pond.

f) The water required for dry ash wetting at silo outlet prior to loading on Trucks, shall be met from the CMB (RO Stage II reject).

g) Minimum particle size of ash in BA overflow water to settler: 30 microns. Suspended solids in BA overflow water to seller: Minimum TSS to be considered 1000 ppm. TSS after settler shall be maximum 100 ppm.

2.02.02 **POLLUTION CONSIDERATIONS**

a) Liquid Effluent: For liquid effluent generated (if at all) 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 is such that a large surface area (provided in the Ash Dump) shall adequately cool the recovery water. Besides, it will 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 dB (A) measured at a distance of one (1) mt. from the equipment concerned as per Noise Rating Curve ISO 85.

2.02.03 **FLY ASH HANDLING SYSTEM**

It is contemplated to convey the fly ash from respective fly ash hoppers (ESP & Air heater) up to the combination filter separator cum buffer hopper by pneumatic vacuum system in the first stage conveyance of fly ash. EPC contractor shall keep the bottom level of ESP hopper adequately high to enable small truck movement for ash collection in emergency.

2.03.01 LAYOUT CONSIDERATION

a) Vacuum pumps shall be situated under the ESP 1st field (Near FAE Towers). Vacuum pumps will be provided in a RCC building.

b) Silo utility building. There shall be office Block of 50 sqm & a guard room of 5 sqm adjacent to Silo Utility Building. (At silo area)

c) One adequately sized maintenance building shall be provided by Bidder

IN ADDITION TO ABOVE BUILDINGS BIDDER SHALL OFFER FOLLOWING BUILDINGS

(A) The ash handling equipment shall be distributed in following major buildings tentatively shown in the enclosed plot plan.

a) Ash Slurry Pump House containing slurry pumps of multiple series, seal water pumps etc. Space shall be provided to install one more stage slurry pumps and another set of seal water pumps at later date to enable dispose slurry to new ash dump area or rising existing ash pond dyke height.

b) Ash Water Pump House

c) There shall be separate building for conveying compressors, fluidizing blowers and heaters, instrument air compressor and drier.

d) Ash handling central control room.

The associated electrical facilities shall be placed in annexed buildings or as found suitable. The buildings shall be provided with necessary office space, toilet etc as applicable. Adequate maintenance space and lay down area shall be provided in buildings. Approach to all equipment, piping, valves shall be provided. Where such facilities are not possible, separate platform, approach ladder etc shall be provided. A clear space of 1000 mm minimum shall be provided between two equipment / pipe /valve. Headroom of 2500 mm minimum shall be provided wherever man approach is applicable. All pipe racks shall have walkway of 600 mm width. All stairs shall be 1200 mm width. Hand railing shall be 1200 mm height made of 32 NB medium GI pipes conforms to IS 1239. All platforms shall be made of Gratings.

There shall be BA Slurry pipe support, FA Surry Pipe support, Ash water pipe support, Dry FA Pipe support, BAOF Pipe support etc. in the form of pipe rack for total Ash Handing System Completion.

Construction of Silo & Bottom Ash Hopper and its necessary arrangement/ accessories for the system completion.

Weigh bridge as indicated in Chapter 23 shall also be supplied.

3.00.00 OPERATION AND CONTROL PHILOSOPHY

3.01.00 The basic operation and control related to the ash extraction & removal system will be independent for each unit and will be carried out in co-ordination from different local panels located near the system/equipment, either in automatic interlocked sequential mode or remote/ local de-interlocked manual mode as explained hereunder. Bidder shall also refer clause 4.00.00 & of Annexure 'C' 3.00.00 of volume V also for I&C works.

3.01.01 All instruments like pressure indicators, pressure switches, level control instruments, level indicators, level switches with alarm contacts, level control valves, flow indicators etc., as indicated in the enclosed single line flow diagram to facilitate effective control of the system, shall be furnished by the Bidder. Any other instruments not categorically shown in the flow diagram or mentioned in this specification but considered necessary for the safe & satisfactory operation of the system shall also be furnished by the Bidder.

3.01.02 All drive motors & motorised actuators & pneumatic valves will be controlled either from respective local panel or AHS main control room DCS with starting interlocks & permissive in remote mode as also from local start-stop station in de-interlocked local mode by means of "Local/Remote Selection" switch. The power circuit for the above will be in the MCC and HT/LT switchgear located in the switchgear room. Emergency lock out trip switch will be provided with all major drives with necessary interlock. All Air/Electric valves will be operated / controlled from AHS main control room. Local operation shall also be possible through manual override to be provided on locally mounted air line equipment (solenoid valve) for the actuators.

3.03.00 Broadly, the ash handling system operation/control scheme can be described as below :

There are mainly three zones of operation viz. Bottom Ash Hopper area, ESP Fly Ash Handling Area & Silo Area. The drives, valves & field instruments of these three areas are controlled by the AHP DCS located in AHS Main Control Room (MCR).

Various controls and interlocks shall be provided for the trouble free operation of the plant.

The various local junction boxes/local panels shall be located near the respective equipment in different areas.

Common Systems , viz., Ash Water & Ash Slurry system, Fly Ash Unloading system, Instrument Air system & various Sump Draining systems are all controlled through AHP DCS.

Bottom ash local control panel shall be floor mounted type with Push buttons, Lamps, actuators & Mimic etc. and will be erected near bottom ash hopper area. Bottom ash operation will be done from this panel which shall be monitored from its Mimic and interfaced with AHS DCS in AHP control room DCS.. The input & output signals of bottom ash area will be taken to AHP DCS through the RIO unit, located near the bottom ash local control panel.

Silo area Utility panel will be located in the Utility building adjacent to the Silo. This panel will also house control switches, lamps etc. for local operation. The I/O from this area shall communicate with the AHP DCS in AHS main control room through RIO Unit.

One Silo Unloading panel with control switches and lamps shall be provided on each Silo Unloading floor. The silo unloading operation will be done from this panel. Suitable alarm / annunciation system shall be provided to warn of any mal- functioning of the ash handling system.

3.04.00 Control Devices & Locations

The operation & monitoring of the ash handling system will be carried out

from the following devices at indicated locations.

3.04.01 Local Control Room (LCR)

The AHS Main Control Room (LCR) houses the following devices :

a) Two (2) no. Engineering cum Operating Work stations, Two (2) no. Large Video Screens with work stations and one (1) no, operating work station shall be provided in the Ash handling system main control room. Each work station shall include 21" TFT monitor, Key board, Mouse, etc.

b) one (1) no. A3 Lase colour printer along with all accessories.

c) One (1) Direct Emergency Stop Push Button with protective cover shall be provided on the control Desk. The EPB shall be directly wired to MCC for AHP which shall trip all the conveyors at a time in case of emergency conditions.

In addition to the above, one (1) no. operating work station shall be provided in Central Control Room. This operating work station shall act as extended operating work station and shall have all the features of LCR work station.

The inputs & outputs of Ash Slurry & Ash water Pump House area will be directly fed (or through remote I/O rack depending upon the location of AHS Main Control Room) to this AHS .

The Local Control Room shall have the basic indications for overall system operations from different sub-systems. The status of the following shall be indicated at the Main Control Room in AHP control room.

a) Operation of Bottom Ash.

b) Operation of Coarse Ash.

c) Operation of Fly Ash vacuum conveying.

d) Operation of slurry pumping series and number of pumps operating.

e) Operation of HP and LP Ash Water Pumps and the number of pumps operating.

f) Operation of Fly Ash pressure conveying.

g) Number of vacuum pumps and conveying blowers under operation.

h) Number of silo under operation.

i) Number of fluidizing blowers at ESP area and the silo area under operation.

j) Instrument Air Compressors.

3.04.02 Bottom Ash Local Panel (BALP)

Bottom Ash local panel (BALP) will be erected near bottom ash area. This

panel will have mimics, control switches etc. Bottom ash hopper operation will be done from this panel which can be monitored from AHP DCS system through HMI. The inputs & outputs and field instrument of bottom ash area will be taken to the main AHP DCSDCS through remote I/O station. The status of all the BA area drives shall be available on BALP as well as in AHP DCS.

For each Unit, one BALP shall be provided to control the following activities/facility :

i) Bottom Ash Removal through Scrapper Chain Conveyor.

ii) Clinker Grinder Operation.

iii) Bottom ash hopper Overflow Transfer Pump.

iv) Bottom ash hopper Make-up water System.

v) Bottom Ash Removal through Jet Pumps.

As a typical example of the general nature of the controls, the functional requirements as well as the facilities for bottom ash local control panel are furnished below. Similar detail functional requirements for all other control panels shall be furnished by the Bidder.

a) Functional Requirements

The following are some major functional requirements for the bottom ash local panel :

i) Opening/Closing of jet pump water line valves.

ii) Opening/Closing of clinker grinder seal water valve.

iii) Operation of clinker grinder drive motors.

iv) Opening/Closing of bottom ash hopper feed gates. (cylinder for feed gate operation shall be suitably designed and provided with reed switch for position indication)

v) Start/Stop of vertical drain pumps and opening/closing of corresponding discharge valves.

vi) Opening/closing of water line valves for jet pump for drain sump.

vii) Start/Stop of overflow transfer pumps.

viii) Opening/Closing of Isolation valves for Overflow Transfer Pumps.

ix) Opening/closing of seal water line valves for overflow transfer pumps.

x) Asking for permission" BA Cleaning to start" and Sending "cleaning over" signal for bottom ash system to AHP DCS in main control room.

b) Each of the bottom ash local panels shall have, among others the

following :

i) Start, stop and reverse push buttons with indicating lamps for clinker grinder motors.

ii) Safety feature detecting clinker grinder jamming and auto reversal of clinker grinder drive on occurrence of such jamming.

iii) Auto/manual selection facility for reversal of grinder rotation in auto or manual mode.

iv) Open/close push button for hopper feed gates with position indicating lamps.

v) Open/close push button with indicating lamps for valves in the jet pump water lines, overflow transfer pump isolation, water line to jet pump for drain sump.

vi) Start/stop push button with indicating lamps for overflow transfer pumps.

vii) Indicating lamps for high, low and danger levels of overflow & slurry sump.

viii) Indicating lamps for high and low levels of drain sump.

ix) Auto/manual selector switch for drain pumps.

x) Start/stop push button for drain pumps in manual mode of operation with indicating lamps.

xi) Ammeter for each motor.

xii) All other relays, fuses, wiring, tubing, space heaters etc.

xiii) Mimic diagram depicting the B.A. removal operation.

c) Indication/Annunciation

Audio-visual lamp/window annunciations shall be provided for each of the following conditions:

i) Receipt of system start signal from Main Control Room
ii) Water pressure to jet pump low.
iii) Control air pressure low.
iv) Grinder seal water pressure low.
v) Seal water pressure for overflow transfer pump - low.
vi) Clinker Grinder - tripped (for each grinder motor).
vii) Control supply failure.
viii) Overflow transfer pump tripped (for each pump motor).
ix) Overflow slurry sump level - High.
x) Overflow slurry sump level - Low.
xi) Overflow slurry sump level - Danger Low.
xii) Drain sump level - High.
xiii) Drain sump level - Low.
xiv) Other annunciations as necessary for safe and co- ordinated operation.

The annunciation system shall be complete with accept, reset and test push buttons.

3.04.03 Silo Utility Local Panel (SULP)

Silo area control panel will be erected in silo area MCC room. This panel is also having control switches, lamps etc. One silo unloading panel with control switch and lamps is also there in silo unloading platform which will bring the inputs & outputs to silo area control panel. The silo area operation will be done from this panel however that can be monitored from AHP DCS in main AHS control room. The inputs & outputs and field instrument signals of silo area will be taken to AHP DCS through RIO Unit located in Silo Area MCC room/Utility building.

3.04.04 Silo Unloading Local Panel (SUNLP)

One silo unloading local panel with control switch and lamps will be there on Silo unloading floor which brings the inputs & outputs to silo area control panel. The silo unloading operation will be done from this panel

3.04.05 Local Push Button Station (LPBS)

Local push button stations will be provided (ONE FOR EACH MOTOR) to facilitate deinterlocked field trial operation of the respective drives/equipment and will be located near each respective drives/equipment .Each of the push button station will incorporate one lockable “STOP” push button and located near respective equipment.

Local operation by-passing process interlocks of each drive / power actuator can be carried out by putting respective “TRIAL-NORMAL” selector on HMI in “TRIAL” position. In “NORMAL” position of the selector, the drive can be started from MMI, through respective DCS; except three nos. Recovery Water Pumps in recovery pump house, Priming Pump, if any & motors related to Clarifier system. Stopping of these motors can be effected through actuation of STOP switch at any control location irrespective of selection of “NORMAL” or ‘TRIAL” position.

3.04.07 Manual Override of solenoid Valve Local override operation knob to be provided on the solenoid valves.

3.04.08 Bottom Ash Removal System (System Operation And Interlocks)

a) The bottom ash hopper of each unit consisting of V- sections, each having two ash outlets, each outlet being equipped with one set of feed gate feeding the scraper chain conveyor. The scraper conveyor feeds the transition chute below which the clinker grnder and jet pump are installed. Thus four bottom ash disposal lines, thus finally emerge from both bottom ash hopper, which will be working simultaneously under normal operating condition.

3.04.09 Clinker Grinder

a) The following starting and running permissive will be applicable for Clinker crusher irrespective of mode of reversal.

i) Corresponding bottom ash conveying path is “THROUGH”.

ii) Water supply pressure at inlet to corresponding jet-pulsion pump is “NORMAL”.

iii) Seal water supply pressure for corresponding crusher is “NORMAL”.

iii) Instrument Air supply pressure is “NORMAL.”. –
iv) Motor protection not operated.

b) Crusher can be stopped by actuating STOP push button on BALP. Crusher can also be stopped from its Local Push Button station by Emergency STOP push button.

c) In the event of sealing water pressure or/and the jet pump water pressure falling below preset valve, the running grinder will trip and the corresponding hopper feeder gate will close.

d) In the event of tripping of the clinker grinder motor due to its overloading, the motor shall automatically reverse in rotation, subject to availability of seal water pressure, in short impulse to remove the jammed material. Reversal operation will continue for a preset time period after which the motor will again start rotating in normal direction. Even if after that overload persists due to jamming or if not the motor had already tripped during reversal operation, the motor will trip with parallel closure of feeder gate. The Clinker grinder can be restarted only after judiciously selected preset time period.

e) Feeder gate will remain open in any case only when clinker grinder is running.

3.04.10 Hopper Feed Gate

a) The hopper feed gate can be operated from the BALP through actuation of OPEN/CLOSE push button. The following permissive will be applicable for hopper feed gate opening.

b) Scraper Conveyor is “RUNNING”. The hopper feed-gate under open condition will close if the scraper chain conveyor is “Tripped” or gets “Jammed”.

3.04.11 Bottom Ash Hopper Overflow Water Transfer Pump

a) The following starting and running permissive will be effective during operation of overflow transfer pumps :

i) Starting Permissive

- Overflow transfer tank level is at or above preset “LOW” level.

- Motor protection not operated.

ii) Running Permissive

- Overflow transfer tank level is above preset “DANGER LOW”.

- Respective overflow transfer pump seal water supply pressure is achieved “NORMAL” within a preset time from pump starting.

- Motor protection not operated.

b) The “HIGH” level in the Overflow Transfer Tank will be indicated through RED lamp and the same will be annunciated through hooter.

c) The motor can be stopped by actuating STOP push button on BALP. Motor can also be stopped from its respective Local Push Button Station by actuating its `Emergency Stop’ Button.

3.04.12 Pneumatic Valve On Make Up Water Line To Overflow Transfer Sump

a) One (1) pneumatic “ON-OFF” type make-up water valve is provided for the overflow transfer tank. The operation of this make-up valve can be carried out from BALP in remote manual or in interlocked automatic mode. Operation mode selection will be through “OPEN-CLOSE-AUTO” selector actuator provided on BALP.

b) With “AUTO” mode selected, the valve operation will be initiated and interlocked with overflow transfer tank level as indicated below.

i) The valve will open fully when overflow transfer tank level reaches the preset “LOW” level.

ii) The valve will close fully when overflow transfer tank level attains the preset “HIGH” level.

c) With remote Manual / De-interlocked Mode, opening and closing of the valve can be carried out by putting the selector on “OPEN” & “CLOSE” positions respectively.

3.04.13 **ECONOMISER ASH SYSTEM OPERATION**

Below each economizer hopper there is a water trough expansion joint and ash from the Economiser hopper will be discharged through a down comer pipe to a flushing box below.

Water will be supplied to the water trough and the flushing box by the Economizer Ash Water Pumps . Eco Ash Water Pumps, will be operated from DCS HMI through actuation of selector Eco.

Ash Water Pump ON/OFF and respective “START” & “STOP” push buttons. In case of tripping of any one of the two pumps running for two units, the common stand by pump will start automatically. Economiser ash shall be continuously removed in slurry form so long the boiler is in operation. The ash slurry discharged from the flushing box will be transported to the bottom ash hopper by gravity, stored in the bottom ash hopper & removed alongwith bottom ash to the ash slurry sump by Jetpulsion Pumps below the B. A. Hopper.

3.04.14 **FLY ASH SYSTEM OPERATION**

The fly ash system operation will be carried out for removal / onward

conveying of fly ash from ESP hoppers & Air Heater hoppers of the unit. The fly ash cleaning operation will be carried out from the Main Control Room, DCS, normally once in a shift of eight hours.

The entire fly ash cleaning operation is performed in two stages for dry disposal & one stage for wet disposal as described below.

3.04.15 **FLY ASH VACUUM SYSTEM**

a) Under the first stage of operation of dry disposal, fly ash from the ESP field hoppers and APH hoppers is conveyed through four independent and parallel conveying lines to four Combination Filter Separator cum Buffer Hopper units for DRY mode of ash removal.

b) For DRY mode of fly ash removal, the ash conveying streams from the fly ash hoppers get connected to the Filter-Separator units by opening the cylinder operated header valves to the Filter Separator units. Each Filter Separator unit receives ash through a dedicated stream. All the four Filter Separator Units (FSU) will be in operation during system operation in DRY mode.

The fly ash conveying from ESP & APH field hoppers up to the Filter-Separator units will be basically performed by means of pneumatic vacuum conveying process in which ash from the hoppers is fed into the conveying line and conveyed along under vacuum produced by mechanical exhausters connected at downstream terminal of the vacuum conveying network.

c) The filter/separator assembly is a combination mechanical and pulse jet cleaned dust collector unit capable of removing dry ash particles from conveying air.

The pulse jet system for the dust-separator filter bags must be initiated before commencing fly ash cleaning operation.

The filter-separator will continue in operation so long the following conditions are fulfilled, i.e., the Starting & Running Permissive of the Filter/Separator will be :

i) Instrument air pressure is “NORMAL”.

ii) Buffer hopper ash level is below “HIGH”.

The filter-separator will fail to operate in case any of the above conditions is not satisfied during system operation.

“AUTO-MANUAL” Selector switch is to be provided for pulsing mode selection. The Selector switch in “AUTO” position activates Solenoid Valves duly monitoring differential pressure across the clean air and dusty air plenum of bag filter. When the differential pressure is above a preset value, the Solenoid Valves will be activated one after another till the differential pressure falls below a preset value.

d) All the ash conveying streams operate simultaneously. The number of Filter Separator Units in service are decided depending on the no. of streams operating.. Under normal operating sequence, one mechanical exhauster of each conveying stream will be operated.

e) The ash cleaning operation is normally carried out simultaneously through all the four ash conveying streams on one row at-a-time basis for each stream. The hoppers on operating row will be cleaned sequentially one after another. The ash cleaning operation can be performed either in an "automatic sequential" mode or in a "remote manual" mode decided by means of an "AUTO-MANUAL" selector.

The ash cleaning operation can be initiated and carried out either in "Auto-Sequential" mode or, "Remote Manual" mode decided by means of corresponding "AUTO-MANUAL" mode selector. In "Auto-Sequential" mode, the ash cleaning operation starts from a particular hopper of a row and proceeds from one hopper to other and one row to another in a predetermined sequence. In "Remote Manual" mode, however, the operative row and hopper can be decided independently out of sequence.

3.04.16 **FLY ASH PRESSURE SYSTEM**

a) Under the second stage of operation, designated as above, the fly ash received in Buffer Hoppers is conveyed to the Fly Ash Silo for dry ash disposal by means of pneumatic pressure conveying process. During the cleaning operation, ash from the Buffer Hoppers is fed into the conveying line through cyclic operation of NUVAFEEDER/ AIR LOCK VESSELS provided below the Buffer Hoppers and is conveyed onwards with the help of compressed air supplied at the inlet end of the conveyor.

b) Two (2) ASH TRANSPORT VESSELS/ AIR LOCK VESSELS are connected to each Buffer Hopper, which operate in remote interlocked timer based sequence to collect ash from Buffer Hopper and unload the same into the fly ash pressure conveying lines.

c) The Ash transport vessel located between the buffer hopper and the conveying pipeline along with two ash inlet & outlet gates acts as an air-lock vessel. The operation of the Ash transport vessel gates will be of cyclic order having timer based sequence.
One of the two Ash transport vessels connected to a buffer hopper unit will be in service at a time and the other one will be standby.

d) Full-Load Control

During fly ash pressure conveying, if the conveying line pressure rises above the preset value sensed by a "FULL-LOAD" pressure set point of pressure transmitter ,the bottom gates of all the Ash transport vessel on the operating ash conveyor (if open) will close immediately and remain closed until the line is cleared and the line pressure falls below the FULL LOAD PRESSURE set value, thus providing "FULL LOAD control" during the ash conveying.

3.04.17 **OPERATION OF COMBINATION FILTER-CUM-SEPARATOR**

The filter-separator will continue in operation so long the following conditions are fulfilled , i.e., the Starting & Running Permissive of the Filter/Separator will be :

a) Instrument air pressure is "NORMAL".

b) Buffer hopper ash level is below “HIGH”.

The filter-separator will fail to operate in case any of the above conditions is not satisfied during system operation.

c) The following interlocks relating to the buffer hopper will be effective during fly ash cleaning operation.

i) During buffer hopper filling, if the “HIGH” level probe of the buffer hopper gets immersed in ash, it will immediately energise an annunciation.

ii) If the level probe provided in the buffer hopper senses “HIGH” level and the signal is maintained for 60 seconds, it will cause instantaneous closing of the ash intake valve followed by “Fly Ash Vacuum System Tripped” annunciation.

3.04.18 **OPERATION OF ASH TRANSPORT VESSEL**

a) The following starting / running permissive will be effective for cyclic operation of ASH TRANSPORT VESSEL/ / AIR LOCK VESSELS.

i) Instrument air supply pressure is “NORMAL”.

ii) Fly Ash Silo ash level is below “HIGH”.

iii) Silo vent – filter pulse jet cleaning sequence is “ON”.

iv) Corresponding fly ash conveying path upto the silo is THROUGH.

v) Conveying air supply valves for the ash conveying lines are “OPEN”.

vi) The conveying air compressor is in operation and conveying air header pressure is “NORMAL”.

The failure of attaining any of the above permissive at any moment of system operation will stop the conveying operation. “FLY ASH PRESSURE SYSTEM TRIPPED” will be annunciated.

3.04.19 **OPERATION OF MECHANICAL EXHAUSTER**

a) Starting permissive

Mechanical Exhauster seal water supply pressure is `NORMAL’ Vacuum conveying path is selected. ( this will consequently open its suction valve) Instrument Air Pressure is `NORMAL’

b) Running Permissive

Mechanical Exhauster seal water supply pressure is `NORMAL’ Instrument Air Pressure is `NORMAL’

3.04.20 **OPERATION OF ASH INTAKE VALVE**

The Ash Intake Valves on each fly ash conveying stream will be energised subject to fulfillment of the following :

i) On line Mechanical Exhauster is “RUNNING”.

ii) On line Vacuum Relief Valve is “CLOSED”

iii) Water pressure to air-washer is “NORMAL”.(For WET System only).

iv) Filter-Separator Bag pulse jet sequence is “ON”(For DRY system only).

v) Instrument air pressure is “NORMAL”

vi) Buffer Hopper ash level is below “HIGH”(For DRY system). Non-availability of any of the above conditions at any moment of system operation will close the ash intake valves with “FLY ASH VACUUM SYSTEM TRIPPED” annunciation.

3.04.21 **OPERATION OF CONVEYING AIR COMPRESSOR**

The Starting/ Running Permissive for REMOTE operation of the compressors is obtained through DCS by ensuring the following:

i) The isolation valves on selected conveying path are open & “THROUGH”.

ii) Cooling water supply pressure for compressor is ”NORMAL”.

iii) Cooling Water flow is adequate.

3.04.22 **OPERATION OF ASH SILO VENT FILTER PULSE JET SYSTEM**

The pulse jet sequence circuit of Ash Silo vent filter gets activated by actuation of “F.A. Pressure SYSTEM START” command from HMI or, ”Silo Fluidising Air Blower START” command from Silo Unloading Panel . This will energise a local controller to carry out pulse jetting of the vent filter in an automatic timer based sequence.

3.04.23 Water & Slurry System Operation of H.P. and LP and Economiser Water Pump

a) The following starting & running permissive will be effective during operation of the H.P and LP. And Economiser water pumps:

i) Starting Permissive

- Ash Water Sump level is at or above preset “LOW”.

ii) Running Permissive

- Ash Water Sump level is above preset “DANGER LOW”.

3.04.24 **OPERATION OF VARIOUS SUMP DRAINAGE PUMPS**

a) The following starting & running permissive will be effective for

operation of the Drainage Pumps :

i) Starting permissive

- Drain Sump level is at or above preset “LOW”.

ii) Running permissive

- Drain Sump level is above preset “DANGER LOW”.
- Respective Drainage pump seal water supply pressure becomes “NORMAL” within a preset time from pump starting.

3.04.25 OPERATION OF DUST CONDITIONER WATER PUMP

a) Following starting & running permissive will be effective for operation of the Dust Conditioner Water Pumps.

i) Starting permissive

- Silo Utility Sump level is at or above preset “LOW”

ii) Running Permissive

- Silo Utility Sump level is above preset “DANGER LOW”.

3.04.26 ASH SLURRY PUMPS

a) During operation of the ash slurry pump series, the following starting and running permissive will be effective (except during flushing operation) :

i) Starting permissive

- Respective slurry sump compartment level is above preset “LOW”
- Valve at pump chain suction is “OPEN”
- Fluid coupling / Gear box cooling water supply pressure is “NORMAL”.
- Pressure at LP & HP Seal Water supply headers for Slurry Pump series is “NORMAL”.
- Pump in upstream side of the series is running.

ii) Running permissive

- Pump gland seal water pressure is “NORMAL”
- Valve at pump chain discharge opens within a pre-determined time period from the starting of the first pump in the chain and remains “OPEN”.
- Upstream pump in the chain is running

- Downstream pump in the chain is started within a pre-determined time interval.
- Valve at pump chain suction is “OPEN”
- Respective slurry sump compartment level is above preset “DANGER LOW”
- Fluid coupling / Gear box cooling water supply pressure is “NORMAL”.
- Return Cooling Water Temperature is not HIGH
- In the event of tripping of any one pump in the chain, other pump/s in the chain will instantaneously trip signaling **“**Ash Slurry Pump Chain Tripped” annunciation. The discharge valve will close after a preset time from tripping of the pump chain.

3.04.29 Fluidising Air System ESP & Buffer Hopper Fluidising Air-Blower Starting permissive:

Respective Blower is selected and its “START” command is given from HMI.

3.04.30 Esp & Buffer Hopper Fluidising Air-Heater

a) The following starting and running permissive will be effective during operation of heaters –

Starting permissive:

Any Fluidizing Blower is `ON’

Temperature is below `HIGH’ as sensed by corresponding instrument.
Running Permissive:
Temperature is below `HIGH’ as sensed by corresponding instrument.

3.04.31 **ASH SILO FLUIDISING AIR BLOWER**

Starting permissive:

Respective Blower is selected and its “START” command is given from Silo Utility Panel.

3.04.32 **ASH SILO FLUIDISING AIR-HEATER**

a) The following starting and running permissive will be effective during operation of heaters –

Starting permissive:

Any Fluidizing Blower is `ON’

Temperature is below `HIGH’ as sensed by corresponding instrument.

Running Permissive:
Temperature is below `HIGH' as sensed by corresponding instrument.

3.04.33 **OPERATION OF INSTRUMENT AIR COMPRESSOR**

a) Following starting / running permissive will be effective for operation of the air compressor:

i) Cooling water supply pressure for air compressor is "NORMAL".

ii) Lubricating oil pressure "NORMAL".

b) The motor can be stopped by actuating STOP command from HMI or, by STOP push button on Local Control Panel. Motor can also be stopped from its respective Local Push Button Station by actuating its `Emergency Stop' Button. All interlock and logic functions for the package shall be performed through AHP DCS.

3.04.34 **ASH SILO UNLOADING**

Continuous silo level shall be shown by installation of level transmitter. Preferably, the silo fluidising should be started 30 minutes ahead of starting ash unloading from silo and be kept 'ON' so long as the unloading system is 'ON'.

3.04.35 **SILO UNLOADING BY ROTARY UNLOADER**

a) The following starting and running permissive will be effective for operation of Rotary Unloader -

i) Water supply pressure to unloader is NORMAL i.e. above a preset value sensed by a pressure switch.

ii) Instrument air pressure is at or above a preset value sensed by Pressure switch.

b) The following opening and running permissive will be effective for operation of the Ash Feed Valve -

i) Rotary Unloader is RUNNING.

c) The conditioning water to ash conditioner will be controlled by a manual globe valve provided in its water supply line.

3.04.36 Level Control for Ash Slurry Sump

Bidder shall furnish the followings:

3.04.37 "High" level & "Low" level alarm in respective control panel.

Continuous slurry sump level shall be shown by installation of level transmitter. Also the following shall be available.

3.04.38 "Very Low" level alarm with tripping of all running slurry Pumps subject to fulfillment of both sensing through level indicator and actuation of Float Switch.

3.04.39 Level indication device to monitor level in the remote control panel along with Local Arrow Scale device.

3.04.40 Sump Make up

Suitable Control Valve Complete with all associated accessories (preferably pneumatic operated) on the make up water line (Low Pressure Ash Water) actuated from sensing of sump level shall be provided.

3.05.00 Level Control for Ash Water Sump

Bidder shall furnish the following :
Continuous sump level shall be shown by installation of level transmitter. Also the following shall be available.

3.05.01 High" level & "Low" level alarm in respective control panel.

3.05.02 "Very Low" level alarm with tripping of all running Ash Water Pumps subject to fulfillment of both sensing through level indicator and actuation of Float Switch.

3.05.03 Level indication device to monitor level in the remote control panel along with Local Arrow Scale device.

3.05.04 Suitable Control Valve complete with all associated accessories (preferably pneumatically operated) on the make up water line (from Water Source) actuated from sensing of sump level shall be provided.

3.06.00 Level Control for Overflow Transfer Sump

Continuous sump level shall be shown by installation of level transmitter. Also the following shall be available.

3.06.01 "High" level & "Low" level alarm in respective control panel.

3.06.02 "Very Low" level alarm with tripping of all running transfer Pumps subject to fulfillment of both sensing through level indicator and actuation of Float Switch.

3.06.03 Level indication device to monitor level in the remote control panel along with Local Arrow Scale device.

3.06.04 Suitable Control Valve complete with all associated accessories (preferably pneumatically operated) on the makeup water line (from Water Source) actuated from sensing of sump level shall be provided.

3.07.00 Pressure indicators, Flow indicators, Level indicators, Pressure Switches etc. as & where required for smooth functioning of the system shall be furnished by the bidder.

3.07.01 All complete wiring & hardware shall be provided by the bidder so that it can be readily connected to the purchaser's switchgear wherever required.

3.07.02 Besides above so far described which is the min. requirement, the bidder shall include in his proposal a detailed & complete description of the Control System for safe, satisfactory & best operation of the plant complete with Schematic diagrams, description & function of component, rating etc.

4.00.00 SCOPE OF WORK

4.01.00 Scope of Supply

The scope of work of the bidder covered under this specification is described here-in-under. The items which are not specifically mentioned but needed to make the system complete and reliable for safe operation and guaranteed performance shall also be treated as though included and the same shall be furnished unless otherwise categorically excluded.

The bidder shall take a note that design, engineering of the entire Ash Handling Plant envisaged in the specification is the responsibility of the bidder himself - such design engineering essentially includes system design and sizing of all equipment/ components.

In case of confusion/contradiction with other volumes, if any there, the bidder is advised to seek clarification.

Quantities indicated here below are broadly indicative and for the purpose of tendering only.

4.01.00 **BOTTOM ASH HANDLING SYSTEM UP TO COMMON SLURRY SUMP**

4.01.01 Total Eight (8) (4W+4S) Scrapper chain conveyors - Four scraper chain conveyors for each 660 mw unit.

4.01.02 Two (2) dry bottom ash hopper – one for each 660 MW unit. .

4.01.02 Four (4) hydraulic cylinder operated Feed Gate for each dy bottom ash hopper.

4.01.03 Total four (4) transition chutes for receiving bottom ash from scraper chain conveyor – two for each 660 MW unit.

4.01.02 One (1) hydraulic cylinder operated Feed Gates for each transition chute.

4.01.04 Total eight (8) (50% duty) Clinker Grinders to be installed below the transition chutes to Crush large lumps - complete with drive motors, Fluid couplings, gearboxes, Chains & Sprockets, Protective guards & all other accessories – four (4) for each 660 MW unit.

4.01.05 Total eight (8) (50% duty) Feed Sumps installed below Clinker Grinders Complete with abrasion liner, flushing connections & all accessories – four (4) for each 660 MW unit.

4.01.06 Total eight (8) (50% duty) jet pumps installed below clinker grinder for pumping bottom ash slurry – four (4) for each 660 MW unit.

4.01.07 Total two (2) overflow weir box- one for each 660 MW unit, each provided with abrasion resistant plates, arrangement to receive overflow water from BA hopper and discharge Connection to Overflow transfer sump for each triple V hopper.

4.01.08 Total two (2) RCC overflow transfer sump lined with wear resistant plates to receive overflow water from weir box – one for each 660 MW unit.

4.01.09 Four (4) streams of ash slurry transport pipelines from discharge of jet pumps up to distribution trough of common ash slurry sump complete with valves, alloy fittings, sleeve type couplings, supports, hangers etc. as required for each 660 MW unit.

4.01.10 Two (2) overflow transfer pumps complete with drive motors, Couplings & other accessories, instrumentations etc. to pump out the overflow liquid to the settling tank for each 660 MW Unit.

4.01.11 Two (2) Ejector operated drain pumps to be installed into the drain pits at BA hopper area to transfer the drain to the overflow transfer sump/tank for each 660 MW Unit.

4.01.12 One (1) Seal Trough overflow tank per unit (Total 2 tanks) to collect overflow from seal trough of SCC & seal water return from Vaccum pump. Tank shall have 30 min retention capacity.

4.01.13 Two (1W+1S) – Seal water overflow transfer pumps per unit (Total 4 pumps) installed in the seal water overflow tank to recirculate seal water.

4.02.00 **COARSE ASH HANDLING SYSTEM UP TO COMMON SLURRY SUMP**

4.02.01 Requisite numbers of manually operated plate/knife gate valves, water trough type expansion joint, flushing box along with pipes, hangers, pipes, fittings etc. shall be furnished under each economizer hopper to discharge coarse ash to scraper chain conveyor of respective unit in slurry form.

4.03.00 Fly Ash System up to Combination Filter Separator cum Buffer and thereafter up to Fly Ash Storage Silo.

4.03.01 Fly Ash System from Hoppers up to Combination Filter Separator cum Buffer Hopper (Dry Handling through vacuum).

a) Fluidizing pads with support structures, pipes, valves & fittings etc below the ESP & APH hoppers.

b) Necessary adapters to match the hopper outlet flanges.

c) Requisite number of air intake valves.

d) Requisite numbers of fly ash hopper remote operated individual ashintake valves complete with actuators, associated solenoid valves, instrument air pipings, valves, fittings etc. which will be placed on the downstream of ash isolation valves.

For ESP 1st, 2nd and 3rd field hoppers only (please refer single line flow diagram for details), specially fluidized type ash intake valves with pneumatically actuated valves, poke rods and other fittings shall be provided or ash intake valves with full proof fluidising arrangement at ESP hoppers to ensure free flow ash into stream shall be provided.

e) Requisite number of remote operated slide type gate valves for fly ash stream branch isolation with electric position indicator.

f) Total four (4) Combination Filter Separator cum Buffer Hopper of transfer hoppers each having ash storing capacity of around minimum **25 cum** for each 660 MW unit shall be provided**.** Necessary Pressure/vacuum relief mountings, level sensing devices, hopper fluidizing pads with pipings, fittings etc., Cast basalt/ equivalent lining in the bottom pyramidal section of the hopper; all necessary structures, stairways, handrails etc. Requisite

numbers of manually operated knife gate valves at surge hopper/ Combination Filter Separator cum Buffer Hopper outlets.

g) Eight (4W+4S) nos. low speed water ring type Vacuum Pump to generate necessary vacuum for first stage vacuum conveying for each 660 MW unit.

h) Total four (4) sets of vacuum pneumatic conveying pipelines of 1st stage conveyance from air intake valves to Mechanical exhausters, each set suitably designed for corresponding vacuum conveying stream for each 660 MW Unit.

i) Fluidizing air system (for 1st stage conveyance) comprising Total two (2) of hopper fluidizing blowers and total Two (2) nos. of hopper fluidizing blowers heaters to serve the ESP, A/H hoppers & Combination Filter Separator cum Buffer Hoppers complete with suction filters cum silencers, relief valves, discharge pressure indicators, isolating and non return valves, drive motors; instrumentation; all necessary pipes, valves; fittings, hangers, supports; thermal insulation & cladding etc for each 660 MW Unit.

4.03.02 Fly Ash System from Combination Filter Separator cum Buffer Hopper up to Silo (Dry Handling through pressure system)

a) Total Three (3) sets (Two sets working & one set common stand by) of fly ash conveying screw compressors (oil free) with intake air filter cum silencer, discharge valve with non return valve, relief valve, and all necessary instrumentation for supplying conveying air to the system for each 660 MW Unit.

There shall be three (3) air receivers, one for each conveying oil free screw compressors of 2 cum size for each 660 MW Unit.

b) Three (3) sets of refrigerant type air drying units installed at outlet of each conveying air compressor. The capacity of each air drier shall be equal to capacity for each conveying air compressor.

c) Total four (4) sets of dry fly ash conveying pipes with valves, specialties, fittings, supports, hangers etc. from buffer hopper to fly ash storage silos for each 660 MW Unit.

d) Total four (4) Common R.C.C. fly ash storage silos of capacity 1000 T each for storing fly ash and allowing transport trucks to receive fly ash from it. Each silo shall be fitted with air slides (fluidizing pads), diffusion hoods at the silo bottom and shall be complete with suitable number of pulse jet operated bag filters followed by suitable number of vent fans; high, level transmitter for ash conveyer control.

Each silo shall have one (1) openings duly blanked with flanges (with isolating valves) for future fly ash conveyance; one (1) rotary Drum Conditioners cum Unloaders for discharging conditioned ash to the trucks, two (2) telescopic spouts with scavenger fan for unloading on closed tankers and two (2) nos. jet pump connections for disposing flyash in slurry form to existing ash dyke..

Each silo shall be provided with Two Nos. (2) large size access door for maintenance & inspection purpose; level detection device for

showing ash level in silo; relief valve to handle any unusual pressure/vacuum surges inside silos; antistatic protection (electrical) if required to prevent dust explosion.

e) Fluidizing Air system Comprising total (5) silo fluidizing blowers (one for each Silo and one common stand by) Complete with Suction filters cum silencers, relief valves, discharge pressure indicators, isolating & non return valves, drive motors, electric air heaters five (5) nos 1W for each silo & 1 common standby.; all necessary pipes, valves, fittings, hangers, supports ; thermal insulation and cladding etc.

4.03.03 **FLY ASH WET SYSTEM**

In case of emergency condition 50% of Flyash in wet form shall be disposed off in slurry from by jet pumps under the remote silo to the existing ash pond. In case it is not possible to dispose wet fly ash to the existing ash pond by jet pumps then separate sets of ash slurry pumps installed in as separate ash slurry pumpshouse located near the silo shall dispose off the wet flyash to the existing ash pond.

The scope of wet flyash handling shall include but not limited to the following :

a) Two (2) nos. jet pumps per silo with HP water connections to dispose off the wet flyash to the existing ash pond.

b) Wet flyash piping with all associated valves from renmote silo to the existing ash pond.

c) In case it is not possible to dispose the wet flyash to existing ash pond by the jet pumps then 4 x 50 % ash slurry pumps shall be installed to dispose off the wet fly ash to the existing ash pond. Ash slurry pumphouse shall be constructed near the flyash silo for housing these ash slurry pumps. In such case slurry pumphouse is provided for disposing flyash then space provision shall be kept in the pumphouse for installing three additional pumps in future alongwith necessary sump.

4.04.00 **BOTTOM ASH, COARSE ASH, FLY ASH SLURRY CROSS COUNTRY TRANSPORT SYSTEM**

All types of ash slurry and sludge get collected in the common slurry sump. The common slurry pumps transport the fluid up to the ash dump area by means of trunk slurry piping.

4.04.01 One (1) common over-ground adequately sized ash slurry sump of R.C.C. construction suitably compartmentalized; common slurry distribution trough; plug gates, overflow connection, internal wear resistant plates, individual compartment slurry outlet connection, agitating nozzles with pipes & valves, level sensing & controlling instrumentation.

4.04.02 Total three (3) sets of slurry pumps each set comprising suitable & optimum No. of stages (provision for incorporating at least one no. future stage to be made) of pumps complete with variable speed fluid coupling (scoop controlled) for 1st stage & v-belt drive for subsequent stage sealing water connection, fluid coupling cooling water system associated slurry pipelines, instrumentation etc. Slurry Pumps shall be of 50% duty. Provision shall be made in the ash slurry sump & pumphouse to install an additional ash slurry pump in future.The future pump should be installed without any additional civil modification.

4.04.03 There shall be three (3) (2W / 1S) cross country slurry disposal pipes on pedestals, on existing terrain, complete with supports, fittings, coupling, specialties etc. from ash slurry pump discharge to ash dump area. Normally slurry pipes shall be on pipe rack in plant boundary & on pipe pedestal outside plant boundary.

4.04.04 Vertical, Centrifugal, single stage, semi-open or (open non-clogging) type impeller type drain pumps to be provided in Slurry Sump area, Vacuum Pump House Area and near silo area. In Slurry sump area total two no drain pumps for two units (one working and one stand by) shall be provided. In Silo area total two no drain pumps for two units (one working and one stand by) shall be provided. In Vacuum Pump House Area total four no drain pumps for two units (one working and one stand by for each unit) shall be provided. For BA system operation the area shall be provided with two four nos ejector type drain pumps (1W+1S) per unit shall be provided for the area drain pit.

4.05.00 **COMMON MAKE UP WATER & RECOVERY WATER SYSTEM**

Water from Station Cooling Tower blow-downs; raw and/or clarified water and also decanted water from the ash dump area shall comprise the input water sources for Ash Handling system. Various types of water are used for various Consumers while keeping Maximum vigil on the aspect of reuse of water such that water economy is achieved.

4.05.01 Ash Handling Plant Make-up Water

a) AHP Seal Water Pump

RO Stage I Permeate Water (through AHP Seal Water Pump) shall be used for providing seal water to all required eqpt like clinker grinders, jet pumps, slurry pumps, vacuum pumps, sea trough and rotary dust conditioner in silo.

b) Ash water from guard pond.

Make up to ash water sump shall be from CTBD/ guard pond for meeting the HP water, LP water & economizer ash water requirements.

c) Ash Compressor cooling shall be through DMCW Pump.

d) RO Stage II reject from CMB shall be used for dust conditioning in Flyash silo.

4.05.02 Two (2) nos. (1W+1S) LP Seal Water Pumps along with pipes, valves, fittings, supports, instrumentations, etc

4.05.03 Two (2) nos. (1W+1S) HP Seal Water Pumps along with pipes, valves, fittings, supports, instrumentations, etc

4.05.04 Following pumps shall be installed in the Ash Wwater Pumphouse.

- Four (4) nos., each of 100% duty, HP Ash Water Pumps. Two (2) (1W+1S) pumps shall be for each 660 MW Unit .
- Four (4) nos., each of 100% duty, LP Ash Water Pumps. Two (2) (1W+1S) pumps shall be for each 660 MW Unit .

- Four (4) nos., each of 100% duty, Economiser Water Pumps. Two (2) (1W+1S) pumps shall be for each 660 MW Unit .
- Two (2) nos. (1W+1S) Flushing water pumps.
- Provision shall be kept in the ash water pumphouse for installation of eight additional pumps in future (2 nos of each type listed above) for the future 660 MW unit.

4.05.06 Total Two (2) FA unloader Spray Pump with drives valves, pipelines, fittings, accessories etc for each 660 MW unit. These shall be located near the flyash silos..

4.06.00 **INSTRUMENT AIR SYSTEM**

The entire demand of Ash Handling Plant Air Requirement for control, operation of remote operated Valves, Pneumatic Cylinders etc. shall be independently met from Instrument Air System to be furnished by the Ash Handling Bidder.

4.06.01 3 x 50% duty Oil free Screw type Instrument Air Compressors-total (two working & one stand by) complete with Intercoolers, After Coolers if required inlet air filter cum silencers, and complete with drive motors, pulleys, belts, piping, valves, strainers, fittings, indication and protective instrumentations, panels, instrument pipings, supports, hangers, specialties etc. shall be furnished.

4.06.02 3 x 100% duty Air Drying Plants (Refrigerant type) - (Two(2) sets working and one set stand by). Each set of Air Drier shall have a through put equal to One (1) compressor output.

4.06.03 At least two (2) Air Receivers 5 cum size complete with all fittings, vent connection, trap drain stations, relief valves, instrumentation, valve fittings, supports etc. For distribution of air in the FA silo area one additional receiver 3 cum size will be necessary because of distance to absorb pressure excursion. Moisture separator shall be provided.

4.06.04 All necessary distribution piping; valves; fittings, supports etc. within the Ash Handling plant.

4.06.05 Crane and hoist as necessary in vacuum pump house, ash slurry pump house, compressor house, ash water pump house, recovery water pump house, chemical house related with clariflocculator, silo floor and other areas as necessary. For details refer chapter 17 Vol III.

4.07.00 **MAKE UP WATER SUPPLY:**

4.07.01 All piping including valves, pipe supports, fittings, bypass lines, instrument air connection (if applicable) and all instruments for both raw water make up and cooling tower blow down (as make up) line up to the ash water sump after the specified terminal points of raw water and cooling tower blow down line (mentioned elsewhere in the specification including raw water and cooling tower blow-down water), will be in the scope of the ash handling vendor.

4.09.00 **SCOPE OF SUPPLY AND WORKS - ADDITIONAL NOTES**

The detailed scope of supply and work for the following sub- systems, associated

with this plant, although have not been specified in detail within this volume shall be deemed to be included within the Main plant package and has already been covered in detail in corresponding sections. The scope of such work under this specification includes, but not limited to the following:

a) All Civil Work of and pertaining to the Ash Handling Plant.

List of Work - Ash Slurry Pump House; Ash Water Pump House; All pump Sumps; Ash handling control-cum-Fly Ash Equipment Building, housing in its ground floor respective Fly ash Hopper Fluidizing Blowers and Mechanical Exhausters; Fly Ash Conveying Compressor Building, housing in its ground floor common conveying compressors/Blowers and Instrument Air Compressors; Fly Ash Storage Silos; Weigh Bridge along with all accessories at silo area; Silo utility building, Cross country pipe Bridge, culvert, (roads) crossings, pipe pedestals; etc. at ash disposal area; etc. For details refer Volume VI.

b) All Structural - List of Work - Overhead Pipe racks; Work (Steel) FAE TOWERS; Economiser Coarse Ash Tank Structures etc. complete with stairs, galleries, platforms etc.

.

c) All Architectural - for all Civil Work, Supplies as required Supplies and work and as per good engineering practice including toilets, Drinking water facilities. Ref. Relevant part of specification.

d) All Electrical - Auxiliary power transformer(11/3.45 KV),HT/LT switchgears; LT power transformer, PMCC; all cablings, Supplies & Works Illumination; grounding system; Lightning Protection; etc. . Ref. Relevant part of specification.

e) All Instrument - As required and as per standard/good station Supplies engineering practice including cables, junction boxes; instrument hardwares and softwares, etc. Ref. Relevant part of specification.

f) Ventilation - The FACP rooms, MCP room and wherever PLC System & Air equipments are placed shall be air-conditioned; All other Rooms conditioning System and Buildings shall be properly ventilated by judicious selection system of equipment. For detail, Ref. Relevant part of specification.

g) Fire Protection - As per recommendations of the fire safety System codes available in the country and as per good engineering practice for all Buildings installing equipment and having operator habitation. Ref. Relevant part of specification.

h) Electric Overhead- As required in the Ash Handling Plant. Traction Cranes; . Ref. Chapter 17 , Volume III.

i) Erection, Testing - As required and as described elsewhere. Pre-commissioning Adherence to Safety codes/norms etc. Ref. Relevant part of specification.

4.10.00 **SCOPE OF SUPPLY SHALL INCLUDE**

i) Complete cleaning, protection and painting.

ii) Packing, forwarding and transportation to site including transit insurance.

iii) Shop testing of all equipment as listed elsewhere in this specification.

iv) Unloading, storage and handling at site, leveling, grouting, erection of plant, touch up painting at site, final check up, testing and commissioning of all equipment and accessories of the complete plant

v) Any additional equipment and materials or works, which are not specifically mentioned, but required to make the installation complete in every respect shall be under the scope of the specification.

vi) The contractor shall arrange his own insurance for storage associated with scope of contract defined above. For insurance clause, Bidders are advised to refer the Volume-I, Conditions of Contract.

vii) The contractor shall arrange for necessary handling equipments, if required, for the erection of equipments under his scope.

viii) Supervision of equipment Civil/Foundation work.

ix) Lubricants (oil/ grease) till commissioning. (i.e., till the commissioning of the unit is over.)

x) Mandatory spares.

xi) Recommended spares

xii) Special tools and tackles

5.00.00 AIR DRYING PLANTS (REFRIGERANT TYPE)

5.01.00 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	:	Requirement for refrigerent condensing type units
iv) IS-5111	:	Testing of refrigerant compressor
v) ISO 8753.1	:	Filter quality classes

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 deg 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 Kg/cm2 (g) or more as per the requirement of Contractor

The compressors and Air Drying plants shall operate under the following ambient conditions.

(i)	Minimum temperature	10 deg.C
(ii)	Maximum temperature	50 deg. C
(iii)	Design condition (temperature & Relative humidity)	50 deg.C & 100% RH
(iv)	Height above MSL (m)	As given in Plant information

(A) One number Air drying plant shall be provided for each Instrument air compressor. The air driers shall be refrigerant type.

Wet Compressed air undermines efficiency of smallest to the largest pneumatic system. Therefore, moisture removal in compressed air system installation is a must. The incoming saturated, moist air shall be precooled in the Air - to - Air Heat Exchanger by the outgoing dry chilled air to ensure that a greater part of Water Vapour gets condensed into liquid moisture. Further moisture separation shall take place in the Freon -to- Air Heat Exchanger where air is chilled to a temperature of +2 Deg. C. and moisture condenses. This temperature is termed as pressure 'Dew Point'. The Moisture Separator removes the condensate by an Automatic Condensate Trap i e. auto drain.

The compressed dry air shall be reheated in Air -to- Air Heat Exchanger and fed to the point of application. As long as compressed air temperature remains above the +2 Deg. C., no further condensation shall occur. The refrigeration circuit shall be conventional circuit comprising refrigerant Compressor, air and water cooled Condenser , Expansion Valve etc. using Freon R-22 as refrigerant gas. Ecofriendly Refrigerant like R-134 A, R-404 A, R-407C shall be used. ADP shall be water cooled

(B) The compressor shall be hermetically sealed.

(D) The material of Construction for various components of ADP shall be as follows:-

ADP Vessel	Carbon Steel
All internals of adsorber vessels	SS-304

Cooler shells, channels and covers, Cooler tube sheet & tubes	Same as that in intercooler / after coolers
• Relief Valves	Brass or SS
• Desiccant	Silica gel or activated alumina
• Air Piping	Galvanized Steel
• Valves in air line	CI or Cast steel or Forged Steel body with SS trim
• Valves in water pipe lines	SS/ Bronze / Gunmetal

(F) Control Philosophy

Sequential operation of the ADP & air compressors shall be controlled automatically with a provision for manual take over.

Change over of tower from drying mode to standby mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor.

The control system shall provide the (as minimum) alarms, "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 of the same.

6.00.00 VACUUM PUMPS FOR FLY ASH EXTRACTION

6.01.00 Vacuum pumps shall be sized to meet evacuation criteria as indicated in accompanying data sheet. A minimum margin of 10% over the above capacity shall be considered for sizing of the vacuum pumps.

6.02.00 Silencers shall be provided so that each vacuum pump complies with the noise level limits stipulated by statutory authority. Moisture Separator shall be provided to separate liquid and air and to reduce noise.

6.03.00 DATA SHEET OF VACUUM PUMPS

Type	:	Low speed liquid ring type
Nos. working and standby	:	As indicated in the Single line flow diagram
Design condition	:	Vacuum pump shall be sized for 600 C gas temperature and 34^0 C seal water temperature with gas as 100% dry basis.

		However motor capacity shall be suitable to handle same capacity of air at 20^0 C
Guaranteed figure	:	For 20 C gas temperature and 15 C seal water temperature
Sizing of vacuum pumps		To cater to the ash removal rates as specified. A minimum margin of 10% over the above capacity shall be considered for sizing the vacuum pumps. In case the first field of ESP goes out of service, the second field shall collect the ash of first field and so on. The design shall take care of this aspect.
Material of Construction		
Casing with cones/ Port Plates	:	Ni Cast Iron (min 2.0% Ni)
Shaft	:	Carbon Steel EN8
Impeller	:	Stainless Steel
Shaft Sleeves	:	Stainless Steel
Type of coupling between Pump & MotorAccessories	:	V Belt drive along with belt-guards. Necessary moisture separator and silencer, Vibration isolation pad, Vacuum breaker, Accoustic enclosure if applicable.
Location, Duty	:	Indoor, Continuous.
Inlet seal water temperature	:	34 deg. C
Noice level	:	85 dB (max) at a distance of 1M from equipment

7.00.00 **HORIZONTAL CENTRIFUGAL PUMPS**

7.01.00 The ash slurry pumps, B.A. over flow pumps, HP pumps, LP pumps, Economiser Water Pumps, sludge pumps, seal water pumps shall essentially be horizontal and centrifugal type.

Data Sheet of Horizontal Centrifugal Pumps

S. No.	Description	Ash slurry disposal pumps	HP, LP, Economiser Water Pumps, Flushing Water Pump, BA overflow water pumps and other Horizontal water pumps as indicated in the single line flow diagram.	
	Type	Horizontal, single or multi stage Centrifugal type (All identical pumps shall be	Horizontal, single or multi stage centrifugal type (All identical pumps shall be interchangeable)	

S. No.	Description	Ash slurry disposal pumps	HP, LP, Economiser Water Pumps, Flushing Water Pump, BA overflow water pumps and other Horizontal water pumps as indicated in the single line flow diagram.	
		interchangeable)		
	Duty	Continuous	Continuous	
	Fluid to be pumped	Highly abrasive slurry .Pump shall be designed to handle maximum ash lump size expected at the outlet of clinker grinder	Sea Water	
	Parameters	Flow s per design guidelines contained in accompanying specifications & Head		
	Suction condition	Flooded suction with suction lift of 2m		
	Pump speed (max.)	1,000 rpm	1,500 rpm	
	Impeller tip speed	1676 meters / min. (max.)	As per mfgr. Std.	
	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 disposal pumps for the subsequent stage through belt drive	Directly driven through coupling	
	Material of construction			
	Casing	Refer datasheet below	Duplex SS 2205 UNS 31803	
	Impellers		Duplex SS 2205 UNS 31803	
	Shaft		Duplex SS 2205 UNS 31803	
	Shaft Sleeves		Duplex SS 2205 UNS 31803	
	Bolts/ Nuts		SS 316L	
	Column Pipe		SS 316L	

DATASHEET FOR ASH SLURRY PUMP

1	ASH SLURRY PUMP		
A	Quantity and Capacity		3 Nos for bottom ash and 3 nos for flyash (if reuired).; Bidder to decide.

B	Type		Horizontal, centrifugal, Single Stage, double casing
C	Type of Drive		Belt/ direct drive
D	Gland sealing		Forced external water
E	Material of construction		
	Outer casing		ACI to IS 4771 Type 1(a) with 4.5% Ni with 500 BHN
	Inner casing & casing liners		ACI to IS 4771 Type 1(a) with 4.5% Ni with 500 BHN
	Impeller		ACI to IS 4771 Type 1(a) with 4.5% Ni with 500 BHN
	Shaft		SS 316 L
	Shaft Sleeve		SS 316 L
	Bolts/ nuts		SS316L

8.00.00 VERTICAL PUMPS

DATASHEET FOR BA DRAIN PUMP

Sl. No.	**Item**	**Units**	**Description**
1	Numbers	No.	Two (1 w + 1 s) per unit
2	Type		Vertical, non-clog
3	Capacity rate	Cum/hr	Min 100
4	Head	mwc	As per requirement.
5	Type of lubrication		Self lubrication
6	Max speed of pump	Rpm	1000
7	Material of Construction		
	i. Casing		Duplex SS 2205 UNS 31803.
	ii. Impeller		Duplex SS 2205 UNS 31803.
	iii. Shaft		Duplex SS 2205 UNS 31803.
	iv. Shat sleeves		Duplex SS 2205 UNS 31803.
	v. Column pipe		SS 316 L
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		Duplex SS 2205 UNS 31803.
	viii. Bolts & Nuts		SS-316L
8	Electric supply		415V, 3 phase, 50 Hz.
9	Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55

Sl. No.	Item	Units	Description
10	Speed of pump motor rating	rpm	1450

DATASHEET FOR SEAL TROUGH OVERFLOW TRANSFER

Sl. No.	Item	Units	Description
1	Numbers	No.	Two (1 w + 1 s) per unit
2	Type		Vertical, non-clog
3	Capacity rate	Cum/hr	As per requirement.
4	Head	mwc	As per requirement.
5	Type of lubrication		Self lubrication
6	Max speed of pump	Rpm	1000
7	Material of Construction		
	i. Casing		SS 316
	ii. Impeller		SS 316
	iii. Shaft		SS 316
	iv. Shat sleeves		SS 316
	v. Column pipe		SS 316
	vi. Packing		Braided Impregnated Teflon
	vii. Flexible coupling		SS 316
	viii. Bolts & Nuts		SS 316
8	Electric supply		415V, 3 phase, 50 Hz.
9	Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55
10	Speed of pump motor rating	rpm	1450

9.00.00 **SLURRY LINE VALVES**

Adequately sized pneumatic cylinder operated metal to metal seated knife edge gate valves/plug valves shall be provided at the outlet of Jet pumps handling bottom ash; at the suction and discharge of combined ash slurry disposal pumps and BA over flow water pumps suction/discharge.

9.01.00 The selection of the type of valve shall be done based on the line pressures. It shall be ensured that the metal to metal seated knife edge gate valves strictly meet the testing requirements of MSS-SP 81 code for seat leakages.

9.02.00 Valves shall be provided with a mechanical indicator and limit switches to

indicate open or closed position of the valve locally and remotely.

9.03.00 Data sheet - Slurry line valves

i) For working pressure up to 10 kg/cm2 : Metal to metal seated knife gate valve shall be selected.

ii) For working pressure above 10 kg/cm2 – Plug type regular pattern valve or resilient sealed knife gate valves shall be used.

iii) Material of construction shall be as follows:

Body/Cover	SS 316L
Gate/Plug	SS 316L
Stem	SS 316L

10.00.00 ASH SLURRY DISPOSAL LINE (BA AND FA) PIPES

10.01.00 Ash Slurry Disposal Pipes

10.01.01 The bottom ash slurry transportation piping shall continue without bends, branches or merging for a distance of at least 8-10 pipe diameter length from jet pump outlet.

10.01.02 The ash slurry disposal pipelines shall be provided with adequately sized drain connections with blind flanges (with valves) at lower most location and vent connections with blind flanges (with valves) at top most location as per the final layout requirements.

10.01.03 Bidder shall conduct line surge studies for the ash disposal pipelines and submit these to the Engineer for review. Suitable arrangements as required to protect the system based on approved line surge studies shall be included in Bidder's scope.

10.02.00 **FITTINGS**

10.02.01 All fittings (bends, elbows, laterals & spool pieces etc.) used in ash slurry disposal piping up-to ash dyke shall be basalt lined with flanged ends.

10.02.02 These fittings shall be as per good engineering practice and of large radius (Min. 3D) construction.

10.02.03 Basalt lined spool pieces of minimum 1.5 meter length shall be provided at the discharge of every fitting immediately after slurry pump discharge.

10.03.00 Couplings

10.03.01 For ease of rotation and replacement of ash slurry disposal pipes at regular intervals of time for maintenance purpose, sleeve type couplings shall be provided.

10.03.02 Straight length of pipes without any intermediate coupling shall not exceed 30 meters. It shall be possible to replace or rotate (as applicable) any fitting and any particular spool or pipe during maintenance without unduly disturbing neighboring healthy joints and pipe spools. Bidder shall furnish calculation

for selection and spacing of couplings taking into account forces due to expansion contraction, deflection, lateral displacement etc.

10.03.03 The coupling shall be capable of taking a minimum of 2° angular deflection and sufficient gap between ends of pipes at couplings shall be provided to take care of expansion in piping.

10.04.00 **DATA SHEET**

Bottom ash slurry line	MS ERW steel pipes, min. 9.52 thk as per IS:3589 Gr FE 410 with 20 mm thk Basalt Lining or Cast Iron Pipes.	
Ash slurry disposal pipe	- Do -	
Fly ash slurry pipe	- Do -	
I. Pipe Fittings (Bends, Elbows, Laterals And Spool Pieces Etc.)		
Material and Hardness:	i) From plant boundary to Ash dyke ii) Over Ash Dyke	Min. 20 mm thick cast basalt lined MS fittings
	i) Bottom ash slurry and fly ash slurry handling lines ii) From Ash Slurry Pump House to plant boundary	Min. 20 mm thick cast basalt lined MS fittings (MS shell of 6 mm thickness)
Cast basalt Fittings	Hardness : 8 mhos (minimum)	
	Bending strength : 300 Kg/cm2 (minimum)	
	Compressive strength : 4500 Kg/cm2 (minimum), Density: 2.8-2.9 gm/cm3	
Basalt lined piping shall be provided within ash slurry pump house and in Culverts/ Trenches/Bridges.		
II	Type of Joints	Sleeve type coupling joint in straight length, flanged joints at fittings,bends, elbows, laterals etc.
III.	Couplings	
1.0	Type:	Sleeve type couplings with minimum 9.0 mm thick sleeve.
2.0	Material of Construction	
2.1	Sleeve:	CI FG 260: IS 210
2.2	Flanges/End rings:	Cast Iron FG –260
2.3	Nuts & Bolts:	SS 316L

10.05.01 **DATA SHEET**

10.05.02 Pneumatic Ash Transport Pipe Lines & Fittings

Piping	**Conveying from ESP to Buffer Hopper**	**Conveying from Buffer Hopper to Storage Silo**
a) Manufacturer**:**	As per approved Vendor list	

Piping	**Conveying from ESP to Buffer Hopper**	**Conveying from Buffer Hopper to Storage Silo**
As per approved Vendor list		
b) Material and hardness**:**	CI Pipe conforming to IS:1536 / BS:1211 with minimum thickness conforming to class D. Pipes of non-standard size without conforming IS/BS will not be accepted	MS ERW Pipe with min. wall thickness of 8.00 mm as per IS 3589
c) Velocity of air – ash Mixture (M /Sec.)**:**		
i) Pick up velocity**:**	21.0 m / s	14.0 m / s
ii) Exit velocity:	18.0 m / s	15.0 m / s
d) Quantity of each pipe length (M) **:**	As per layout drawing.	
e) Total pipe quantity (M)**:**	As per layout drawing.	
f) Type of joints		
i) Pipe to Pipe **:**	Sleeve Coupling	
ii) Pipe to fitting / valve **:**	Sleeve Coupling / Flanged	
iii) Fitting to fitting / valve**:**	Sleeve Coupling / Flanged	

10.05.03 Pneumatic Ash Transport Pipe Lines & Fittings **-** Fittings (Elbows, bends etc.) and spool piece

	Conveying from ESP to Buffer Hopper	**Conveying from Buffer Hopper to Storage Silo**
a) Type of fittings, bends, elbow, lateral & spool piece**:**	Integral wear back	
b) Estimated number of various fittings & spool	As per layout drawing.	
c) Radius of fittings : d) Length of straight spool piece **:**	As per layout drawing As per layout drawing	
e) Material of construction, thickness and hardness of fittings, spool Piece and Lining, if applicable.	Min. 20 mm thick cast basalt* lined MS fittings (MS shell of min. 6 mm thickness) or Ni-Hard / Chrome Alloy CI, min. 450 BHN with min. 20mm thick integral wear back	
F)Properties of Cast Basalt	Hardness : 8 mhos (minimum), Bending strength : 300 Kg/cm2 (minimum), Compressive strength : 4500 Kg/cm2 (minimum), Density: 2.8-2.9 gm/cm3	

11.00.00 BOTTOM ASH HOPPER & ECONOMIZER ASH TANK

Maximum water level in bottom ash hopper	As per Bottom ash Hopper seal plate assy
Hopper Body	Tested quality mild steel plates of thickness not less than 10mm (IS 2062) except top 1100mm of hopper including seal trough shall be constructed of 6 mm thick SS 316L. The entire inner BA Hopper walls shall be lined with suitable castable refractory.).
Refractory anchors	Stainless steel, AISI:316L
Sluicing/Arch Breaking/wash nozzles	Body: SS Nozzle tip : tool steel or SS of hardness not less than 550 BHN or SS with ceramic inserts.
Refractory Cooling water header inserted in refractory	Stainless steel
Seal trough	Stainless steel SS: 316L, Seal trough of the bottom ash hopper should be integral construction.
Refractory	Castable refractory of minimum 230 mm thickness. Protection measures such as embedded impact bars shall be provided to prevent damage to refractory in area of clinker impact.
Temp. of Bottom Ash	1050 Deg.C
Minimum effective ash storage capacity	**8** hours (Bottom Ash + Economiser Ash)
Minimum angle between hopper wall & horizontal	45 Deg. (Approx.)
Cooling Water Temperature	40 Deg C.
Maximum allowable ash level in bottom ash hopper	300 mm below the maximum water level.
TSS of overflow water	Less than 100 PPM.
Quantity of furnace ash for calculating cooling water requirement	25% of total ash at 100% PLF with worst coal firing.
No pits in the boiler bottom are allowed to accommodate bottom ash handling equipment.	

11.01.00 BOTTOM ASH HOPPER DISCHARGE GATE

Data Sheet of Bottom Ash Hopper Discharge Gates

Quantity / Nos.	:	Four per Hopper
Capacity of Each Gate	:	Shall be capable of discharging 100% of the contents of one hopper section within specified time.
Drive of Feed Gate	:	Hydraulic, to ensure smooth & guided opening / closing to limit friction & wear.
Inclination of feed gate	:	Same as that of BA hopper.
Wear protection liners	:	Shall be provided on gates

			inside of gate housing & sliding surface coming in contact with gate.
	Accessories of Ash gate housing		
	Access door	:	600mm dia (min)
	Material of Construction		
	Gates	:	Cast Iron IS:210, Gr. FG-260.
	Gate wear liners	:	6mm thick SS:316
	Gate spindle	:	SS
	Housing Wear plates/ impingement plates	:	25mm thick Alloy Cast Iron IS:210 Gr. FG-260 Min. 400 BHN
	Housing	:	10mm thick (min.) Mild Steel IS: 2062
12.00.00	**CLINKER GRINDER**		
	Function	:	To reduce bottom ash clinkers to (-) 25mm to facilitate pumping through the proposed slurry pipe lines.
	Location	:	B.A. hopper discharge gates housing in case of jet pump system.
	Crushing Capacity	:	To match scraper chain conveyor To evacuate bottom ash from dry bottom ash hopper Grinder speed Not to exceed 40 RPM
	Bearing of clinker grinder	:	Grease lubricated, heavy duty roller bearings. Clear water sealing to be provided at gland seals (TSS of clear water less than 40 PPM)
	Type	:	915 mm double roll : Rolls shall be suitable for auto reverse rotation also in the event of jamming.
	Drive Arrangement	:	Electric reversible drive motor, fluid coupling and gear box. Drive motor speed not to exceed 1000 rpm & shall be sized for frequent start stop-reverse-stop & start duty.
	Wear plates	:	Wear plates shall be provided on clinker grinder inlet and other wearing surfaces of the grinder chamber.

	Base Frame	:	Common Steel fabricated base frame for grinder motor and drive shall be furnished.
	Quantity	:	Four (4) nos.(2W+2S) for each 660 MW Unit.
	Safety Features	:	Grinder motor shall not start till sufficient pressure is obtained in seal water connections.
	Material of Construction		
	Grinder Chamber	:	SS 316 L – with Mn Austentic steel plates IS 276, 10 mm thk.
	Wear Plates	:	12-14% Mn. Austenitic steel plates to IS:276. 10mm thick or 20 mm thk Alloy C.I. with min. 450 BHN
	Grinder Rolls & teeth	:	Manganese steel (ASTM A128, 12-14% Mn) casting, shop hardened to 300 BHN at all working surfaces and work hardened to 400 BHN. Grinder teeth shall be weldable.
	Grinder Shaft	:	Stainless Steel -304 / EN-24.
	Shaft Sleeve	:	SS 316 L
	Clinker outlet chute / Ejector	:	10mm thick mild steel (IS: 2062) lined with feed sump wear resistant liners as above.
13.00.00	**JET PUMP**		
	Quantity	:	Four (4) nos for bottom ash (4 x 50%) for each 660 MW unit and Two (2) nos (1W+1S) for each Flyash Silo.
	Rated capacity (M3/hr)	:	Two (2) nos. ,each of 50% duty. pumps per transition chute to evacuate the dry bottom ash with a minimum 25mm wear on the diameter of throat. Two nos (1W + 1S) per silo and sized to evacuate 50% wet flyash generated in a shift in 4.5 hours.
	.		
	Features	:	Jet pump shall allow for the easy and quick inspection, removal & replacement of the jet pump sections that are subject to wear.

Constructional Details	:	A jet pump should comprise an inlet section, a high pressure water supply connection through a converging nozzle, a mixing zone & a diverging discharge section to the slurry pipe system.

Material of Construction :

- Inlet section, throat & discharge/tail piece	Alloy cast iron as per IS: 4771 type 1(a) min. 4.5% Nickel with min. hardness of 500 BHN
- Nozzle Inlet	CI Grade FG-260 as per IS 210
- Nozzle Tip	Ceramic lined stainless steel (SS304)/tungsten carbide. Min **550** BHN
Tube/ outlet piece	Alloy CI with 2.5% Ni (min) 340 BHN IS 4771

14.00.00 ESP-SURGE/BUFFER HOPPER & SILO FLUIDIZING BLOWERS

a) The blowers shall be oil lubricated and preferably air cooled.

b) The Blowers shall be constant volume/positive displacement type and each blower shall be provided with suction filters, pressure relief valves with the corresponding vent pipe work, necessary isolating and non-return valves, inlet and/or outlet silencer so that blower unit can comply with the noise level requirements outlined in General Technical Conditions and all other accessories of drive and mounting For ESP and buffer hoppers; As per flow diagram.

c) Necessary heating arrangement with a suitable bypass shall be provided at the discharge of the blowers to raise the temperature of aeration air to a temperature of at least 150°C. Schemes shall also include for thermal insulation of all air pipe work from the blower/heater outlet to the point of contact of fly ash.

d) All air blowers and their drives provided under this contract shall be completely interchangeable.

Technical specification of Aeration Blowers for ESP Hopper, Buffer Hoppers & Silo are as follows:

Purpose	For fluidising the ash in buffer hoppers, ESP hoppers & Silos.
Quanity	For ESP-Surge/Buffer Hopper – Two (2) Nos. (1W+1S) for each 660 MW Unit For Silo- Four (4) Nos. 1W for each Silo 1 common standby.
Design	Positive displacement type to meet the aeration air

requirements of fly ash hoppers and buffer hoppers. A 10% margin on capacity shall be provided over and above the maximum requirement.

Duty Continuous, Indoor

Design condition 50 Deg C and 90% RH

Material of Construction

Casing	CI Gr. 260 to IS:210
Shaft	EN 8
Rotors	CI Gr. 260 to IS:210
Gear	EN 353
Piping	MS ERW as per IS 1239/3589, insulated to limit surface temperature to 60 ^{0}C.

Following Instruments shall be provided

a) Pressure gauge at the blower outlet 1 No.

b) Pressure switch at the blower outlet 1 No.

15.00.00 FLUIDISING AIR HEATER

Heaters: One (1) no. for each Fluidizing blower to be provided to maintain the discharge temperature of the air at least 130 Deg C at the aeration pad.

1.00	Application	Hopper (ESP/ Buffer Hopper / Silo)Fluidizing Air Heating
2.00	Working Atmosphere	Heavily dusty, tropical, power plant atmosphere.
3.00	Design ambient dry bulb Temperature	45 Deg.C
4.00	Whether exposed to direct rain and sun	Under Shed
5.00	Type	Electrical, (heating elements shall be segregated into two banks).
6.00	Quantity Required	As per Single line flow diagram
7.00	Rate of Air Flow	As per Blower parameter
8.00	Air Pressure	Based on Blower parameter.
9.00	Inlet Air Temperature for design purpose	Outlet temperature of Blower considering minimum ambient temperature specified at blower inlet.
10.00	Design Outlet Air Temperature	To suit system requirement to maintain the discharge temperature of the air at least 50 Deg.C above the water vapour dew point but not less than 150 deg centigrade.
11.00	Type of Duty	Continuous operation
12.00	Supply Details	415 V ± 10%, 50 Hz ± 5%, combined variation ± 10%, 3 phase, 4-wire, effectively earthed system
13.00	Air Heater Load Condition	Balanced three (3) Phase
14.00	Insulation between	Secondary Insulation Bushing

	heating element body and supporting plate	
15.00	Temperature indicator	
a)	Type	Bimetallic type/ equivalent
b)	Size	150 mm dial
c)	Range	To Suit duty Condition.
d)	Quantity required for each air heater	Two (2) nos. One on inlet and other on outlet side for each heater.
16.00	Temperature Switch	To be provided for each heater where number of heaters working is more that one.
a)	Type	Bidder to indicate for approval
b)	Contact rating	3 amps. at 240V A.C
c)	Suitable for cutting off heating element individually	Yes
d)	Quantity Required	One for each heater
e)	Range	To Suit duty condition
17.00	Temperature Element	
a)	Type & Make	Bidder to indicate for approval.
b)	Range	Bidder to indicate for approval.
c)	Quantity required for each air heater	One (1) no at common header of heater
18.00	Indicating Lamp	
a)	Quantity Required	One (1) for each heating element
b)	Location	Integral with the body of heater
c)	Indication	Heater 'ON' / 'OFF'
The bidder shall include any other instrument required to make the system safe, efficient and reliable.		
19.00	Terminal Box	
a)	Location	Bidder to indicate
b)	Withstand capability for fault level	50 KA (each) at 415 V unless specified otherwise
c)	Power Cable details	To be furnished during order finalization
20.00	Earthing	
a)	Type	Bolted Type
b)	Locations	Two (2) nos. on opposite side of the base of Air Heater Assembly One (1) no. on terminal box.
c)	Details of Earthing Conductor	8 SWG Galvanized Iron Wire
21.00	Whether cable gland and lugs are in scope of supply	Yes
22.00	Mounting bracket included in scope of supply	Yes
23.00	Testing	
a)	Hydraulic Test Pressure of shell	5.0 Kg/cm2g
b)	Air leak test pressure of assembly	1.5 Kg/Cm2g
24.00	Thermal Insulation	At the heater internal and external

		surfaces - such that the external cladding temperature is not exceeding 60 Deg. C. Insulation (mineral wool) material density during application not less than 150 Kg/ Cu. M

16.00.00 INSTRUMENT AIR COMPRESSOR

Applicable codes

BS:1571(part-I & II)	Acceptance test for positive displacement compressors and exhausters
IS:6206	Guide for selection, installation and maintenance of air compressors, plants with operating pressure up to 10 bars
ASME PTC 9	Displacement compressors, vacuum pumps & Blowers
IS 5727	Glossary of terms relating to compressor and exhausters
IS:5456	Code of practice for testing of positive displacement type air compressors and exhausters
BS 726	Compressor performance test
ISO 1217	Displacement compressors-Acceptance tests

16.01.00 GENERAL CRITERION

Type of Compressor	:	Oil free Screw Compressor
Duty	:	Continuous
Location	:	Indoor
Qty	:	Three (3) (2W+1S)

As indicated in the single line flow diagram.

Design Ambient Temp	:	50 Deg.C, 100% RH
Design Requirement	:	Instrument quality air as per specification at the required pressure and flow rate to meet the requirements of instruments, valves, actuators, bag filter cleaning etc. A 10% margin shall be provided on compressor capacity over and above the maximum flow requirement. Compressor shall be rated for a minimum pressure of 8 Kg/cm2 (g).
Drive	:	Electric Motor (Six(6) starts per hour)
Drive motor rating	:	Refer volume-IV, electrical specification.

Annunciation	:	Local/Remote as required
Noise level #	:	Max 85 dB(A) at a height of 1.5m above floor level in elevation and at a distance of one meter horizontally from nearest surface on equipment. The noise level stated is in a free-field condition.

MATERIAL OF CONSTRUCTION

Gear casing, Compressor	:	Cast Iron, Coated with corrosion resistance material
Compressor Casing / Rotor Housing	:	Cast Iron, Coated with corrosion resistance material
Rotors	:	Forged Carbon Steel, Coated with corrosion resistance material
Bull gear	:	Low Alloy Steel
Pinion Gear	:	Low Alloy Steel
Timing Gears	:	Low Alloy Steel
Drive shaft	:	Low alloyed Carbon steel
Shaft Seals/ Retainer rings	:	SS
Safety Valves	:	SS/Bronze/Gunmetal
Inlet throttle Valve & Housing	:	SS or Aluminum
Air Piping	:	Galvanized Steel
Oil Piping	:	SS
Cooling Water Piping	:	Galvanized Steel
Valves in oil lines	:	SS
Valves in water lines	:	SS/Bronze/Gunmetal

TESTING AND INSPECTION

Hydrostatic Tests	:	Yes
Spot Radiography of Welds	:	Yes
Bend Test for receivers (as per BS-5169)	:	Yes
Performance tests at Full load; full discharge pressure; and full RPM as per BS-1571, Part-2 or equivalent.	:	Yes

17.00.00 DATASHEET FOR AIR WATER/ OIL CONVERTER

1	Type of operation		4 way solenoid valve

2	Location		Near BA Hopper
3	Material of construction		MS to IS 2062 (Galvanized inside & outside along with all protuberances)
4	Corrosion Allowance		1 mm
5	Accessories		relief valve, drain valve; all air & water/oil pipe works with four way double coil center off type Solenoid Valves, isolation valves, pressure hoses etc

18.00.00 DATASHEET FOR FLUSHING APPARATUS

1	Quantity and Location		4 nos.; below eco hoppers for each 660 MW Unit
2	Removal capacity	TPH	Bidder to decide
3	Material of construction		
4	Body		10 mm thick MS plate to IS 2062 Gr.A
5	Nozzle		Body: Cast Iron/Mild Steel ; Tip: Anti corrosive tool steel/ stainless steel/SS with ceramic inserts hardness not less than 550 BHN.
6	Liners		6 mm thick replaceable stainless steel (SS)-410 liners of hardness 400 BHN on complete base area and impingement area of the wall

19.00.00 DATASHEET FOR HOPPER /CHUTE ISOLATION VALVES

1	Location		Below Economiser/APH/Induct/ESP hoppers
2	Method of operation		Manual (Chain wheel operated)
3	Material of construction		
4	Body		ACI 230 BHN (IS:210 FG 260)
5	Gate		10mm thick MS with minimum 35 microns of hard chrome on both sides/ SS – 316 with stelliting to achieve hardness of 300-350 BHN.
6	Seat		Integral seat/ Replaceable stainless steel hardened & smooth finished (250 BHN minimum).

20.00.00 DATASHEET FOR FLYASH FEED VALVES

1	**Fly Ash Inlet Valves**		
1.1	Type		Swing disc/ rotary/ Dome/

			Cone type
1.2	Location		below buffer hopper
1.3	Quantity		1 per Ash Vessel
1.4	Operation		Solenoid operated pneumatically actuated with provision of manual override facility
1.5	Material of construction		
1.5.1	Valve Body		ACI with 230 BHN(IS:210 FG 260)
1.5.2	Disc/Dome/Cone/Plate		10mm thk SS 300-350 BHN
1.5.3	Shaft		SS-410/EN8
2	**Fly Ash Discharge valves**		
2.1	Type		Swing disc/ rotary/ Dome/ Cone type
2.2	Location		below buffer hopper
2.3	Quantity		1 per Ash Vessel
2.4	Operation		Solenoid operated pneumatically actuated with provision of manual override facility
2.5	Material of construction		
2.5.1	Valve Body		ACI with 230 BHN(IS:210 FG 260)
2.5.2	Disc/Dome/Cone/Plate		10mm thk SS 300-350 BHN
2.5.3	Shaft		SS-410/EN8

21.00.00 DATASHEET FOR FLY ASH INTAKE /MATERIAL HANDLING VALVE

1	**Fly Ash Extraction Valves**		
1.1	Location		below AHP, duct and ESP hoppers
1.2	Method of operation		Solenoid operated pneumatically actuated with provision of manual override facility
1.3	Material of construction		
1.3.1	Body		ACI 200-230 BHN (IS:210 FG 260)
1.3.2	Valve Seat		ACI 450 BHN
1.3.3	Valve Plate/Slide Gate		10mm thk. SS 316
1.3.4	Valve outlet piece		ACI 450 BHN
1.3.5	Shaft		SS-410/EN8

22.00.00 DATASHEET FOR FLY ASH BRANCH SEGREGATING VALVES

	Fly Ash Branch segregating valves		
1	Type		Swing type / Slide plate type
2	Location		Vacuum conveying line

			branch
3	Quantity		As per layout requirement
4	Operation		Solenoid operated pneumatically actuated with provision of manual override facility
5	Material of construction		
	Valve Body		ACI with 230 BHN(IS:210 FG 260)
	Disc/Dome/Cone/Plate		3 mm thk. SS-316 with 300-350 BHN
	Shaft		SS-410/EN8

23.00.00 DATASHEET FOR AIR INTAKE VALVES

1	**Air intake valves**		
1.1	Location		Ash conveying lines
1.2	Type		Spring loaded
1.3	Material of construction		
1.3.1	Body		CI as per IS 210 FG Gr 260
1.3.2	Disc		Min. 3 mm THK. SS 316
1.3.3	Spring		Spring Steel
1.3.4	Spring seat, spring rest, spring stop guide		M.S

24.00.00 DATASHEET FOR VACUUM BREAKER

1.0	**Vacuum Breaker**		
1.	**Type**		Slide plate type or popup type or butterfly type
1.1	Quantity		One per fly ash stream
1.2	Method of operation		Solenoid operated pneumatically actuated
1.3	Material of construction		
1.3.1	Body		ACI 250 BHN
1.3.2	Gate		Min. 3 mm THK.SS 316

25.00.00 DATASHEET FOR FLYASH SILO

1.0	**Fly Ash Storage Silo**		
1.1	Quantity & construction type		4 Nos.; RCC
1.2	Effective Capacity of each silo	M^3	1000 (Effective ash storage shall be considered at min 1000 mm below soffit of silo roof beam with stored ash having a positive angle of repose. All dead spaces in silo for installation of fluidizing pads shall not be considered in silo volume calculation.)

1.3	No of outlets per silo		**6 nos.** One (1) Nos. Rotary Drum Conditioners cum unloaders for providing necessary RO stage 1 permeate water spray for dust suppression during loading of ash on open trucks. The ash unloading rate shall be minimum 165 T/hr. Two (2) Nos. Telescopic spouts arrangement with scavenger fan complete with suction bag filter shall be provided for unloading of fly ash in closed tanker. Both the outlets for ash handling shall be provided with manual chain wheel operated plate valve and cylinder operated plate valve and feeder with control. The ash unloading rate shall be minimum 165 T/hr/per outlet. Two (2) Nos. jet pump connections with HP water supply to dispose off 50% flyash generation in wet slurry form to existing ash pond under emergency. One (1) Nos. Additional blanked flange with isolating valves shall be provided considering probable future requirement for ash transportation directly to Ash Utilization
1.4	Accessories to be mounted on Silos		
1.4.1	Vent Filters		Non woven polyester needle felt
1.4.2	Pressure/Vacuum Relief Door		Required
1.4.3	Level Probe		Radar Type
1.4.4	Access ladder		Inside silo
1.4.5	Terminal Box		4 per silo
1.4.6	SILO ASH LEVEL TRANSMITTER		1 no. per silo
1.4.7	LEVEL SWITCH WITH THE TELESCOPIC CHUTES		2 nos. per silo
1.4.8	DIFF.PR.GAUGE & DIFF. PR. SWITCH ACROSS THE VENT FILTER		1 no. per silo
1.4.9	FLUIDIZING PAD		Ceramic tiles/Sintered Bronze/ Woven SS Mesh

1.4.10	PARTICULATE EMISSION AT VENTFILTER OUTLET		Below 50 ppm
1.4.11	UNLOADER HOOD IN SILO		Yes
1.4.12	GENERAL		The storage silo shall be designed to provide a clear headroom of 5.5m (from paved floor level to Bottom of Silo beam) for a road tanker to come under the silo and receive the ash from the retractable chutes. To facilitate locating these chutes over the road tanker opening, it shall be possible to move the chute in all directions in the horizontal plane.
1.4.13	FREE BOARD		750 mm

26.00.00 DATASHEET FOR BAG FILTER

1.0	**Bag Filter**		
1.1	Quantity and Location		**4 nos. at** top of Buffer hopper for each 660 MW Unit ; **1 no. for each Silo**
1.2	Type		Reverse Pulse Jet Type
1.3	Material of Filter Bag		Nomex,(The material of bag shall be capable of continuous exposure of temperature 150°C min and momentary contact 170°C)
1.3.1	**Bag Casing MOC**		SS-304
1.4	Air to Cloth ratio (max)	M^3/min/ M^2	**1.0 For Buffer Hopper & 1.5 for Silo (With 10 % bags in plugged condition)**
1.5	Efficiency		99.9%
1.6	Max. outlet dust emission		50 mg/NM3
1.7			
1.8	General		a) All bag filters shall be supplied complete with auto-matic pulse jet bag filter cleaning equipment with all necessary instrumentation including diff. Pr gauge, diff pr switch, solenoid operated pulse valve. b) Clean air plenum on bag filter with clear man height shall be provided for easy access of bags for maintenance. Bag filter manhole shall have easy access through platform/stair etc

27.00.00 DATASHEET FOR TRANSPORT AIR COMPRESSORS

1	**TRANSPORT AIR COMPRESSOR**		
1.1	Type		Oil free rotary screw type
1.1a	**Location**		Indoor
1.1b	Quantity		As indicated in Single line Flow Diagram
1.1c	Design Ambient Condition		50 DegC & 100% RH
1.1d	Drive & Motor rating		Electric motor; Ref. Vol.IIIC Electrical Specification
1.1e	Annunciation		Local / Remote as required
1.2	Material of Construction		
1.2.1	Compressor Chamber		CI coated with corrosion resistant material
1.2.2	Rotor		Forged Carbon Steel coated with Corrosion resistant material SS for second stage
1.2.3	Timing Gears, Bull Gear, Pinion Gear		Low Alloy Steel
1.2.3a	Drive Shaft		Integral with rotor
1.2.4	Inlet Throttle valve & housing		Aluminium /SS
1.2.5	Shaft Seal		High Alloy Steel
1.2.6	Unloading cylinder header		Aluminium
1.2.7	Water separator		CI
1.2.8	NRV		SS Spring loaded
1.2.9	Blow off valve		SS
1.2.10	Safety valve		Brass
1.2.11	Tube of blow of cooler		SS 304
1.2.12	Cooler casing		CS/SG Iron
1.2.2	Noise Level		95 dBA from 1.0 m 1.5 M from the equipment

28.00.00 DATASHEET FOR SCRAPER CHAIN CONVEYOR

S. No.	Description	Unit	Data
1.0	Quantity	Nos.	Four (2W +2S) for each 660 MSW unit. Total 8 nos (4W + 4S)
2.0	Continuous normal operating capacity of each SCC	T/H	Actual ash Generation (Min 15 TPH)
3.0	Linear speed of chain	m/min	0.3-0.8
4.0	Linear speed of chain (fixed or variable)		variable
5.0	Min operating depth of water in upper trough	M	2
6.0	Operating water temperature to maximum be maintained in upper trough	Deg C	60
7.0	Design of chain – associated components like sprocket & chain pulleys, fight connectors etc.		As per manufacturers recommendation.
8.0	Basalt Lining		
8.1	Hardness		Min 8 mhos
8.2	Bending strength		Min 300 kg/cm2
8.3	Compressive strength		Min 4500 kg/cm2
8.4	Density		2.8-2.9 gm/cm2
9.0	Final Drive Transmission	Kg/cum	Chain & sprocket
10.0	Type of couplings		Fluid
11.0	Protective guard for couplings required		Yes
12.0	Factor Safety for Scraper Feed Chain		Min 6
13.0	Material of Construction		
13.1	Chain		40 C-G/ S4 (RUD), Hardness> HV 750 (can reach 800)
13.2	Scraper		16 Mn + 65 Mn, Thickness 10 mm.
13.3	Drive Chain wheel/ guide wheel		CrNi Mo alloy steel/ Cr Ni alloy magnesium iron
13.4	Galvanic anode material and position of trough		Alloy made of Al,Zn,In inside of scraper chain side plate under the water
13.5	Trough structure		Q235-A
13.6	Material of liner in soleplate of upper trough/lower trough		Basalt, Thickness 40mm
13.7	Side plate angle of discharge chute	Deg	70
14.0	Discharge Cute		Yes – Two (2) nos.
15.0	Inspection Door		Required
16.0	Drain Connection		Required

29.00.00 **DATASHEET FOR ASH CONDITIONER & UNLOADER**

1	ASH CONDITIONER & UNLOADER		
1.1	Designation		Continuous Dust Conditioner & Unloader
1.2	Type		Paddle / Hydromix Type
1.3	Material handled		Flyash
1.4	Maximum Moisture Content		20%
1.5	Type of Material		Abrasive
1.6	Bulk Density	Kg/cum	750
1.7	Location		Underneath Fly ash Silo
1.8	Operation		Continuous during each unloading operation
1.9	Paddle type Dust Conditioner		
1.9.1	Metering device		To be provided upstream of Paddle Mixer
1.9.2	Type of Metering device		Air Lock type rotary feeder air slide
1.9.3	Trough of paddle mixer		U Type
1.9.4	Type of Shaft		Hollow Pipe
1.9.5	Type of shaft support		Spherical roller bearings at ends. intermediate hanger bearings shall be avoided
1.9.6	Material of Construction		
1.9.6.1	Trough		MS with 6 mm Thk SS410/ SS 304 5 mm thk liners
1.9.6.2	Top Cover Plate		MS 6 mm thk
1.9.6.3	Shaft		SS 304
1.9.6.4	Paddles		SS 304 welded to shaft
1.9.6.5	Spray Nozzles		SS
1.9.7	Type of Gate at silo outlet		Double rack & Pinion Type – Motor operated
1.9.8	ROTARY FEEDER		
1.9.8.1	Inlet		Alloy CI Type 1 as per IS 4771 with hardness of min 340 BHN for all parts coming in contact with flyash. Alternatively MS fabricated with 10 mm thk TISCRA/ SAIL hard liners construction

30.00.00 **DATASHEET FOR ALL VERTICAL SUMP PUMP IN AHP AREA**

1.	Liquid pumped	Water contaminated with dirt, grit, ash, solid particles etc
2.	Capacity of each pump (m^3/hr)	Bidder to decide
3.	Total dynamic head (MLC)	By bidder
4.	Type	Vertical, non-clog, ac motor driven
4.1	Max. Pump Speed	1500 RPM
4.2	Quantity	As per Single Line Flow Diagram
4.3	Suction Condition	Submerged
4.4	Fluid to be pumped	With 30% particle by weight
5.	Type of coupling	Flexible or rigid coupling
6.	Type of lubrication	Permanent grease packed construction
7.	Speed (rpm)	Not exceeding 1500 rpm
8.	Material of construction	
8.1	Pump casing	Duplex SS 2205 UNS 31803. hardened
8.2	Shaft	Duplex SS 2205 UNS 31803
8.21	Shaft Sleeve	Duplex SS 2205 UNS 31803
8.3	Impeller	Duplex SS 2205 UNS 31803
8.4	Wearing rings	Duplex SS 2205 UNS 31803
8.5	Base plate/skirt plate	Duplex SS 2205 UNS 31803
8.6	Shaft packings	Braided impregnated Teflon
8.7	Stuffing box	Duplex SS 2205 UNS 31803
8.8	Couplings	Duplex SS 2205 UNS 31803
8.9	Gaskets	Cloth inserted red rubber
8.10	Bolts & nuts	SS 316L

31.00.00 **DATASHEET FOR WEIGH BRIDGE**

1	WEIGH BRIDGE		
1.1	Capacity & Type		100 T ; Pit less
1.2	Accuracy		$\pm$0.25%
1.3	Accessories		10 mm thk Ceramic liner Ni-Cr Alloy CI (with min Nickel content of 2.5% and 400 BHN)
1.3.1	UPS		Yes with 1 hr backup
1.3.2	Printer		Yes
1.3.3	PC		Yes
1.3.4	Software		Yes

32.00.00 DATASHEET FOR BOTTOM ASH OVERFLOW TANK

Bottom Ash Overflow Tank:

Effective storage capacity	As per Design Criteria.
Tank	Shall be of self supporting type or underground sump.
	1.05 T/cum

Density of Stored Contents	
Material of Construction	SS 316L. Or underground RCC sump with protective coating as per Vol VI
Accessories	Make up, drain, overflow & other associated pipings & valves; Two discharge outlet & two inspection window.

33.00.00 DATASHEET FOR EXPANSION JOINTS FOR ECONOMIZER HOPPERS

a) The expansion joints shall be of water seal type construction to accommodate the thermal expansions of economizer hoppers.

b) Adequate sealing shall be provided to prevent ingress of air into economiser hoppers.

c) Necessary make up water and drain connections shall be provided in the expansion joints.

d) The material of construction of the body of the expansion joint shall be 8 mm thick MS to IS:2062.

34.00.00 **AIR LOCK TANK/PUMP TANK/ASH TRANSPORTER**

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.

Data Sheet : Air Locks / Pumps Tanks

Design pressure	1.5 times the design pressure of associated Air Blower/ Compressor or 2 times the operating pressure whichever is higher. Design calculations shall be submitted for Owner's approval

Material of construction	Tested quality IS:2062
Nos. provided	One working set and one standby set for each Combination filter Separator cum buffer hopper.
Aeration pads	As per requirement (Ceramic tiles/ sintered bronze/woven SS mesh)
Liner	Wear Resistance ACI min. 350 – 450 BHN or SS

35.00.00 BUFFER HOPPER

a) Fly ash from the various collection chutes/hoppers shall be conveyed to bag filter cum buffer hopper. Aeration pads shall be provided in the bottom sloping portion of buffer hopper to prevent compaction and to fluidize the fly ash during discharge from the buffer hopper. Buffer hoppers are to discharge the fly ash extracted from various fly ash collection chutes to pressure transporter system.

b) EACH BUFFER HOPPER should be provided with a Vacuum/pressure relief Valve. Pressure relief to atmosphere from the buffer/surge hoppers shall be through vent filter. Buffer hopper shall have provision of emergency manual unloading of ash.

Data Sheet of Dry Fly Ash Buffer Hopper

Number	As per flow diagram
Material of construction	10 mm thick MS plate as per IS 2062
Discharge	To pump tanks/air lock system as specified
Aeration pads	As per requirement (Ceramic tiles/sintered bronze/woven SS mesh)
Vent/ equalizing valve	Yes
Capacity	25 Cubic Meter for individual Combination filter seperator cum Buffer Hopper (provided one no for each vacuum conveying stream)

36.00.00 Slurry Disposal Line Valves At Dyke Area

36.01.00 Valve shall be knife gate construction.

36.02.00 The size of all valves shall be the same as that of parent pipe.

Material of construction shall be as follows :

a) Plate : 10 mm thk. MS: IS 2062 Gr A with 10-12 micron chrome plating on both sides.

b) Body : SS 316L

Note: Blank/ through spouts arrangement is also acceptable for discharge points at ash pond. This shall be subjected to acceptance during detail engineering.

Data Sheet for Ash Slurry Sump Isolation Plug Valves, Sump Liners and Agitating Nozzles

36.03.00 The ash slurry sump shall have isolated compartments. Each compartment shall serve one(1) no) stream of ash disposal pumps. The bottom ash slurry shall be led to a common distribution trough at the top of the slurry sumps which will have manually operated plug valves enabling the slurry to flow to the desired compartments (corresponding to the pump steams in operation).

36.04.00 It shall be possible to operate slurry sump isolation valves from platform at top of sump . The valve shall be provided with gear operator if effort required to operate the valve exceeds 25 kgf.

36.05.00 Material of construction for slurry sump isolation valves shall be corrosion and abrasion resistant and shall be of quality most suited to proposed application. Suitable measures to protect the bearings from ash ingress shall be provided.

36.06.00 Valves shall be suitable for outdoor duty.

36.07.00 All the slurry distribution troughs and sump compartments shall be provided with abrasion liners in the areas of slurry impingement.

Alloy CI, 350BHN lining for the inner walls of the slurry sump shall be provided by Contractor. The lining should be minimum 20 mm thick, on side walls and 30 mm thick at bottom".

36.08.00 Bidder shall provide adequate number of high velocity water jetting/agitating nozzles in the slurry trenches/sumps to avoid setting of ash particles at the bottom of the trenches/sumps. The material of jetting/agitating nozzles shall be anti corrosion tool steel/or SS-410/416 of hardness 500-550 BNH.

37.00.00 **Water and Air Piping, Fitting and Accessories**

All piping shall be provided with vents at the highest points and drains at the lowest points along with vent valves and drain cocks. Vents shall not be less than 15mm in size. Drains shall not be less than 25 mm size.22.7 The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to valves and other piping accessories required for operation and maintenance.

37.01.00 Piping shall generally be routed above ground but where specifically indicated/approved by the Engineer the pipes may be arranged in trenches or buried. Bidder shall provide either coal tar and Bitumen tapes on conventional coat and wrap system for corrosion protection of buried piping as per relevant codes and standards.

37.02.00 Overhead piping shall have a normal minimum vertical clearance of 3 meters above walk ways and working areas and 8 meters above roadways unless otherwise approved by the Engineer.22.10 Pipe Size in pump suction side shall be at least one pipe size larger than the corresponding pump discharge connection.

37.03.00 The pipe supports shall be spaced as follows :

Pipe size(NB)	25	50	80	100	150	200	300	400	500
Spacing in metre	2.1	3.0	3.7	4.3	5.2	5.8	7.0	8.2	9.1

DATA SHEET OF WATER AND AIR PIPING, FITTINGS AND ACCESSORIES

WATER PIPES			
1.0	Type of Pipes	a) Upto & including150 NB	MS, ERW pipes to IS:1239 Heavy grade
		b) 200 NB to 450 NB	MS ERW to IS 3589. FE 410 grade.
		c) 500 NB and above	Rolled and welded from MS plate to IS:226 Dimensional tolerance as per IS:3589. or SAIL or Equal make spiral welded pipes.
2.0	Pipe Sizes	As required.	
3.0	Thickness of Pipes	a) Pipe specs. as per IS:1239	Pipe thickness shall be of Heavy grade.
		b) Pipe spec. as per IS:3589 (ERW)	Min 6.35 mm thick for 200 NB to 400 NB size and Min. 7.14 mm thick for 450 NB size.
		c) Pipe spec. as per IS:3589 (ERW) from IS 226 plates/spiral welded	Min. 8mm thick
4.0	Type of Line joints.	a) 50 NB and below	i) Socket welded to ANSI:B16.11. for high pressure application. ii) Butt welded as per ANSI B 16.25
		b) 65 NB and above.	Butt welded to ANSI:B16.25.
	Quantity	As required	
6.0	Fittings (Bends)	a) For sizes upto & including 65NB	Short radius bends and material same as that of parent pipe.
		b) For sizes 80 NB to 300 NB	Standard elbow and material same as that of parent pipe
		c) 350 NB & above.	Miter bends with Miter angle not exceeding 22.5°. Material shall be same as that of parent pipe and dimensional tolerance shall be as per BS : 534.

	Flanges	Slip on flat face type with drilled and pressure rating as per valve and other specialties. Material of construction shall be as per IS:2062.

DATA SHEET FOR WATER AND AIR LINE VALVES

For fluidizing air line valves design and construction shall take special consideration for temperature of service fluid.

1.0	**Gate/Globe/Check Valve**		
1.1	For sizes 50 mm and below and working pressure up to 15 Kg/cm^2(g)		
(i)	Body/Wedge/Disc	:	Gun Metal/ SS 316L (for all valves in sea water)
(ii)	Trim & Seat	:	Gun Metal / SS 316L (for all valves in sea water)
(iii)	Stem	:	Brass / SS 316L (for all valves in sea water)
1.2	For sizes 65 mm and above and working pressure upto 15 Kg/cm^2(g)		
(i)	Body/Wedge/Disc	:	C.I. to IS 210 Gr. FG 260/ SS 316L (for all valves in sea water)
(ii)	Trim & Seat	:	SS/ Gun Metal/ SS 316L (for all valves in sea water)
(iii)	Stem	:	SS 410/ SS 316L (for all valves in sea water)
(iv)	Hand wheel	:	C.I. to IS 210 Gr. FG 220/ SS 316L (for all valves in sea water)
1.3	For all sizes and Working pressure above 15 Kg/cm^2(g)		
(i)	Body/Wedge/Disc	:	Cast/Forged carbon steel/ SS 316L (for all valves in sea water)
(ii)	Wedge/Disc/Plug	:	Cast carbon steel with 13% Cr lined/ SS 316L (for all valves in sea water)
(iii)	Trim and Stem	:	Stainless steel/ SS 316L (for all valves in sea water)
(iv)	Quantity	:	As required
2.0	**Butterfly valve (Design Standard: BSEN 593-2004/AWWA-C-504)**		
(i)	Body		SS 316L
(ii)	Trim/Spindle		SS 316L
(iii)	Disc		SS 316L

(iv)	Hand wheel (in case of manual operated valve)		SS 316L
(v)	Test Pressure		Hydro and air test pressure will be as per selected rating of valve. However Hydro test pressure of shell/body should not be less than twice of working pressure
3.0	**Plug Valve**		
(i)	Body	:	SS 316L
(ii)	Plug	:	SS 316L
(iii)	Test Pressure	:	Hydro test pressure will be as per selected rating of valve. However Hydro test pressure of shell/body should not be less than twice of working pressure.
(iv)	Note (1)	:	For slurry and ash contaminated water lines, regular pattern plug valve to be provided.
(v)	Note (2)	:	For Diaphragm operated pressure switch, pressure gauge isolation, 40 NB regular pattern plug valve to be provided
4.0	**Ball Valve (upto 150 NB only, Design Standard: BSENISO 17292)**		
(i)	Body	:	SS 316L
(ii)	Ball/Spindle	:	SS 316L
(iii)	Stem & Gland	:	SS 316L

38.00.00 DATASHEET FOR SEAL TROUGH OVERFLOW TANK

Quantity	Two (2) nos**.**
Effective storage capacity	30 minutres retention capacity.
Tank	Rectangular, atmospferic
Water stored	Seal Water (RO Stage I permeate)
Material of Construction	SS 316.
Accessories	Make up, drain, overflow & other associated pipings & valves; Two discharge outlet & two inspection window.

CHAPTER 17

17.0 CRANES AND HOISTS

17.1 Scope

17.1.1 Cranes and hoists to facilitate the lifting and transporting of various equipment during construction, maintenance or replacement of the plant components shall be provided.

17.1.2 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.

17.1.3 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 EOT crane)
  ii. Sea Water Intake Pump House (single girder Overhead EOT crane)
  iii. Ash Compressor House (Underslung Crane)
  iv. Ash water Pumphouse (Underslung Crane)
  v. Ash Slurry pumphouse (Overhead Single Girder EOT Crane)
  vi. Ash water recovery Pumphouse (Underslung Crane) (if applicable)
  vii. Clarified Water Pump House (Under Slung Crane)
  viii. Filter water Pump House (RO Stage I Permeate) (Under Slung Crane)
  ix. Air Compressor Room (Overhead EOT Crane)
  x. DG room. (Under Slung Crane)
  xi. Work shop (Single Gider overhead EOT Crane) – Min 10T
  xii. Boiler Feed Pump House (Overhead EOT Crane)
  xiii. Stores
  xiv. GIS (Double Girder Overhead EOT)
  xv. UF Permeate Pumphouse (underslung EOT)
  xvi. Mill Reject compressor room (Underslung EOT)

- Electric hoists/ Manual chain pulley blocks in areas like Boiler area(ID fan, FD fan, PA fan, Boiler circulation pump, coal feeder area, Airpreheater, seal air fan, ESP, Bottom ash silo, fly ash silo and mill reject ash silo, Mill reject compressor, Power house building (Vacuum pumps, CEP, DMCW pumps, ACW pumps, butterfly valves at condenser inlet and outlet, condenser water box, Lube oil unit, control oil unit and central lube oil system), Electro Chlorination building, Desalination building Gravity filtered pipe gallery, Coal Handling System (Crusher House, Transfer towers, Head/Tail end of conveyors, Bunker building, flap gate, flow divider, junction tower, ERH, etc.), Water treatment plant , Effluent treatment plant and Sewage treatment plant, Sea water intake pump house stop-log gates and screens, HVAC Building, AC plant, Fuel Oil Pump House, ETP, Air Washer Room, Chemical house, Hydrogen generation building, AHP(compressor, vacuum pumps, slurry pump house) & any other areas as applicable.
- Gantry Crane (EOT) shall be provided for handling stop log gates & screens in the CW Pumphouse,

17.2 Equipment Sizing and Design Criteria

17.2.1 **EOT Cranes**

The turbine building EOT crane is required to handle the heaviest component other than the generator stator with the auxiliary hoist rated for 20% of main hook capacity. The main crane is used for maintenance of main steam turbine and electric generators, generator coolers, condensate pumps, lube oil units and other equipment located in turbine bay. The auxiliary hoist is used to handle smaller components more rapidly.

The CW Pumphouse EOT crane shall be rated for the heaviest component to be handled in the CW Pumphouse.

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.

The EOT cranes shall of the double girder plate box type construction.

The EOT cranes shall be designed as per Class M5 for mechanical and structural components and Class M5 for all electrical components IS: 807, 1S 3177.

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. The cabin shall be airconditioned. The CW Pumphouse EOT crane shall be operated from pendant push button station hanging from the crane.

All cranes of capacity above 7.5 T shall be overhead EOT cranes. Cranes of capacity 7.5 T & below shall be underslung type.

17.2.2 **Creep Speed for EOT Cranes:** 10% of main speed shall be creep and shall be provided for all motions of the turbine building EOT crane viz. long travel, cross travel, auxiliary hoist and main hoist.

17.2.3 **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 500 mm width with safety handrails shall be provided along the full span length of the cooling water building crane.

17.2.4 **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 are designed with a maximum deflection of 1/900 of crane span at rated load.

The cabin for operator in the turbine hall EOT cranes shall be airconditioned and window A/C shall be provided for the same.

17.2.9 **EOT cranes for other buildings**- The cranes shall be underslung type

17.2.10 **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.

Apart from above the following fixed chain pulley blocks having 6 m lift shall be supplied by the bidder.

1T capacity – 10 nos.
3T capacity – 10 nos.
5T capacity – 8 nos.
10T capacity – 3 nos.

17.2.11 **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

17.3 **Electrical Requirements**

17.3.1 Electrical equipment shall be adequately rated to permit simultaneous operation of nay combination of motions of the crane for it duty service.

17.3.2 **Motors**

17.3.3.1 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.

17.3.3.2 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.

17.3.3.3 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.

17.3.3.4 Each motor more than 30 KW rating shall be provided with space heater. All electrical equipment accessories and wiring shall have tropical protection.

17.3.3.5 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.

17.3.3.6 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.

17.3.4 **DSL**

17.3.4.1 DSL shall meet the following requirements :

- Shrouded bus bar type.
- Minimum 20% allowance for wear and tear shall be considered during sizing.
- Voltage drop for all conductors and cables/ wires shall be limited to 3% of rated voltage between the main disconnect witch and motor terminals.

17.3.5 **LIMIT SWITCHES**

The limit switches shall be totally enclosed type IP-55.

Each hoist shall be furnished with two (2) limit switches meeting the following requirements:

- A screw type limit switch with self resetting features which will act in case of over hoisting.
- A gravity operated hand reset type limit switch as a back up protection against over hoisting. Track type limit switches shall be provided on the bridge and trolley to prevent over travelling in either direction.

17.3.7 Trailing cable shall be 1100 V grade, tinned copper, heat resistant, with EPR insulation and as per Class – 5 of IS-8130. Also should have inner PCP sheath and outer CSP sheath with nylon chord reinforcement & heat resistant, oil resistant and flame retardant heavy duty FRLS type.

17.3.8 For other electrical and specific design requirements of electrical items refer Volume IV of the EPC specification.

17.4 **Control & Instrumentation Requirements**

17.4.1 Necessary start/stop and emergency controls shall be provided. Automatic reset type limit switches shall be provided to prevent over-travel for

a) Over hoisting and lowering motions of the hook.

b) Long travel motion

c) Cross travel motion

17.4 **OPERATING SPEEDS FOR MISCELLANEOUS HOISTS**

a.	Hoist	:	3 m/min
b.	Trolley travel	:	6 m/min
c.	Long travel	:	10 m/min

d.	Creep speed	:	10% of full speed (as applicable)
e.	Crane runway rails	:	Rails to suit

DATA SHEET FOR TG BUILDING EOT CRANE

1.	Number of Cranes			:	Two (2) nos.
2.	Crane Classification			:	Class-II to BS:466-1947 IS:807 & IS:3177
3.	Type of service			:	Indoor
4.	Capacity – Main Hoist				
	a.	Rated	Tonnes	:	By Bidder (Min 125T)
	b.	Test load	Tonnes	:	125% of rated load
5.	Capacity – Auxiliary Hoist				
	a.	Rated	Tonnes	:	By Bidder
	b.	Test load	Tonnes	:	125% of rated load
6.	Type of Hooks				
	a.	Main Hoist		:	Ramshorn type swiveling hook with locking device
	b.	Auxiliary Hoist		:	Standard single swiveling hook with locking device
7.	Number of trolleys			:	One (1)
8.	Number of hoists on trolley			:	Two (2): One (1) Main and One (1) Auxiliary Hoist
9.	Crane structure			:	Bridge Girders of box type and steel fabricated construction
10.	Operating speeds with full load (M/min)				
	a.	Main Hoist		:	1.5
	b.	Auxiliary Hoist		:	6
	c.	Trolley travel		:	15
	d.	Longitudinal bridge travel		:	30

	e.	Creep speeds	:	10 percent of full speed for all motions
11.	a.	Crane runway rails	:	To suit
	b.	Runway Conductors (DSL)	:	as indicated in write up
12.	Operator's cabin :			
	a.	Type	:	Fixed open type
	b.	Location	:	On one (1) side of the bridge (towards B-row)
	c.	Height	:	2 metres
13.	Brakes :			
	a.	Hoists (Main/Aux) operated shoe type brake for each hoist	:	a) Electro-hydraulic thruster 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	:	Parking brake operable from the operator's cabin

DATA SHEET FOR EOT CRANE FOR OTHER AREAS

1.	Number of Cranes			:	One (1) in each area
2.	Crane Classification			:	Class-II to BS: 466-1947 IS: 807 & IS: 3177
3.	Type of service			:	Indoor
4.	Capacity – Main Hoist				
	a.	Rated	Tonnes	:	As specified
	b.	Test load	Tonnes	:	1.25 times rated load
5.	Capacity – Auxiliary Hoist				
	a.	Rated	Tonnes	:	As specified
	b.	Test load	Tonnes	:	1.25 times rated load
6.	Type of Hooks				
	a.	Hoist		:	Standard single swiveling hook with locking device
7.	Number of trolleys			:	One (1)
8.	Number of hoists on trolley			:	One (1)
9.	Crane structure			:	Bridge Girders of box type and steel fabricated construction
10.	Operating speeds with full load (M/min)				
	a.	Hoist		:	1.5
	b.	Trolley travel		:	15
	c.	Longitudinal bridge travel		:	30
	d.	Creep speeds		:	10 percent of full speed for all motions
11.	a.	Crane runway rails		:	To suit
	b.	Runway Conductors (DSL)		:	As indicated in write up
12.	Brakes for cranes & hoists :				
	a.	Hoists		:	a) Two (2) nos. Electro-hydraulic thruster type brake
	b.	Long travel		:	a) Two (2) nos. Electro-hydraulic thruster type brake

c.	Cross travel	:	a)	Two (2) nos. Electro-hydraulic thruster type brake
			b)	Two (2) nos. hydraulic thruster (foot operated)
			c)	One (1) no. Electro-hydraulic thruster type brak

CHAPTER 18

18.0 COMPRESSED AIR SYSTEM

18.1 Description

18.1.1 The compressed air system shall comprises of Instrument Air (IA) System and Service Air (SA) system.

18.1.2 The IA system shall supply required quality air to various pneumatically operated valves and instruments of SG, TG and all BOP systems envisaged excluding Ash Handling Plant. SA system shall meet the service air requirement of the proposed Units.

18.1.3 Service Air Compressor may be used for Instrument Air System connecting with Air Drying Plant in case of non availability of Instrument Air Compressors. The valves and piping arrangement for such interconnection shall also be provided

18.1.4 The service & instriument air compressors alongwith air driers shall be located in a separate building.

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18.2 The scope of supply for Instrument Air System shall include but not limited to the following:

i. Three (3), oil free multistage rotary screw compressors for providing IA air for facilities in Ennore SEZ area. Out of these two (2) shall be working and one (1) shall be on standby duty

ii. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps for each compressor.

iii. Suction filter along with blow off valve and silencer for each compressor.

iv. Three (3) refrigerant type Air Drying Plants for compressors in Ennore SEZ area. Capacity of each drier shall be equal to capacity of compressor. Out of these two (2) shall be working and one (1) shall be on standby duty.

v. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels

vi. Three (3) vertical Air Receivers in Ennore SEZ area complete with supporting structure, pressure gauges and switches, safety valves, drain traps.

vii. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc. Refer clause 3 of Annexure 'C' volume V Instrumentation and Control works.

viii. Smaller air receivers, each of capacity 2 cum shall be provided as requtred in areas located away from the compressor house to maintain pressure.

18.3 The scope of supply for Service Air System shall include but not limited to the following:

i. Three (3), oil free multistage rotary screw compressors. Out of these two (2) shall be working and one (1) shall be on standby duty.

ii. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps for each compressor.

iii. Suction filter along with blow off valves and silencer for each compressor.

iv. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels

v. Three (3) nos. vertical Air Receivers [of capacity 10 M^3 (min)] complete with welded supporting stand and foundation bolt, pressure gauge and switch, safety valves, drain cock as minimum. Two air recievers shall be for each unit.

vi. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc. Refer clause 3 of Annexure 'C' volume V Instrumentation and Control works.

vii. Smaller air receivers, each of capacity 2 cum shall be provided as requtred in areas located away from the compressor house to maintain pressure.

viii. Mositure trap to be provided at boiler end and turbine end and wherever necessary.

18.4 **Design Requirements**

18.4.1 All equipment shall be designed for continuous operation.

18.4.2 The capacity of each IA compressor and SA compressor in Ennore SEZ Area shall be as per requirement..The discharge pressure at the outlet shall not be less than 8.0 Kg/cm^2 (g).

18.4.3 Noise level shall not exceed 85 dBA when measured at a distance of 1.0 meter 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.

18.5 **Air Compressors**

18.5.1 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. The air pipe work shall be of GI pipes of heavy quality construction.

18.5.2 Compressors shall be identical oil free, rotary, screw type. 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 compressor.

18.5.3 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 should trip on motor overload; low oil level; and compressor temperature high.

18.5.4 Compressed air piping shall be sized for minimum pressure drops and considering velocity range of 6-10 m/sec as per IS: 6206. All pipelines shall have butt welded connections with minimum 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.

18.6 **Air Receivers**

18.6.1 Air receivers shall be provided for service air and instrument air separately as shown in the flow diagram.

18.6.2 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.

18.6.3 Air receivers shall be designed for minimum 1.5 times compressor discharge pressure. The water capacity of air receiver shall be 10 M^3.

18.6.4 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.

18.7 **Air Drying Plants**

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 deg 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". Air Driers shall be HOC type.

Air Drying Plants (REFRIGERANT TYPE)

18.7.1 **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	:	Requirement for refrigerent condensing type units
iv) IS-5111	:	Testing of refrigerant compressor

v) ISO 8753.1 : Filter quality classes

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 deg 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 7.5 Kg/cm2 (g) or more as per the requirement of Contractor

The compressors and Air Drying plants shall operate under the following ambient conditions.

(i)	Minimum temperature	10 deg.C
(ii)	Maximum temperature	50 deg. C
(iii)	Design condition (temperature & Relative humidity)	50 deg.C & 100% RH
(iv)	Height above MSL (m)	As given in Plant information

(A) One number Air drying plant shall be provided for each Instrument air compressor. The air driers shall be refrigerant type.

Wet Compressed air undermines efficiency of smallest to the largest pneumatic system. Therefore, moisture removal in compressed air system installation is a must. The incoming saturated, moist air shall be precooled in the Air - to - Air Heat Exchanger by the outgoing dry chilled air to ensure that a greater part of Water Vapour gets condensed into liquid moisture. Further moisture separation shall take place in the Freon -to- Air Heat Exchanger where air is chilled to a temperature of +2 Deg. C. and moisture condenses. This temperature is termed as pressure 'Dew Point'. The Moisture Separator removes the condensate by an Automatic Condensate Trap i e. auto drain.

The compressed dry air shall be reheated in Air -to- Air Heat Exchanger and fed to the point of application. As long as compressed air temperature remains above the +2 Deg. C., no further condensation shall occur. The refrigeration circuit shall be conventional circuit comprising refrigerant Compressor, air and water cooled Condenser , Expansion Valve etc. using Freon R-22 as refrigerant gas. Ecofriendly Refrigerant like R-134 A, R-404 A, R-407C shall be used. ADP shall be water cooled

(B) The compressor shall be hermetically sealed.

(D) The material of Construction for various components of ADP shall be as follows:-

ADP Vessel	Carbon Steel
All internals of adsorber vessels	SS-304
Cooler shells, channels and covers, Cooler tube sheet & tubes	Same as that in intercooler / after coolers
• Relief Valves	Brass or SS
• Desiccant	Silica gel or activated alumina
• Air Piping	Galvanized Steel
• Valves in air line	CI or Cast steel or Forged Steel body with SS trim
• Valves in water pipe lines	SS/ Bronze / Gunmetal

(F) Control Philosophy

Sequential operation of the ADP & air compressors shall be controlled automatically with a provision for manual take over.

Change over of tower from drying mode to standby mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor.

The control system shall provide the (as minimum) alarms, "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 of the same.

DATA SHEET FOR COMPRESSED AIR SYSTEM (ENNORE SEZ)

1.0 Air Compressors

			Service Air	Instrument Air
1.1	Quantity (Working and Standby)	:	3 (2W+1S)	3 (2W+1S)
1.2	Type	:	Oil free, multistage, rotary, screw type	
1.3	Capacity	:	min 40 NM^3/ min @ 8.4 $kg/cm^2(g)$	
1.4	Material of Construction			
	a. Compressor chamber	:	Cast iron coated with corrosion resistant material	
	b. Rotor	:	Forged carbon steel coated with corrosion resistant material; 2^{nd} stage stainless steel	
	c. Timing gears	:	Low alloy steel	
	d. Inlet throttle valve & housing	:	Aluminium/stainless steel	
	e. Shaft seals	:	High alloy steel	
	f. Unloading cylinder header	:	Aluminium	
	g. Water separator	:	Cast iron	
	h. Non return valves	:	Stainless steel spring loaded type	
	i. Blow off valve	:	Stainless steel	
	j. Safety valve	:	Brass	
	k. Tube of blow off cooler	:	Stainless steel type 304	
	l. Cooler casing	:	Carbon steel/SG iron	
	m. Gear box casing	:	Cast iron/SG iron	
	n. Gears	:	Alloy steel	
	p. Bearings	:	Oil lubricated antifriction type suitable for at least 40,000 running hours	
	q. Shaft seals	:	Floating restrictive ring type design	

2.0	**Air Receiver**		**Service Air**	**Instrument Air**
2.1	Quantity	:	3	3
2.2	Type	:	Vertical cylinder type	

2.3	Water Capacity	:	10 M^3	10 M^3
2.4	Material of construction	:	MS to IS 2062	
2.5	Safety relief valves	:	Required	
2.6	Automatic drain trap	:	Required	
2.7	Standard	:	ASME Sec-VIII or IS 2825	
3.0	**Air Drying Plant**			
3.1	Quantity	:	3 (2W+1S)	
3.2	Capacity	:	60 Nm^3/ min (Min)	
3.3	Type	:	Refrigerant type	
3.4	Dew Point of air at drier outlet	:	(-) 40^0 C	

CHAPTER 19

19.0 AIR CONDITIONING AND VENTILATION SYSTEM

19.1 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 not withstanding 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.

19.2 Codes and Standards

Relevant Indian/International standards, such as ASHRAE, ISHRAE, AMCA and IS etc. as applicable to AC & ventilation system and latest issues of these applicable codes and standards shall be adopted.

19.3 Design Criteria for Air conditioning system

19.3.1 Dry bulb temperature 47^{o} C.

For other details of ambient conditions, refer published documents for meteorological data for Plant site.

19.3.2 Inside design conditions to be maintained in all air-conditioned areas.

Dry bulb temperature : 22 ± 1.0^{o}C

Relative humidity : 50 ± 5%

19.3.3 A minimum design margin of 10 % shall be considered while sizing AC Plant and related equipment like chillers, chilled water pumps and AHUs for each area. Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.

19.3.4 Margins for calculating heat load:

i. 12.5%, 10% & 10% margins on sensible heat, latent heat & overall heat respectively is to be considered while calculating heat load.

ii. For winter load calculations, 50% of the equipment load as available in the room is to be considered.

19.3.5 All windows in the air conditioned area shall be provided with light coloured venetian blinds.

19.3.6 Fresh air quantity of 1.5 air change/hour or $35 m^3$/hr per person or suitable to maintain over pressure of 2 MMWC whichever is higher shall be considered.

19.3.7 False-ceiling shall be provided in all air conditioning areas.

19.3.8 For chemical lab, the airconditioning system shall be designed for 100% outdoor air (the room air is exhausted and not recirculated through the A/C unit). 2 x 100 % Split units are acceptable for chemical lab.

19.3.9 To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas , air handling units room and Packaged Air conditioners (PAC) rooms shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/m^3 finished with 26 swg aluminum cladding.

19.3.10 AHU room's walls ,Packaged Air Conditioners room's walls and first 6 meters of supply air duct from AHU/PAC air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/m^3 and shall be covered with 26G aluminum perforated sheet. Perforation area shall be 30% of free area.

19.3.11 Lighting load of 2 Watts per Ft^2 or actual which ever is higher shall be considered for heat load calculations.

19.3.12 The occupancy for general/ office area shall be minimum one person per 3 Sq.M and for conference room the same shall be one per 1.5 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq.M (Minimum).

19.3.13 The Air-conditioning spaces shall be maintained at positive pressure of 2 mmwc to avoid any infiltration of dust.

19.3.14 Plant for all air-conditioned areas shall operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).

19.3.15 Motor operated valves shall be provided as per system requirement for chilling machines, pumps, cooling towers in order to facilitate remote operation of entire air-conditioning plant and to select standby unit.

19.3.16 Noise Criteria – Design noise level shall be of NC 35-45 within Control room, Control equipment room, Instruments and Electronic room and offices.

19.3.17 Design Criteria for Air Inlet Louver – Face velocity of the louver shall be 2.5 m/s (max.).

19.3.18 Design Criteria for Volume Control Damper – Velocity across the Damper shall not exceed 10 m/s.

19.3.19 Duct Design Criteria – Velocity shall be 7.5 m/s.(max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.0 m/s. for the diffusers/grills.

19.3.20 Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec.

19.3.21 Water piping shall be sized for a maximum velocity of 2.5m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.3.22 Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1 deg C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.

19.3.23 All Carbon steel sheets under air conditioning system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall

conform to Class 275 of IS: 277.The air distribution system shall be sized to have a constant frictional drop.

19.3.24 For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100.

19.3.25 Thermal Insulation Design Criteria –

EQUIPMENT/MATERIAL	THERMAL INSULATION
Ducting	50 mm thick fibre glass of density 48 kg/cum and TF quality finished with 26 swg aluminium cladding. For Exposed ducting, 50 mm thick fibre glass rigid board (density 48 kg/cum and TF quality) finished with 26 swg aluminium cladding.
Refrigerant Piping for Split Air Conditioners and Packaged air conditioners	13 mm thick Nitrile foam.
Refrigerant Piping of Water Chilling Unit	75 mm thick expanded polystyrene (TF Quality) of density 32 kg/cum finished with chicken wire mesh, 12.5 mm thick sand cement plaster.
Chilled Water Piping and associated valves.	Chilled water piping shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum covered with 12.5 mm thick Sand Cement Plaster. The portion of CHW pipe exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum and finished with 26 swg aluminium cladding.
Drain Piping from AHU and Chiller	Drain Piping shall be insulated with 25 mm thick EPS (TF quality) of density 16 kg/cum covered with 26 swg aluminium cladding.
Chiller	As per manufacturer standard.
Chilled Water Pump	50 mm thick thermal insulation of EPS (TF quality) of density 32 kg/cum covered with 26 swg aluminium cladding.
Expansion Tank	50mm thick thermal insulation of EPS (TF quality) of density 16 kg/cum covered with Sand Cement Plaster.
Air Handling Unit	Double skin type with PUF insulation
Indoor Unit of split AC	As per Manufacture's Standard
Package A.C	As per manufacturer's standard

19.3.26 Design Chilled water flow shall not be less than 0.7 Cu.M/hr per TR air-conditioning load and design Condenser cooling water flow shall not be less than 1.0 Cu.M/hr per TR air-conditioning load.

19.3.27 For maintenance of compressors/chilling units, pumps, AHUs (air handling units) etc. chain pulley block of suitable capacity and/or suitable structure shall be provided in the AC plant rooms and AHU rooms.

19.3.28 Redundancy of Equipments

The number of chilled water pumps, condenser water pumps and cooling towers shall be equal to the number of chilling units and condensing units.

- Chilling Units - 2 x 100%
- Condensing Unit - 2 x 100%
- Condenser water pumps - 2 x 100%
- Chilled water pumps - 2 x 100%
- Package air conditioners - 2 x 100%
- Window/Split air conditioners - 2 x 100%
- FRP cooling towers - 2 x 100%
- Air handling units (DX type) - 2 x 100% (Per AHU room)
- Air handling units water type) - Multiple AHUs of similar (Chilled capacities per AHU room
- Fresh air fan unit - 2 x 50% per AHU room

19.3.29 All the pumps shall have 10% margin on capacity and head over the actual requirement.

19.4 **Design Criteria for Ventilation system:**

19.4.1 The capacity of Air washers, Supply air fans, exhaust air fans/ roof extractors, ducting system shall be designed as per the Design criteria & Equipment specification elaborated below. Sizing calculations for all the equipments shall be submitted for approval of Owner. However the minimum quantity of the air washer units of Ventilation System for each unit shall not be less than 4 numbers (two numbers on A row and two on B row). A minimum 10% margin shall be considered while sizing the equipment/plant capacity.

19.4.2 The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

S No.	Area	Air Changes
i.	For all evaporative type ventilation system	8
ii.	General areas	15
iii.	Various pump houses	20
iv.	Switch gear / MCC rooms.	25
v.	Battery rooms & other areas where gaseous fumes are generated	30
vi.	Chlorination plant building	30
vii.	D G set room	45

19.4.3 However in areas producing lot of heat, the temperature limitation should be the criteria, which is as follows:

- Inside dry bulb temperature shall be minimum 5 deg.C below the design ambient dry Bulb temperature during summer for evaporative cooled areas.

- Inside dry bulb Temperature shall be maximum 3 deg.C above the design ambient dry Bulb 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.

- Inside dry bulb temperature for battery room shall be maintained at 25^{o}C. The air flow rate for battery room shall be sized considering minimum 30 air changes per hour or hydrogen concentration of 2% or less of the room volume whichever gives higher air flow shall be considered.

19.4.4 All ventilation system shall operate on 100% fresh air.

19.4.5 All mechanically ventilated areas like MCC/Switchgear rooms shall be positively ventilated by means of supply air fans, generally in combination with exhaust fan/ roof extractors. Wherever exhaust fan/ roof extractors are not provided, the pressurised condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odour generating areas such as toilets shall be negatively ventilated by means of exhaust air fans/ roof exhausters and inlet louvers.

19.4.6 Supply air fan catering for electrical switchgear/MCC rooms, Elevator machine rooms etc. shall be provided with pre filters and fine filters. Efficiency of Pre filter shall not be less than 90% down to 10 microns while for fine filter 99.5% down to 5 microns.

19.4.7 All the equipments of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.

19.4.8 The supply air ducts of evaporative/ UAF type ventilation system shall be provided with automatic (motor operated) fire dampers of fire rating 2 hours at the entry to each of the enclosed area like switchgear rooms, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and the operation of these dampers shall also be possible from the control panel remote manually.

19.4.9 For maintenance of Air washer unit material handling equipment as per size & type defined in Chapter 17, Vol III of specification shall be provided in the Air Washer rooms of Evaporative Ventilation System.

19.4.10 Circulating water capacity for Air washer units shall be minimum 1 M^3/hr per 1000 M^3/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 M^3/hr per 1000 M^3 /hr of air flow.

19.4.11 Water piping shall be sized for a maximum velocity of 2.5 m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.4.12 The air distribution system shall be sized to have a constant frictional drop along its length.

19.4.13 The air washer unit and unitary air filtration unit shall be designed for a maximum face velocity of 2.0 m/sec.

19.4.14 The air washer unit shall be designed for at least 90% saturation efficiency while UAF for 60% saturation efficiency.

19.4.15 For pumps, fans and blowers, continuous motor rating (at 50^0 C ambient) shall be at fifteen percent (15%) above the demand of the equipment at duty point or ten percent (10%) above maximum load demand of the equipment whichever is higher.

19.4.16 For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

19.4.17 All Carbon steel sheets under evaporative ventilation system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall conform to Class 275 of IS: 277.

19.4.18 For calculating friction loss in piping system, WILLIAM & HAZEN formula shall be used with C - value as 100.

19.4.19 Supply air fans, exhaust air fans/ roof ventilators of each area shall be provided with their local starter panel.

19.4.20 Design Criteria for Back Draft Damper – Velocity across damper shall not exceed 6 m/s.

19.4.21 Duct Design Criteria – Velocity shall be 12 m/s.(max.) for main duct, 9.0 M/s. (max.) for branch duct and 3.75 m/s. for the grills.

19.4.22 REDUNDANCY OF EQUIPMENTS

- Pumps for each Air Washer Unit shall be 2 x 100% Capacity or 3 x50%. For UAF it shall be 1 x 100%.
- Fans for each air washer unit shall be 3x 33% capacity while for unitary air filteration unit shall be 1x100% capacity.
- Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

19.5 **Systems to be Furnished**

19.5.1 **Air Conditioning System**

a) A centralized water cooled chilled water system with screw chilling units shall be provided for the following areas:

Main control room areas comprising unit control room, electronic cubicle room, shift in-charge, engineers room, maintenance engineers room, printer room, UPS room, relay room, SWAS (Dry) panel room, conference room, office rooms, record room, analyzer room and static excitation room in TG building.

b) A separate water cooled direct expansion type air conditioning plant of 2x100% capacity shall be provided for ESP/VFD control room.

c) Water Cooled Precision Type Packaged air conditioners shall be provided for the following areas:

i) Switchyard control room

d) Water Cooled Package Type AC units shall be provided for the following areas

- Each floor of Administration building covering all areas
- Each floor of Service Building

e) Air Cooled Non Ductable Split/Window AC units shall be provided for the following areas

- Office and meeting room areas of workshop building
- Weigh bridge Control Room
- Elechtrochlorination plant control Room
- ETP Control Room
- CW Control room
- Fire Station building control room
- H2 Generation Control Room
- Technical library
- Space/ Room for storing C & I items in warehouse.
- Operator cabin of TG Hall EOT Crane
- Ash handling control rooms
- DM plant control room including labs & offices
- CHP Control Room
- ECHS Control Room in NCPTS Stage II
- Sea Water Intake Pumphouse Control Room at NCTPS
- Clarified Water Pumphouse Control Room
- Filtered Water Pumphouse Control room
- GIS Control Room
- Chemical laboratory
- RO Stage I Control room in including labs & offices
- RO Stage II Control Room
- C&I laboratory, training hall, MRT laboratory
- Fuel oil Control Room
- Any other Control Room

19.5.2 **Ventilation System**

a) TG Building

Evaporative type ventilation system shall be provided for TG building as specified below. Air washer units of double bank spray system shall be distributed along A-row and B-row of the building. Filtered and Cooled air from each air washer unit shall be distributed to various areas through supply air ducting and grills. The TG building shall be provided with adequate number of roof extractors.

b) ESP Control Room (Non air conditioned areas)

Unitary Air filtration units of single bank spray system using water repellant type nylon filters shall be provided for ESP building. Unitary air filtration units shall be located at roof top of ESP building.

c) Ambient air ventilation system for the other areas

i) Turbine hall- Roof exhausters
ii) CW pumphouse
iii) Filtered Sea Water Pumpshouse in NCTPS Stage II
iv) Filtered Water Pumphouse
v) Fire Water Pumphouse
vi) Ash Water Pumphouse
vii) Ash Recovery Pumphouse
viii) Ash Slurry pumphouse
ix) Workshop Building
x) Air compressor room
xi) Air Compressor Room in NCTPS Stage II
xii) AC plant rooms
xiii) DG set rooms
xiv) RO Plant I
xv) RO Plant Stage II
xvi) Sea Water Intake Pumphouse in NCTPS Stage II
xvii) RO Stage I Permeate Pumphouse in NCTPS Srage II
xviii) UF Permeate Pumphouse in NCTPS Stage II
xix) Chemical House in NCTPS Stage II
xx) DM Plant
xxi) CPU
xxii) Stores
xxiii) Gate Houses
xxiv) Switchyard control building (Non a/c areas)
xxv) Battery and battery charger rooms
xxvi) All MCC rooms & cable vaults
xxvii) Compressor/vacuum pumphouse (AHP)
xxviii) Coal handling switchyard gear room
xxix) Transfer tower/tunnel for CHP.
xxx) Elevator machine rooms
xxxi) All other areas not airconditioned.
xxxii) Workshop
xxxiii) Toilets
xxxiv) Stores
xxxv) H2 Generation Building

Any other area/building which has not been specifically included above, but required ventilation shall be provided with suitable ventilation system.

19.6 **System description Air Conditioning System**

19.6.1 **Centralized Water Cooled Chilled Water System**

(a) A centralized water cooled chilled water system with screw chilling units are envisaged for airconditioning the areas viz. main control room areas. The water cooled screw chilling units along with chilled water pumps, condenser cooling water pumps and cooling towers shall be provided. The number of chilled water pumps, condenser cooling water pumps, cooling towers shall be equal to the number of chilling units. The air conditioning system shall also include multiple air handling units, associated air distribution system, chilled water piping, condenser water piping, valves & fittings, insulation, strip heaters, humidifiers, expansion tank and all other associated accessories and controls. A central control panel within the air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Makeup water for the condenser cooling

water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

(b) The screw chillers shall operate to meet the overall building cooling load requirements through out the day. The chillers shall operate by a combination of chiller optimization and sequencing. The airconditioning controls shall be designed as to interface with the safety controls of each of the air conditioning equipment along with automatic operation. Selector switches and push buttons shall be provided for manual operation of all air conditioning equipment.

(c) Chilled water flow of 10 cum/hr shall be supplied to Sample Cooler in the Analyzer room from the main airconditioning chilled water system.

(d) The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

(e) Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

(f) Humidification package with all necessary controls.

(g) Air distribution system including ducting, grilles, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

(h) Monorail and hoist for handling the A/C units, pumps, etc.

(i) Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge shall be provided for sensitive areas of main control room i.e unit control room, electronic cubicle room, printer room, UPS room, relay room, SWAS (Dry) panel room, & conference room. Other areas shall be provided with pre filters & fine filters. .

(j) The chilling plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of chilling units, pumps etc.

(k) Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

19.6.2 **Water Cooled Direct Expansion System (DX System)**

Independent water cooled central air conditioning system of direct expansion (DX) type with reciprocating compressor is envisaged for ESP control room

i. The water cooled condensing unit along with Air handling units, condenser cooling water pumps and cooling towers shall be provided. The number of Air handling units, condenser cooling water pumps, cooling towers shall be equal to the number of condensing units. In addition, one common standby condensing unit and the associated equipment shall be provided. The air conditioning system shall also include associated air distribution system, condenser water piping, valves and fittings, insulation, strip heaters, humidifier, Differential pressure for filters and all other accessories and

controls. A central control panel within air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Make up water for the condenser cooling water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

ii. The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

iii. Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

iv. Humidification package with all necessary controls.

v. Air distribution system including ducting, grillers, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

vi. Monorail and hoist for handling the A/C units, pumps, etc.

vii. Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge.

viii. The condensing plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of condensing units, pumps etc.

ix. Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

19.7 **System description Ventilation System**

19.7.1 **Evaporative Cooling System for Turbine Building**

i. Four (4) nos. air washers of adequate capacity shall be provided for evaporative cooling of various floors of turbine building including maintenance bay and electrical bay. Each air washer system shall consists of two (2) nos. centrifugal fans (both working), two (2) nos. centrifugal circulating water pumps (1 working + 1 standby), Send trap and air intake louvers, filters, air washer internal, ducts and other accessories. Besides, roof extractors shall be provided. With this system the dry bulb temperature (DBT) within the turbine building shall be maintained at a temperature not exceeding $5^{o}C$ less than ambient DBT at all times of the year. The air washer capacity is to be decided based on:

a) Total internal heat load within the turbine building, inclusive of electricity bay and maintenance bay and considering the heat dissipated by various electrical switchgear, motors, equipment hot surface, steam piping as well as the dissipated heat, solar transmission through the building walls and glass, and any other sources of heat.

b) Summer ambient conditions as furnished to be considered.

c) Efficiency of air washer shall be 90% with two banks opposed type spray system

ii. The number of roof extractors in the turbine building to be sized so as to exhaust about 70% of the total air supplied in order to reduce ingress of dust-laden air into the building.

iii. Air washer shall be double bank spray type mainly consists of an airtight chamber or casing containing air distribution louvers, spray nozzles, a tank for collecting spray water, eliminators with flooding nozzles, pre and fine filters and a pump with piping valves, strainers and specialities for re-circulating water. One (1) level switch in the air washer tank shall be provided to give an alarm in the air washer plant room.

iv. The supplied air will be exhausted through roof exhausters to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.2 **Unitary Air filtration Unit for ESP Control Building**

For ventilation of this building (except the control room), ambient air will be drawn through unitary air filtration units of single bank type comprising fresh air intake louvers, automatically cleanable nylon filters (with water spray) and moisture eliminator and supplied to the space by means of centrifugal fans.

The supplied air will be exhausted through wall mounted gravity operated dampers to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.3 **Ambient Ventilation System for other areas**

Ambient ventilation system shall comprise of supply air fan assemblies with Pre & Fine filters, Gravity louvers, exhaust air fans, roof extractors, gravity dampers or a suitable combination of these along with necessary filters, ducting, grilles etc.

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.

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.

19.7.4 **Specific Requirements**

All battery rooms to be painted with acid & fume resistant paint.

iv. 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 Airwasher nozzles/ water circuit.

19.8 **Equipment Description**

19.8.1 **Chilling Unit/Condensing Unit**

Type		Water cooled type.
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	:	a) For the Chilling units of T G building control room areas, the compressor shall be Hermetically sealed Screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities b) For condensing units of ESP/VFD control rooms shall be Hermetically sealed screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities
Type of drive	:	Motor driven, through direct
Accessories	:	High / Low pressure cutouts, 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 deg.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)
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 134a For Condensing Unit - R-22
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Chiller		
Type	:	DX type and Shell and tube type
Superheating of	:	At least 2 deg.C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Water
		Tube side - Refrigerant
Capacity	:	To match with respective plant capacity.

Shell material	:	Mild steel (IS : 2062)
Tube material		Replaceable seamless finned copper
Fin material	:	Aluminium
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.

19.8.2 **Air Handling Unit (AHU)**

a) Each AHU shall consist of Casing, Fan impeller section, Cooling coil section, damper section, Steel frame with vibration isolators (minimum efficiency of 85%) for the complete AHU, Isolation dampers at the Suction and discharge of each AHU, Pre-filter at the suction and Fine filters (micro-vee type) in the discharge of each individual AHU/common plenum, Absolute (HEPA type) filters in individual discharge of all AHU's/common plenum of Control room, control equipment room, computer, programmer rooms etc 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 22 swg (0.8 mm) galvanized steel, with 25mm thick polyurethane (PUF) insulation of minimum 40Kg./ Cum density in between. 16 gauge galvanized steel hat-channel shall be used as reinforcing to give structural strength.

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 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 than 96%.

g) Centrifugal Fan

a)	Fan impeller	:	Forward/ backward curved blade & centrifugal type.
b)	Impeller material	:	Mild steel spray galvanised with minimum zinc deposition conforming to Class 275 of IS:277.

c)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
d)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.
e)	Drive	:	Motor driven. With removable belt guard.
f)	Static pressure (minimum)	:	120 mm wc

19.8.3 **Precision Type Packaged Air Conditioners**

Packaged air conditioners shall be of precision control type complete with hermetic type Scroll compressor ,shell and tube type water cooled condenser, air handling fan, D-X cooling coil, Microvee filters,In-built dehumidification cycle thru solenoid valve for reading ADP, humidifier package with humidistat and other accessories and controls, electrical strip heaters with suitable thermostat, first charge of refrigerant and oil, controls and all necessary instruments and accessories, all housed in a cabinet made of heavy gauge sheet steel finished in epoxy paint of approved colour and suitable for floor mounting. Suitable drain connection shall be provided for removal of condensable collected inside a tray under cooling coil.

i. Compressor shall be hermetically sealed Scroll type with drive motor. It shall be suitable for R22/R407c refrigerant. The compressor shall be mounted on springs at the lower most section of packaged unit such that the same is easily accessible for servicing.

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. Cooling coils shall be of direct expansion type and made of heavy gauge copper with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of air flow.

v. Filters shall be non-rusting corrugated metallic wire mesh cleanable type and of adequate area so that the air velocity across the filters shall not exceed 2.5 m/sec. Filter shall be in-built with unit heaving efficiency 95% down to 5 microns.

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. Cabinet Construction:

The frame & panel shall be constructed of Cold rolled cold annealed sheet steel duly powder coated and shall be assembled with pop rivets. The side panels of unit shall be double skinned for increase life span and reduction of noise & vibration. Front panel shall be removable hinge for easy service.

viii. De-Humidification

Specific de-humidification cycle (Split Liquid / Split Suction) shall operate by reducing the operating surface temperature in a section of one of the Refrigeration coil by means of a solenoid valve in the Liquid line / Suction line. Full air flow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

ix. All necessary operating and safety controls shall be provided including the following:

Controls:

The controls shall be of microprocessor based programmable 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 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) 24 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.

x. A suitable number of vibration isolation pads shall be provided for the packaged units.

19.8.4 **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	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 410
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	As per manufacturer's standard.
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm

19.8.5 **Air Filters**

a) Pre Filter

1)	**Filter medium :**			
	i)	Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for Fabric type.		
	ii)	V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh for Metallic type pre-filters.		
2)	**Frame**			
		GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge) supported by galvanised steel wire mesh of 10 mm Square with handles.		
3)	**Other requirements :**			
	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.		
4)	**Efficiency :**			
		Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 - 76.		
5)	Minimum thickness		:	50 mm for Fabric type.
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 (AC system)
		:	2) At the suction of each Fresh air fan (AC)
		:	3) At suction of each PAC unit

b) Fine Filters (Microvee type)

1)	Construction	:	By pleating a continuous sheet of filter medium into closely spaced plates separated by heavy corrugated aluminium spacers.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS:737)
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame. Capable of being cleaned by air or water flushing.
4)	Efficiency	:	Average arrestance of 80-90% when tested in accordance with BS:6540/ASHRAE–52-76.
5)	Minimum thickness	:	150 mm or 300 mm.
6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 18 mm WC.
8)	Location	:	i) At the discharge of each individual AHU (AC system). ii) At the discharge of each Fresh air fan (AC system)

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 20 mm WC at rated flow; Final pressure drop - Up to 60 mm WC.
8)	Location	:	At the discharge of each individual AHU feeding to computer rooms, programmer rooms, control room and control equipment room in central control building.

19.8.6 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		F.R.P
Fan		Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill		Non combustible PVC or Equivalent of light grey, cream or white colour.
Louvers		F.R.P / PVC / Aluminium.
Nozzles		Brass with chrome plating/Polypropylene.
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 GI /SS wire mesh of 16 gauge.
Bird screen		25 mm square made of GI/SS wire mesh of 16 gauge.
Ladder		Hot dip galvanised steel ladder for each tower.
Distribution Pipe		Galvanised MS pipe.
Accessories		Drain connection with isolation valve Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. Overflow connection Equalizing connection to connect sump of all the towers wherever applicable. Access door in louvers / fan deck.

Individual sets of cooling towers shall be provided for Central chilling plant in T G building areas, DX type air conditioning system for ESP/VFD control room and Packaged type air conditioning systems for Administrative building, Switchyard control room, AHP control room and other areas/control rooms.

Non- Chemical Type Scale Preventor

The unit should be a non-chemical on-line type scale preventor not requiring any chemicals. Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment.It should work with a combination of Adsorption, and Turbulence. The inner core should be able to convert the hardness salts into colloidal particles.The unit should not require any electricity or any other source of energy.The unit should 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 should be of stainless steel.The method of checking the performance of system through computer simulation shall be provided

19.8.7 **Air Distribution System**

I) Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The thickness of sheets type of bracings and other fabrication details shall be as specified below: -

	Larger dimensions of Duct	**Thickness of GS sheet (mm)**	**Type of Transverse Joint Connection**	**Bracing**
a.	Upto 600	0.63 (24 g)	S-drive, 25 mm pocket or bar slips on 2.5 m centers	25 x 25 x3 angles 1.2 m from joint
b.	601 thru 750	0.63 (24 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x 3 angles braced at 1.2 m from joints.
c.	751 thru 1000	0.80 (22 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x3 angles braced at 1.2 m from joints.
d.	1001 thru 1500	0.80 (22 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers	40 x 40 x 4 angle braced at 1.2 m from joints.
e.	1501 thru 2250	1.00 (20 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers.	40 x 40x 4 angle braced at 600 mm from joints.
f.	2251 and larger	1.25 (18 g)	50 x 50 angle connections or 40 mm pocket or 40 mm bar slips 1 m centers with 35 x 3 bar reinforcing	50 x 50 x 5 angle braced at 600 mm from joints.

II) The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

III) Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of redoxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Wherever

in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.

IV) Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections. Connections shall be made from non-combustible heavy glass fabric 1.02 kg/M^2 (30 Oz per sq.yd) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

V) 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.

VI) Wherever duct passes through wall, all the openings between masonary 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.

VII) An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.

VIII) Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods, there shall be locking device with a mark to show the final adjusted position of the splitter

IX) 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.

X) 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.

XI) Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type.

Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.

XII) All air terminals shall be of mill finish extruded aluminium profile construction.

XIII) 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.

XIV) Each branch line shall have dampers to isolate the branch for maintenance purpose.

19.8.8 **Pipe work Valves and Specialities**

i. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanised steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS:3589 with minimum 6.35 mm thickness.

ii. Fabricated elbows from pipe (5 piece mitre) shall be furnished for pipe fittings of sizes 200 mm & larger. Locally available long radius (R=1.5D) hot bends with thickness same as that of the pipe having butt welding ends as per ASA B-16.9 shall be furnished for pipe fittings of sizes 150 mm up to 65 mm NB. 3000 # ASA standard forged carbon steel pipe fittings to A-105 Gr.II or IS:1875 Class-2 or approved equal with socket welding ends as per ASA-B-16.11 shall be furnished for pipe fittings of sizes 50 mm NB and smaller.

iii. Unless otherwise specified, all flanges shall be ASA # 150 standard (as applicable) forged carbon steel slipon flanges to A-105 Gr.II or approved equal, faced and drilled to ASA-B-16.5. The pipework flanges shall match with the valves and equipment connections. Hexagonal head machined carbon steel bolts to IS:1367 Class 4.6 or approved equal shall be furnished with hot forged carbon steel hexagonal head nuts to IS:1367 class 4.6. The gaskets shall be 3 mm thick wire inserted red rubber full face gaskets, 150 # ASA standard and drilling details to match with the flanges as required.

iv. In general, all the line joints for sizes 65 mm and larger shall be butt welded and the joints at valves shall be flanged unless otherwise specified. For pipe sizes 50 mm and smaller, the line joints shall be in general socket welded and the joints at valves shall be screwed unless otherwise specified. The joints at equipment and instruments shall be as per manufacturer's drawings.

v. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

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.

vi. All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Seller. The Seller's support shall utilize the Purchaser's steel as far as practicable. Where additional secondary steel is required for the hangers, these shall be furnished. The secondary auxiliary steel required for the hangers and supports shall be welded to the Purchaser's steel structure as directed by the Engineer. Welding shall not be permitted across the bottom flange of main structural members.

vii. The bidder shall ensure that the location of hangers and supports shall not increase the force and moments on equipment beyond the permissible limits. The anchors shall be designed for rigid fastening to the structure directly or through brackets. As far as possible, attachments of supports brackets to brick walls shall be avoided. All concrete inserts shall be galvanised and shall be installed on the concrete structure where required for fastening supporting devices.

viii. Bolted pipe clamps used for rod hangers shall be of minimum 6 mm thick. Hanger rods shall be 10 mm dia. All hanger components shall be given a shop prime coat of red lead paint.

ix. Upon completion of the installation of all pipework as per approved drawings, the pipe lines section shall be subjected to hydrostatic testing at 1.5 times the design pressure. All joints shall be carefully examined for sweating or leakage and repairs conducted as necessary and the hydrostatic test repeated till its satisfactory completion to the Engineer's satisfaction. After completing the hydrostatic test, the pipe lines shall be drained and flushed several times to ensure complete cleanliness inside the pipes.

x. All the drain piping between the drain connection of each equipment upto the Purchaser's common drain point in the equipment room shall be provided by the Contractor. Necessary seal loops as required shall be incorporated in the drain piping.

xi. The bidder shall submit the circulating water piping layout for Evaporative Cooling System. The quantities of piping, valves and instruments as required shall be included in the proposal. Requirement of pipe fittings, flanges, bolts and nuts, gaskets, couplings and associated accessories shall be estimated by the bidder and included in the scope of supply.

19.8.9 **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 through out 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 250 NB and above.

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arranement.

viii. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

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.

19.8.9 **Air Washer Unit**

i. Each Air Washer Units (Evaporative System) shall consist of the various Sections such as Air washer chamber / Casing, Tank, Distribution louvers, set of metallic/fabric filters, suction louvers, bird screens, water headers, Spray nozzle, piping, valves, etc, Drift eliminators, Pumps, Fans, Necessary controls & Instrumentation and all other required accessories.

ii. The air washer chamber casing shall be RCC or fabricated from MS sheet as the case may be. The sheet metal air washer chamber casing shall be fabricated from 3.15 mm black M.S. sheet with adequate stiffeners etc. and various sections shall be bolted through gaskets to avoid leakage of water. The inside of casing shall be protected by spray galvanization or by three coats of epoxy painting.

iii. The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the casing and tank shall be spray galvanized. Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup 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.

iv. The distribution plate shall be fabricated out of 16G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

v. Air washer shall be two-bank construction (one uni-flow and the other cross flow). The water shall be sprayed at filter bank. All header and stand pipes shall be galvanized.

vi. 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(g).

vii. The eliminator plates shall be of 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 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 hrs. Type test report of the 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 and drain pipe.

viii. An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.

ix. 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

x. The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for TG building and SISW / DIDW for and ESP/VFD building.

xi. Both inside and outside of all the sections of the metal chamber unit shall be spray galvanized to prevent corrosion. The nuts and bolts used for joining the section shall be stainless steel. The connection pieces shall have at least two (2) coats of rust inhibiting paint.

19.8.10 **Unitary Air Filtration**

Each unitary air filtration shall be of single bank (cross flow) consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Water shall be sprayed at filter bank .Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

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.

19.8.11 **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 90 minutes and should be energized to close and the air conditioning equipment shall be tripped off in the event of fire.

19.8.12 **Centrifugal Fans for Evaporative cooling plants**

i. The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanisation. In case of spray galvaniation zinc deposition should conform to class 275 of IS:277. The minimum thickness of casing shall be 3 mm. 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. The fan shall be of class I construction and Fan velocity should not exceed 10 m/s.

ii. The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristics 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 by key and/or nuts. The impeller along with driven pulley shall be dynamically balanced as per AMCA standard.

iii. The bearing shall be self aligning, heavy duly ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.

iv. Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.

v. 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 a minimum of 70% efficiency.

vi. The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

vii. 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%.

viii. The static pressure of fan shall not be less then 75 mmwc.

19.8.13 **Power Roof Extractors**

Power roof extractor's impeller shall be of axial type. Casing shall be made of MS minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized and impeller shall be made of cast aluminium impeller with blades of aerofoil design. The speed of the roof ventilators shall not exceed 960 rpm for impeller diameters larger than 450 mm and 1440 rpm for impeller diameters 450 mm and less. Hood of the roof ventilator shall be of hinged type providing easy access to motor and impeller. Mounting frame for mounting the roof ventilators shall be provided. Weatherproof lockable type disconnect switch shall be provided such that, the hood can be opened only when the disconnect switch is in "OFF" position.

The roof extractors shall shall be used for buildings of height 7 (seven) metres and above. The static pressure of power roof extractor shall not be less then 15 mmwc.

All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required shall be provided.

19.8.14 **Axial and Propeller Fans**

These fans shall have single piece cast aluminium impeller with blades of aerofoil design.

The fan casing shall be of heavy gauge sheet steel construction minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized.

Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

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 mm WC 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 atleast 25% above the operating speed.

The static pressure of supply air fans with pre & fine filters shall not be less then 32 mmwc while for exhaust fans 10 mmwc. However the propeller fans for toilets and pantries shall be 5 mm wc.

All other accessories like supporting structure etc. as required shall be provided.

19.8.15 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.

19.8.16 **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 1.75 m/sec. The prefilter 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 1.25 m/sec.
- Volume control damper, ducting, fixing frame and necessary supports.
- Filter frame shall be of aluminium and shall be flanged.

19.8.17 **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 specifed under this section shall be implemented in the respective PLCs.

iii. The basic function of the system shall be to closely control and monitor inside 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 for maintaining the room temperature/ RH by controlling the 3 way mixing valves at chilled water line, humidified system and duct heater.

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.

vi. 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).

vii. 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.

viii. Provision shall also be made for the manual restarting of the compressor.

ix. 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.

x. 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.

xi. 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.

xii. Closure of fire dampers shall raise an annunciation in the panel.

xiii. 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.

xiv. 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 chilled water type**

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 the modulating valve shall get its signal from the temperature sensor.

ii. Humidistat 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 Bidder's 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.

19.8.18 **Plant control for Evaporative cooling and Ventilation system**

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.

ii. Air Washer Units (AWU) & Unitary Air Filteration Units (UAF)

iii. Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

iv. 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.

v. Auto/Manual selector Switches and working/Standby selector switches for the pump shall be provided in the panel.

vi. A selection switch enabling the running of AWU fan or pump alone shall be provided.

vii. Miscellaneous control requirements

viii. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ix. Lamps shall be provided for indicating the status of each pump, fans etc. of Ventilation system in the main and local panel.

x. 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 respective panel.

xi. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.19 Bidders shall ensure that the guaranteed control room noise level is maintained and the units are designed for achieving the same. The vibration level of the units shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans) and airconditioning system equipment (A/c units, AHUs, Cooling Towers, Pumps etc.)

CHAPTER 20

20.0 ELEVATORS

20.1 Scope

20.1.1 Scope covers design, engineering, fabrication, installation, commissioning and testing of elevators listed below.

20.1.2 The required equipment and services shall be as described below:

20.1.2.1 One (1) no. rack & pinion type stack elevator of 500 kg capacity complete with all other accessories and associated steel works for 275 m high **chimney**.

20.1.2.2 One (1) no passenger cum goods elevator of 3000 kg capacity for crusher house CRH-1.

20.1.2.3 One (1) no. passenger cum goods elevator of 3000 kg capacity for TT-8.

20.1.2.4 One (1) no. passenger cum goods elevator of 3000 kg capacity for JTB-4 located in NCTPS Stage II.

20.1.2.5 Four (4) nos. 3000 kg conventional passenger cum goods elevator for boiler structure as described in Chapter -1, section – 1 Clause 18.0 –Steam Generator and auxiliaries.

20.1.2.6 Two (2) 680 kg conventional passenger elevator for Turbine building. This elevator shall travel upto Deaerator floor level.

20.1.2.7 Two (2) 680 kg conventional passenger elevators for Service Building.

20.1.2.8 One (1) 680 kg conventional passenger elevator for Administration building.

20.1.2.9 One (1) 680 kg conventional passenger elevators for ESP Control Building.

20.1.2.10 One (1) no. rack & pinion type elevator of passenger cum goods 2000 kg capacity for Flyash Silos. All the silos shall be interconnected with platform and accessed by this common elevator.

20.1.2.11 Any other building/ control room/ MCC room apart from what has been lised above and having more than two floors (>G+2) shall also be provided with 680 kg passenger elevator (each).

20.1.2.12 Electrical equipment such as motors, starters, switches, switch gears, control panels, interlocks, control & power cabling and earthing of electrical equipment.

20.1.2.13 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.

20.2 Rack & Pinion Elevators

20.2.1 Design Criteria for Rack & Pinion Elevators

20.2.1.1 Elevator shall be located outside the RCC stack, Crusher house CRH-1, TT-5 & JTB-5 and shall be capable of operating from the ground floor to the top interior platform with intermediate stops at all interior platforms.

20.2.1.2 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 75°C to 10°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.

20.2.1.3 Elevator shall be attached to the chimney shell using anchor bolts supplied and installed into the chimney shell by the contractor.

20.2.1.4 Design and Operational Requirements

20.2.1.4.1 Design and operation of the stack elevator shall comply with the following requirements:

i.	Carrying capacity (kg)	:	400 (minimum)
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)	:	275.0
vii.	Electrical power supply system	:	415 Volts, 3 phase, 50 Hertz
viii.	Type of loading	:	Passenger cum goods

20.2.1.4.2 Design and operation of the Flyash Silo elevator shall comply with the following requirements:

i.	Carrying capacity (kg)	:	2000 (minimum) each
ii.	Operating speed (m/min)	:	40
iii.	Cab floor size (inside) (mm) width x length	:	1100x1100 (minimum)
iv.	Landing levels (Nos.)	:	As required at all internal platform levels and as per maintenance requirement.
v.	Landing elevations	:	As per requirement
vi.	Total vertical travel (m)	:	By bidder
vii.	Electrical power supply system	:	415 Volts, 3 phase, 50 Hertz
viii.	Type of loading	:	Passenger cum goods

20.2.2 **Equipment Specifications for Rack & Pinion Elevators**

20.2.2.1 **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 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.

20.2.2.2 **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.

20.2.2.3 **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.

20.2.2.4 **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 a 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.

20.2.2.5 **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

20.3 Equipment Specifications for Conventional Elevators

20.3.1 Elevators shall be of conventional type. The elevator shall meet the quality of international standard.

20.3.2 No. of floors/ landings served shall be decided during detailed engineering based on the approved layouts.

20.3.3 For additional requirements of boiler elevators please refer chapter 1 also in addition to requirements listed below.

20.3.3.1 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/s
iv)	Position of machine room	:	Directly above elevator shaft
v)	Machine room	:	Machine room shall be provided with minimum 2T capacity air conditioner for each elevator.

20.3.3.2 **Construction**

20.3.3.3 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.
vi)	Cabin accessories	:	i. Recessed fluorescent light fittings on car floor. ii. Car control station iii. Emergency stop switch iv. 5/15A plug socket with switch on top of lift car.

20.3.3.4 Automatic Rescue Device (ARD) – (Battery drive)

Bidder to provide a modern advanced electronic drive system of “Rescuing passenger trapped in an elevator”.

20.3.3.5 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.

20.3.3.6 All steel embedment for fixing landing doors/ indicators etc to the elevator well shaft and fascia plate shall be supplied by the bidder.

20.3.3.7 Guide rails complete with supporting brackets for the car and counter weights.

20.3.3.8 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.

20.3.3.9 Any other steel works as well as all other accessories/ components not specified in the specification but necessary for making the elevator complete.

20.3.4 **Operation**

20.3.4.1 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. Bidder shall provide 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. Bidder shall provide 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. Bidder shall provide 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).

20.3.5 **Elevator Electrical**

20.3.5.1 **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, 3 wire 50 HZ (+3 % to -5% variation) supply. Motors shall be provided with class F Insulation.

20.3.5.2 **Controls**

The controls shall be variable voltage and variable frequency type and shall provide smooth and constant acceleration and retardation under all conditions of operation. Suitable control shall be provided in the machine room.

20.3.5.3 **Cables & Wiring**

All the cables except trailing cables shall be as per IS 1554-1 or IS 7098-1. The PVC outer sheath of these cables shall be flame retardant, low smoke (FRLS) type with the following FRLS properties.

1. Oxygen index of min 29 (as per IS:10810 Part 58).
2. Acid gas emission of max 20% (as per IEC 754-1)
3. Smoke density rating shall not be more than 60% (as per ASTMD-2843)

The circular trailing cables shall be either in accordance with IS 4289 Part-I (elastomer insulated) or IS 4289 Part II (PVC insulated). The flat type trailing cables if offered shall be in accordance with IEC 60227-6.

All wiring/ cabling between the equipments in the lift machine room and that between the machine room and equipments in the lift well and at the landings shall be wired in HDP conduits/ galvanized steel conduits to be supplied by the contractor. Alternatively armored cables may be used.

20.3.5.4 **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.

CHAPTER 21

21.0 MILL REJECT HANDLING SYSTEM

21.1 System Description

21.1.1 The scope of Mill Reject System shall include collection of mill rejects from mills and transportation of the same to storage bunker through dense phase pneumatic conveying system. From storagwe silo the mill rejects shall be disposed off in trucks.

21.1.2 The scope of supply includes the following :

- One (1) no. pyrite hopper with discharge chute, emergency chute work etc for each mill as required.
- Two(2) nos. pnmeumatically operated isolation gates for inlet & outlet of pyrite hoppers complete with compressed air pipework, solenoid valves & supporting arrangement for each pyrite hopper.
- Conveying pipework from individual mill reject handling equipment to the reject storage silos with all accessories like bends, fixtures, flange joints, structural steel supports, anchors/ inserts/ trestles, walkways etc. as required.
- Mill Reject silos (2 nos), 1 for each unit in steel construction, each having an effective storage capacity of sixteen (16) hours considering all the working mills of the unit in operation and rejectinmg @ 1% of mill capacity for worst coal condition. Necessary supporting steel structurs, platforms, staircase, manual operated unloading gate, 3mm thk 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.
  The storage silos shall be designed to provide a clear access of 4.5 m for a road tanker/ 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 2 x 100% pumps installed for RO Stage II Reject sump for this purpose.
- Four (4) nos air receivers (2 per unit), each of capacity min 5 cum, with all accessories, interconnecting pipework etc shall be provided.
- Two (2) nos. (1W + 1S) oil free screw compressors, with drives & accessorires, to cater to the compressed air requirements of mill reject handling system for two (2) units working simultaneously. Compressors shall be located in the main compressor House.
- Necessary lifting devices of adequate capaciuty to handle the mill reject handling equipment.
- Complete instrumentation as indicated in Volume V.
- Necessary electrical equipment as required.
- Civil structural works associated withmill reject handling system including foundation bolts, pockets, grouting, underpinning etc.

21.1.2 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 storage silo through conveying pipeline of MS ERW heavy grade. Storagesilo shall be of MS construction with SS liners and shall be provided with discharge gate at its outlet to discharge rejects into a truck. The SS liner shall be 3 mm thick SS 304 material. Two

(2) 1W+1S), oil free, rotary, screw air compressors shall be provided for conveying mill rejects from pyrite hoppers 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 sparying pyrite hoppers shall be drawn from RO stage II reject water. Radio Frequency 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 6.0 meters/sec and number of cycles shall not be more than 6 per hour.

21.2 Equipment Description

21.2.1 Pyrite Hopper

One (1) pyrite hopper shall be provided below each bowl mill. 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 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. Pyrite hopper shall be provided with level probes and temperature switches. Arrangement of nozzles to spray water shall be provided when temperature goes beyond the preset value.

21.2.2 Mill Reject Vessel

One (1) mill reject vessel shall be provided for each pyrite hopper to transport mill rejects to storage bunker by means of dense phase conveying system. Transport vessel shall be provided with one cylinder operated inlet valve, outlet vale and air inlet valve. Inlet valve of transport vessel is normally in open position. After lapse of predetermined time or commencement signal by level probe of pyrite hopper, the inlet valve of transport vessel closes and air is injected through air inlet valve and vessel is pressurised. At predetermined pressure, the outlet valve of transport vessel opens and rejects are transported to storage bunker through pipeline. At predetermined pressure, the inlet vale opens and air inlet valve and out valve closes. This cycle goes on repeat.

21.2.3 Storage Bunker

Two nos. of mill reject silos, each with effective capacity of 16 hrs storage and reject generation of 1% of the total coal fired at 100% BMCR condition with worst coal firing shall be provided. The storage bunker shall be provided with stainless steel liners on inner walls. Adequately sized bag filter to vent the transport air to atmosphere, terminal boxes, level probe and pressure relief valve shall be provided over top of storage bunker. Manual operated discharge gate shall be provided at out of storage bunker to unload the rejects into trucks. If necessary, adequately rated chute vibrators shall be furnished to ensure easy unloading of rejects.

21.2.4 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 transport vessel to storage bunker. The compressors shall be of continuous indoor

duty complete with air coolers necessary valves with vent pipe work ducted to a safe discharge outlet. The air pipe work shall be of ERW pipes to IS: 3589/1239 heavy quality construction. At least 10% margin shall be provided on compressor capacity over and above the maximum flow requirement.

21.2.5 Air Receiver

Four (4) nos Air receiver (minimum 5 M^3 capacity each) 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.

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 gauges, pressure switch, 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.

21.2.6 **Mill Rejects Conveying Pipeline**

Rejects conveying pipeline shall be MS ERW heavy grade to IS: 1239/3589. Pipes shall jointed by welding and all fittings, bends etc shall be alloy cast iron and the radius of bends shall be not less than 3D.

21.3.0 **CONTROLS**

21.3.1 **R**efer Annexure A of clause 4.00.10 of Volume V for control system.

DATA SHEET FOR MILL REJECT HANDLIMG SYSTEM

S. No.	Item	Units	Description
1.0	**MILL REJECT SYSTEM**		
a	Max Lump size of mill rejects	Mm	20
b	Max Rate of Rejects Genrated per mil	TPH	By Bidder (Tentative 1.6TPH)
c	Total No. of Coal Mills per unit	Nos.	By Bidder
d	Temperature of Mill Rejects	Deg C	200 (Max)
e	Srorage Required for mill rejects	Nos.	One no. per unit
f	Bulk Density of mill rejects		
	i) for volume considerations	T/m3	1.6
	ii) for structural considerations	T/m3	2.4
g	Design Extraction rate of mill rejects from pyrite hopper		150% of expected coal mill rejects of coal consumption at 100% BMCR considering worst coal
h	Mill reject conveying capacityImpeller	TPH	Minimum 15
2.0	**MILL REJECT HANDLING VALVES**		SS 410
a	Type		Dome/ Type/ Swing Type/ Dome
b	Material of construction		
	i) Body		Cast Iron 225 BHN
	ii) Plate/ Disc		10 mm Thk 300 - 350 BHN SS
	iii) Seat		Replaceable type alloy CI or SS smooth finished with 250 BHN hardness
	iv) Method of operation		Solenoid operated pneumatically actutated with provision for manual override facility
3.0	**TRANSMITTER 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 Heavy Grade
e	Bends/ Fittings/ Laterals		Alloy cast iron 400 BHN
4.0	**MILL REJECT STORAGE SILOS**		
a	Quantity		One no. per unit
b	Construction		Steel Construction (MS IS 2062)with 3mm Thk SS 304 lining in conical as well as vertical portion
c	Type of level measurementand 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)

S. No.	Item	Units	Description
6.0	**BAG FILTER**		
a	Location/ Quantity		1 no. per silo
b	Type		Reverse pulse jet type
c	Material of Bags		Polyester needle felt of antistatic type
d	Air to cloth ratio	m/min	1
e	Conveying air piping		MS ERW as per IS 1239 Heavy Grade upto 150 NB and IS 3589 above 150 NB.

CHAPTER 22

22.0 WORKSHOP EQUIPMENT

Following workshop equipment shall be supplied complete with all accessories to carry out the maintenance and/or for production of spare parts of power plant requirement and housed on a building of minimum dimensions 35 m x 20m.

22.1 HEAVY DUTY LATHE - B

a)	Type	:	Heavy Duty Lathe
b)	Quantity	:	One(1)
c)	Swing over bed	:	575 mm
d)	Height of centers	:	225 mm
e)	Distance between centers	:	2000 mm

Accuracy:

Geometrical Accuracy & Practical Tests to be conducted as per Test Chart conforming to IS: 1878 (Part-1) – 197.

Standard Accessories:

1. Carrier Plate
2. Metric & Inch – change gears
3. 2 Morse Taper Dead centers with center bush
4. Square Tool post
5. Set of Allen keys & spanners
6. Oil can

Optional Accessories:

1. Face Plate
2. Steady Rest
3. Follow Rest
4. Taper turning attachment
5. Rear Tool Post with long cross slide
6. Key-way cutting attachment
7. Chuck Flange
8. 14” x 4 Jaw Dog Chuck
9. 12” x 3 Jaw Self Centering chuck

22.2 MEDIUM DUTY LATHE

a)	Type	:	Medium duty lathe
b)	Quantity	:	One (1)
c)	Swing over bed	:	600 mm

d)	Height of centers	:	200 mm
e)	Distance between centers	:	1500 mm

Accuracy:

Geometrical Accuracy & Practical Tests to be conducted as per Test Chart conforming to IS: 1878 (Part-1) – 1971.

Standard Accessories:

1. Carrier Plate
2. Metric & Inch – change gears
3. Morse Taper Dead centers with center bush
4. Square Tool post
5. Set of Allen keys & spanners
6. Oil can

Optional Accessories:

1. Face Plate
2. Steady Rest
3. Follow Rest
4. Coolant pump with tank and fittings
5. Taper turning attachment
6. Rear Tool Post with long cross slide
7. Key-way cutting attachment
8. 16” x 4 Jaw Dog Chuck
9. 12” x 3 Jaw Self Centering chuck
10. Chuck Flange (A 28)

22.3 UNIVERSAL MILLING MACHINE

a)	Quantity		:	One (1)
b)	Clamping Area	Length	:	1250 mm to 1350 mm.
		Width	:	300 mm to 310 mm.

Accuracy:

Geometrical Accuracy & Practical Tests to be conducted as per Test Chart conforming to IS: 2200 – 1994.

Standard Accessories:

1. One Milling Arbor ISO 40 x 27 x 500 with clamping bolts, bush
2. Supporting Arm Braces

Optional Accessories:

1. Machine Vice 160 mm

2. Universal Dividing Head
3. Vertical Milling attachment with parking bracket
4. Hand operated Rotary Table
5. Coolant equipment complete

22.4 RADIAL DRILLING MACHINE

a) Quantity : One (1)

b) Capacity

i)	Drilling (Max)	:	63 mm dia in C.I.,	50 mm dia in steel
ii)	Boring	:	110 mm dia in C.I.	90 mm dia in steel
iii)	Tapping	:	60 - 70 mm dia in C.I.	30 - 55 mm dia in steel

Accuracy:

Geometrical Accuracy & Practical Tests to be conducted as per Test Chart conforming to IS: 2199 – 1989.

Standard Accessories:

1. Electro Hydraulic Clamping for drill head
2. Morse Taper Reduction Sleeve – IS 6702 Grade 2, MT5 – MT4

Optional Accessories:

1. Box Table 630 mm x 630 mm x 550 mm.
2. Machine Vice 160 mm
3. Coolant equipment complete

22.5 BENCH DRILLING MACHINE

a) Quantity : One (1)

b) Drilling capacity in steel : 13 mm

Accuracy:

Geometrical Accuracy Test to be conducted as per Test Chart conforming to IS: 2426 – 1963.

Standard Accessories:

1. Drill chuck 13 mm cap. with arbor & key
2. Machine Vice 100 mm, plain type

22.6 PORTABLE DRILL GUNS

a) Quantity : Three (3)

Accuracy:

As per manufacture's test certificate/guarantee.

22.7 UNIVERSAL TOOL AND CUTTER GRINDER

a) Quantity : One (1)

b) Maximum diameter of cutter that can be ground : 250 mm

c) Maximum distance between centers : 300 mm

Accuracy:

As per manufacturer's standard.

Standard Accessories:
1. Steady with centres
2. Dividing Head (Bearing Type) with stopper
3. Wheel extension shaft
4. Universal Machine Vice
5. Operating tools

22.8 BENCH GRINDING MACHINE

a) Quantity : One (1)

b) Size of Grinding wheel : 250 mm X 25 mm
(One coarse and one fine)

Accuracy:

Geometrical Accuracy Tests to be conducted as per Test Chart conforming to IS: 2538 – 1963.

Standard Accessories:
1. One set of grinding wheels
2. One set of splash guards
3. One set of tool rest

22.9 DOUBLE WHEEL PEDESTAL GRINDER

a) Quantity : One (1)

b) Wheel : 400 mm dia X 50 mm

Accuracy:

Geometrical Accuracy Tests to be conducted as per Test Chart conforming to IS: 2538 - 1963

Standard Accessories:
1. One set of grinding wheels
2. One set of splash guards
3. One set of tool rest

22.10 POWER HACKSAW MACHINE

a) Quantity : One (1)

b) Round cutting capacity : 300 mm for steel

Accuracy:

Geometrical Accuracy Tests to be conducted as per Test Chart conforming to IS: 3405 – 1966.

Standard Accessories:

1. Adjustable material stop
2. Hacksaw blade
3. Material Stand (Bar Rest)
4. Coolant pump with fittings

22.11 HYDRAULIC PIPE BENDING MACHINE

a)	Quantity	:	One (1)
b)	Pipe size	:	15 to 200 NB
c)	Hydraulic Pressure in Tons	:	45 Tons

Accuracy:

As per manufacturer's standard.

Standard Accessories:

1. One set of formers of 15, 20, 25, 40, 50, 65, 80, 100, 125, 150 & 200 NB size.

22.12 ARGON ARC WELDING MACHINE

a)	Quantity	:	One (1)
b)	Input	:	230 V, %0 Hz, Single phase
c)	Output	:	200A DC @ 60% Duty cycle
			150A DC @ 100% Duty cycle

Accuracy:

As per manufacturer's standard.

Standard Accessories:

1. Protective Helmet with glass
2. Pair of Hand Gloves
3. Chisel and wire brush
4. Welding Torch
5. Set of Tungsten Electrodes

22.13 PIPE AND BOLT THREADING MACHINE

a)	Quantity	:	One (1)
b)	Pipe size	:	From 15 NB to 150 NB

Accuracy:

As per manufacturer's standard.

22.14 SHAPING MACHINE

a)	Quantity	:	One (1)
b)	Length of Ram stroke	:	630 mm(Adjustable)
c)	Length and width of Table top	:	600 mmX335 mm
d)	Length and depth of Table side	:	600 mmX410 mm
e)	Horizontal travel of Table (Max)	:	690 mm
f)	Vertical travel of Table (Max)	:	365 mm
g)	Number of speeds to ram	:	4
h)	Range of ram cycle per min	:	14 to 72

Accuracy:

Geometrical Accuracies Tests to be conducted as per Test Chart conforming to IS: 2310 – 1963.

Standard Accessories:

1. Swivelling Vice
2. Crank Handle
3. Tool Holder attachment
4. HSS Cutting tool (1 No.)
5. Automatic Tool Lifting attachment

22.15 ELECTRIC ARC WELDING MACHINE

a)	Quantity	:	One
b)	Current range	:	70 – 500 A
c)	Open circuit Voltage	:	70 Volts
d)	Operating load Voltage	:	17 – 31 Volts
e)	Current at 60% duty cycle	:	400 A
f)	Input supply	:	415V, 3 phase, 50 Hz
g)	Tig welding torch	:	i) Capacity – 500 A ii) Cont. welding current – 390 A iii)Torch cooling – Water cooling

Accuracy:

As per manufacturer's standard.

Standard Accessories:

1. Welding cable of 10 mtr length with electrode holder
2. Protective Helmet with glass

3. Pair of Hand Gloves
4. Chisel and wire brush

22.16 RECTIFIER WELDING SETS

a)	Construction	:	The welding machine shall be forced air cooled manual arc welding silicon diode rectifiers designed to provide DC welding current. The sets shall be supplied with (i) suitable ammeters and voltmeters for direct reading of welding current and voltage, (ii) a remote current control device and (iii) a four wheeled steerable undergear.
b)	Quantity	:	Two (2)
c)	Input supply	:	415V, 3 phase, 50 Hz
d)	Input primary current	:	55 / 45 Amperes at maximum rated output
e)	Output range of welding current	:	55-500 Amperes
f)	Current at 100% duty cycle	:	280 Amperes
g)	Current at 60% duty cycle	:	400 Amperes
h)	Open circuit voltage	:	59 – 68 volts
i)	Class of insulation	:	E

Accuracy:

As per manufacturer's standard.

Standard Accessories:

1. Welding cable of 10 mtr length with electrode holder
2. Protective Helmet with glass
3. Pair of Hand Gloves
4. Chisel and wire brush

22.17 SLOTTER

a) Quantity : One (1)
b) Stroke, Maximum : 630 mm(adjustable)

Accuracy:

Geometrical Accuracy Tests to be conducted as per Test Chart conforming to IS: 2308 – 1963.

Standard Accessories:

1. Round Table fitted on the machine
2. Special wrench

22.18 OXY-ACETYLENE GAS WELDING/ BRAZING MACHINE & WELDING TABLES

a) Quantity : One(1)
b) Welding tables dimension : 2000 mm X 1000 mm (3 nos.)

Accuracy:

As per manufacturer's standard.

Standard Accessories:

1. Gas Welding Blowpipe
2. Oxygen line regulator
3. Acetylene line regulator
4. Hose Pipe of 5 mtrs. Length.
5. Protective Helmet with glass
6. Pair of Hand Gloves
7. Chisel and wire brush
8. Welding Apron

22.19 AC WELDING TRANSFORMER

a) Quantity : One(1)

b) Input supply : 380 - 440V, 3 Phase, 50 Hz

c) Output: -

Welding Current range : 60 – 400 Amps.

Accuracy:

As per manufacturer's standard.

Standard Accessories:
1. Welding cable of 10 mtr length with electrode holder
2. Protective Helmet with glass
3. Pair of Hand Gloves
4. Chisel and wire brush

22.20 WELDING GENERATOR

a) Quantity : One(1)

b) Input supply : 380-440V, 3 Phase, 50 Hz

c) Output:

Open Circuit Voltage : 100 V

Welding Current range : 10 - 4000 Amps.

Accuracy:

As per manufacturer's standard.

Standard Accessories:

1. Welding cable of 10 mtr length with electrode holder
2. Protective Helmet with glass
3. Pair of Hand Gloves
4. Chisel and wire brush

22.21 MARKING OFF TABLE

a) Quantity : One(1)
b) size : 1600 x 1000 x 200 mm, with M.S. fabricated stand.

Accuracy:

As per manufacturer's standard

22.22 GENERAL WORKSHOP EQUIPMENT

a. Soldering Gun(1 no.)

b. Electric Drying Oven – 5-10 Kg capacity, 50-300^{0}C.(1 no.)
c. Brazing Hearth.(1 no.)
d. Pneumatic Hammer – 3500 stroke/ min, 6,2 bar (1 No.)
e. Working Benches- 2000 mm x 750 mm x 1000 mm Height – (4 nos.)
f. Fitter Vices.- 150 mm s ize
g. One (1) n**o Coil Winding Machine**

22.23 Paint Shop

b. One (1) portable compressor complete with 10 gallon capacity compressed air spraying equipment complete with spray gun, stirrer and accessories.

c. One (1) portable sanding machine

d. One (1) set of sign writing equipment and stencils

e. One (1) buffing and polishing machine

CHAPTER 23

23.0 WEIGH BRIDGE

23.1 One (1) Electronic weigh bridge of 120 Tonnes capacity suitable for weighing loaded road trucks/trailers shall be provided shall be provided in the Flyash Silo area. The system shall have an accuracy of ±0.25% of actual weight. The scope shall include supply of PC, printer, UPS with 1 h our backup, software capable of providing details like net weight, tare weight, total weight etc. Stamping by relevant authorities shall also be included in Contractor's scope of work.

23.2 One (1) Electronic road weigh bridge of 60 Tonnes capacity suitable for weighing loaded road trucks/trailers shall be provided. The system shall have an accuracy of ±0.25% of actual weight. The scope shall include supply of PC, printer, UPS with 1 h our backup, software capable of providing details like net weight, tare weight, total weight etc. Stamping by relevant authorities shall also be included in Contractor's scope of work.

23.3 The weigh bridge shall be provided at the location specified by owner within plant area.

DATA SHEET FOR WEIGH BRIDGE (APPLICABLE FOR BOTH 120T & 60 T WEIGH BRIDGE)

S. No.	Item	Units	Description
1.0	**DESIGN DATA**		
a	Type		Pit Mounted/ Pit less
B	Capacity		Min 5T & Max 120T
c	Size of Platform		To accomodate standard trucks
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		
	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
			Material to be weighed
			Truck/ Wagon/ Vehicle Number
			Batch Number
			Gross weight
			Tare Weight
			Net weight
f	PC Configuration		
			22” TFT Monitor
			4 GB Ram
			Intel Core I7 Processor
			1 TB HDD
			DVD R/W Combo
			4 USB Ports
			2 Serial & 1 Parellel Port
			Windows 8 OS
			Standard Weighing Software

S. No.	Item	Units	Description
			MS Office
g	Printer		Laser Printer
4.0	**CALIBRATION & STAMPING**		
a	Test Weight for Calibration		By Bidder
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		Yes Weigh Bridge shall be supplied with arrangement to avoidvibration & distortionand arrestors to restrictthe platformmotion in longitudinal & lateral motions.
d	Furniture in control room		Yes
e	UPS		Yes
6.0	**TESTS & INSPECTION**		
a	Overload test with 150% of specified load		Yes
b	Performance test at site		Yes

CHAPTER 24

24.0 HYDROGEN GENERATION PLANT

24.1 DESIGN CRITERIA

24.1.1. For continous parallel as well as for two shift or one shift operation of both streams in part load from control panel / OWS

24.1.2 To trip the plant in case of high hydrogen level inside the building with suitable numbers of hydrogen gas detectors.

24.1.3 To maintain set pressure with help of back pressure regulation valve.

24.1.4 Automatic operation of standby compressor. Alarm & tripping of compressor based on suction conditions.

24.1.5 The scheme & construction details of equipment shall be based on manufacturer's standard for bipolar design of the Hydrogen plant.

24.1.6 Capacity to be sized as follows :

Leakage rate per generator	:	"A" Nm^3/day
Requirement of one generator filling	:	"B" Nm^3
Number of TG units	:	C
Hydrogen generation plant capacity	:	[C*1.5* A + B/30] / 12 Nm^3/hr

However, total plant capacity shall not be less than 20 Nm^3/hr with two streams of 50% capacity each of minimum 10 Nm^3/hr.

24.1.7 The complete hydrogen generation plant system equipments layout etc. shall be designed as per the explosive authority and the bidder shall obtain the approval from the chief controller of Explosive – India and other statutory authorities for design and installation of the plant.

24.2 EQUIPMENT DETAILS

24.2.1 Common MCC and PLC panel along with EWS/OWS with A3 size printer. Separate silicon controlled rectifier panel with all accessories i.e. rectifier, transformer etc.

24.2.2 One (1) no. Electrolyzer unit per stream -bipolar sealed compact design with requisite number of cells to generate rated quantity of hydrogen, complete with all accessories and safety features.

24.2.3 One (1) no. Gas Washing Tank per stream or any other alternative device to remove traces of caustic potash entrained with hydrogen gas. Each gas washer has level switches.

24.2.4 Two (2) sets of multistage Hydrogen Gas Compressors capacity 10 Nm^3/hr, each set complete with drive unit, intercoolers and other accessories and instrumentation. Each compressor set 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/cm2 (gauge), with pressure gauge, safety relief valve, temperature gauge etc. along with flame proof electric motor.

24.2.5 Two (2) nos. of Hydrogen Gas After - Coolers.

24.2.6 Two (2) nos. Hydrogen Gas Catalytic Purifier Unit with coolers and all accessories as necessary.

24.2.7 Two (2) nos. Hydrogen Gas Dual Tower Gas Dryer/twin tower moisture separating columns of reactivation features/regenerative design along with valve arrangement so as to suit operation of one column & regeneration of the other.

24.2.8 Two (2) nos. Portable Hydrogen Gas Purity Meters. These meters shall be battery operated.

24.2.9 Two (2) nos. Dual Type After-Filters to prevent entrainment of desiccant particles with the effluent gas from the dryer unit.

24.2.10 Two (2) nos. 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.

24.2.11 One (1) no. Nitrogen manifold common for both streams. Nitrogen gas filled cylinders shall be adequate for two complete purging of the hydrogen gas streams, along with complete scavenging system comprising necessary piping network, all fittings, pressure reducing station etc.

24.2.12 Two (2) nos. Hydrogen Cylinder Hold Racks, each capable of holding sixty (60) cylinders shall be arranged in two adjacent areas of the plant.

24.2.13 One (1) no. Electrolyte (caustic solution) Mixing & Storage tank of SS construction.

24.2.14 Two (2) nos. Electrolyte Transfer Pumps with drive motors, pressure gauge at pump discharge, differential pressure gauge across suction filter etc. complete with all accessories.

24.2.15 Two (2) nos. DM Water Storage tank with minimum capacity of 2 m3 for each stream shall be provided along with drain connection & level switches/level gauge. The drains & over flow from DM tank shall be provided with suitable arrangement to ensure that no air ingress takes place.

24.2.16 Stainless steel interconnecting pipes, valves, fittings, specialties from DMWS tank to H2 Generation plant. DM Water Tank to be located on the roof of Hydrogen-Generation Plant Building.

24.2.17 The Cooling Water for H2 Generation plant shall be taken from service water network system also return hot water piping shall be led to the outdoor drainage system outside Generation Plant.

24.2.18 Two (2) nos. i.e. one (1) no. per stream return hydrogen gas cooler with all fittings, moisture purge station and instruments.

24.2.19 Suitable Leak Detection and interlock system in cell room, compressor room and filling area.

24.2.20 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. Complete instrumentation including alarm annunciation for all stages of the multistage compressor set shall be furnished. The list of instruments shall include but not be limited to those shown in P&I diagram and shall also include among others, continuous hydrogen purity meters with recording and alarm facilities, hydrogen detectors in cell room and compressor rooms and trace oxygen analyzer.

24.2.21 Mandatory Spares, Tools and Tackles.

24.2.22 Complete set of special tools and tackles required for maintenance and overhauling of the equipment for the plant.

Note: Due to danger of hydrogen fire and explosion, the design of the fixtures shall conform to such measures as would ensure safe operation of the hydrogen supply system by avoiding sources of ignition in the zone of production & compression of hydrogen. The plant shall be located in such a way that even small explosion shall not cause any problem to the other areas.

24.3 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. In line with requirements indicated in chapter 19.

24.4 SAFETY REQUIREMENT

The equipment should be built according to the international standards and should fulfill the necessary CCE approval requirements towards pressure vessel directives and explosion hazardous area.

The complete process, together with all relevant parameters, should be constantly monitored and controlled by a microprocessor. Each action that might cause a dangerous situation should be by passed by a Hard Wired Safety System. In case small malfunction of the microprocessor or in an emergency situation, the unit should shut down immediately.

Hydrogen in the atmosphere should be constantly checked and if hydrogen in the atmosphere is detected at a level of 20% of Lower Explosion Level (LEL) for hydrogen (4%), the unit should immediately stop production and put itself in stand by.

Pressure transmitter should constantly monitor and control the system pressure. If the system pressure increases out of range, the production will be stopped and will be put in

stand by. Temperature transmitter should constantly monitor and control the electrolyte temperature. The electrolyte levels should be measured by a level transmitter and should be controlled by a level controller.

Safety devices to protect microprocessor against power line disturbance will be provided. The system should be capable of taking electrical surges.

All the process instruments/Analysers process switches shall be connected through Zener protection.

Redundant leakage detectors shall be provided in the individual rooms of H2 plant. (example Electrolysis room, compressor room, Gas filling room etc.,)

H2 purity analysers in the product line to the tank and the filling line shall be provided. Pt 100 RTD's in individual electrolytic cell shall be provided for temperature measurement & monitoring.

Necessary pressure switches & temperature switches, pressure transmitters, H2 tank level switches used for interlocks & protection shall be provided in addition to local gauges.

24.5 EMPTY CYLINDERS - HYDROGEN AND CARBON DIOXIDE

Adequate quantity of empty hydrogen gas cylinders (min 20 Nos), each of 7 cum capacity, conforming to International Safety Codes and adequate quantity of empty carbon dioxide gas cylinders, each of 7 cum capacity, conforming to International Safety Codes alongwith inbuilt siphon arrangement shall be provided. The number of cylinders provided shall depend upon the unit size and the charge required for each unit. The number of charge / filling shall be minimum three (3).

The cylinders shall comply with the requirements of the latest revisions of the following codes and standards:

a. ICC specification 3A-2130 and 3A-1800.

b. Indian Standard Specification for Identification of the contents of Industrial Gas Cylinder IS:4379-1967.

c. Indian Standard Specification for recommendation for hydrostatic stretch testing of compressed gas cylinders IS:5844-1970.

d. Indian Standard Specification for valve, fittings for compressed gas cylinders IS:3224-1971.

e. International safety codes to BS:2788, BS:1287 and BS:1288.

The cylinders shall comply with US Standard specification for aspects not covered by ICC-3A.

The hydrogen gas cylinders shall be complete with neck-ring and malleable iron cap, valve to CGMA Standards or approved equal. Outside surface shall be painted. The cylinders shall have a minimum internal water volume of 40 litres and shall be suitable for a maximum working pressure of 150 $kg/cm^2(g)$ (design pressure shall be 165 $kg/cm^2(g)$ and test pressure shall be 248 $kg/cm^2(g)$. In built syphon arrangement to ensure out flow of liquid shall be furnished for carbon dioxide cylinders.

The body material for the cylinders shall be manganese steel or chrome molybdenum steel. The cylinders shall be made of seamless steel tubes manufactured by billet-piercing method.

Each cylinder shall be tested as per the guide lines of Chief Controller of Explosives, Nagpur. Test certificates from Chief Controller of Explosives certifying suitability of each cylinder for filling and transportation shall be submitted to Engineer before dispatch of the cylinder to site for approval. The cost of testing and furnishing test certificates shall be included in the quoted price.

DATA SHEET

FOR

HYDROGEN GENERATION SYSTEM

SL. NO.	DESCRIPTION	:	SPECIFICATION
1.	Technology	:	Bipolar Pressurized Water Electrolysis
2.	Capacity	:	10 Nm^3/hr x 2 streams
3.	Purity of hydrogen at final	:	99.998 %
4.	Dew Point	:	Minus 70 deg.C
5.	Pressure after Booster	:	160 BarG

Electrolyser & Gas Separatation Skid

1.	H2 Plant Capacity	:	20 Nm^3/hr
2.	Capacity	:	11 Nm^3/hr per Electrolyser
3.	H2 Purity	:	≥ 99.8 - 99.9 % by Vol. Ex Electrolyser
4.	H2 Purity %	:	≥ 99.998 % by Vol. After Purifier
5.	O_2 Purity %	:	≥ 99.5 % by Vol.
6.	Electrolyte	:	30 % KOH
7.	Operating Temperature	:	90^0C
8.	Design Temperature	:	90^0C ± 2^0C
9.	Operating Voltage	:	DC 0 – 70 Voltas Adjustable
10.	Operating DC Current	:	0 - 900 Amp.
11.	Working / Design Pressure	:	30 BarG / 33 BarG
12.	Discharge Pressure	:	28-29 Bar G
13.	No.of Cells	:	One per stream

14.	No of modules per cell	:	Based on manufacutuer's standard
15.	MOC of cell	:	Ni platedCS
16.	Electrode material		
	• a. > Cathode	:	Nickle
	• b.> Anode	:	Activated Nickel
17.	Turn Down Ratio	:	60% to 100%
18.	Gas Separation skid	:	Two Nos
19.	Gas separation skid consists of		

- Hydrogen Gas Separator & Hydrogen Gas Cooler & Moisture Separator
- Hydrogen Side Electrolyte Pump
- Hydrogen Side Electrolyte Filter
- Hydrogen Side Electrolyte Cooler
- Oxygen Gas separator & Oxygen Gas Cooler & Moisture Separator.
- Oxygen Side Electrolyte Pump
- Oxygen Side Electrolyte Filter
- Oxygen Side Electrolyte Cooler
- Flame arrestors / Interconnected piping / Associated Instruments / Moisture drain & isolation valves

Feed Water & Electrolyte Mixing System

1.	Electrolyte	:	30% KOH
2.	MOC of Electrolyte Making Tank	:	SS 304
3.	Size of Electrolyte Making Tank	:	200 Ltrs
4.	Electrolyte Feed Pump	:	2 Nos.
	• Pumping head	:	By Bidder
	• Power	:	415 V, 50 Hz
	• Enclosure	:	IP 55 Insulation class H
	• Impeller / Casing	:	304 SS
	• Shaft	:	316 SS
5.	MOC of FEED DM Water Tank	:	SS 304

6.	Size of FEED DM Water Tank	:	2000 Ltrs
7.	DM Feed Pump	:	2 Nos
	• Pumping head	:	By Bidder.
	• Power	:	415V, 50 HZ
	• Enclosure	:	IP 55. Insulation Class H
	• Impeller / Casing	:	304 SS
	• Shaft	:	316 SS

DATASHEET FOR GAS DEOXIDIZER

SL. NO.	DESCRIPTION	:	SPECIFICATION
1.	Operating Pressure	:	28-30 bar (g)
2.	Design Pressure	:	30 bar (g)
3.	Gas Tightness Test	:	45 bar (g)
4.	Design Temperature	:	200°C
5.	Pressure vessel design Code	:	ASME Sec VIII
6.	Type of deoxidizer unit	:	Palladium Deoxo Online type.
7.	No, of deoxidizer units	:	1 for each stream
8.	Inlet H2 Capacity for deoxidizer	:	11 Nm^3/hr
9.	Catalyst type in deoxidizer	:	Palladium
10.	Absorber Bed MOC	:	SS 304
11.	Inlet Oxygen Content	:	0,2% (can stand up to 1 %)
12.	Outlet Oxygen Content	:	2 PPM
13.	Cooling water flow-rate	:	1 M^3/hr

DATASHEET FOR GAS DRYER

SL. NO.	DESCRIPTION	:	SPECIFICATION
1.	Operating Pressure	:	28-30 bar (g)
2.	Design Pressure	:	30 bar (g)
3.	Gas Tightness Test	:	45 bar (g)
4.	Design Temperature	:	200°C
5.	Pressure vessel design Code	:	ASME Sec VIII
6.	Type of Hydrogen Dryer	:	Twin Bed Desiccant Type (heated)
7.	No. of Desiccant Bed	:	Two
8.	Inlet H2 Capacity	:	By Bidder
9.	Outlet H2 Capacity	:	10 Nm^3/hr
10.	Desiccant type	:	Molecular Sieve 13 X
11.	Absorber Bed MOC	:	SAS 304
12.	Instruments	:	Explosion Proof
13.	Total Cycle Time	:	24 Hours
14.	Regeneration Cycle Time	:	12 Hours
15.	Outlet Dew Point	:	Minus 70^0C
16.	Heater Capacity	:	By Bidder – Resistance Heater
17.	No. of Heaters	:	One in each tower
18.	Regeneration Gas	:	Dried Hydrogen
19.	Consumption of regeneration gas	:	7 to 8 % of gas

DATA SHEET FOR HYDROGEN GAS COMPRESSOR

SL. NO.	DESCRIPTION	:	SPECIFICATION
1.	Type of compressor	:	Diaphragm type oil free
2.	No. of Compressors	:	2 Nos.
3.	Medium of Gas	:	Hydrogen
4.	Capacity	:	Minimum 12,5 Nm^3/hr (each)
5.	Suction Pressure	:	16 bar (g)
6.	Suction Temperature, Deg.C	:	Ambient
7.	Discharge Pressure	:	150 – 160 bar (g)
8.	Discharge Temperture	:	45^0C
9.	Aount of cooling water required	:	1 m^3/hr (per compressor)
10.	Number of Stages	:	2
11.	Type of inter cooler	:	Water cooled inter cooler provided
12.	Drive	:	V Belt
13.	Hydrogen suction pot	:	400 ltrs @ 16 bar (g)
14.	Compressor speed	:	380 – 440 rpm

MOTOR FOR HYDROGEN COMPRESSOR

15.	Type of construction	:	TEFC Group Gas IIC
16.	Motor name plate rating	:	By Bidder
17.	Rated voltage/phase/frequency	:	415V/3 phase/50 Hz
18.	Type of motor	:	3 phase induction motor
19.	Method of starting	:	DOL
20.	Motor speed	:	1440 RPM

DATA SHEET OF HYDROGEN BUFFER TANK

A hydrogen buffer tank is considered between hdyrgoen generator and compressor for stability ofpressure which acts as buffer cum suction pot.

The size ofvessel is adeauate for providing suction to compressor at the design flow rate hydrogen plant.

SL. NO.	DESCRIPTION	:	SPECIFICATION
1.	No. of Tanks	:	2 Nos.
2.	Operating Pressure	:	16 Bar g
3.	Design Pressure	:	17.6 Bar g
4.	Test Pressure	:	20 Bar g
5.	Operating Temperature	:	Ambient
6.	Operating Pressure	:	65 ^{0}C
7.	Capacity	:	400 Litres
8.	MOC	:	SA 516 gr.70

CHAPTER 25

25.0 FILTERED WATER SYSTEM

25.1 INTRODUCTION

25.1.1 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.

25.1.2 **SYSTEM DESCRIPTION**

The filtered water system shall convey filtered water from the filtered water pump house located on the RO Stage I Permeate sump to various systems like, RO Stage II Supply, potable Water, Service Water, APH/ ESP water wash & HVAC Make up and fire water by means of horizontal pumps.

25.2 SCOPE OF SUPPLY

a) Aboveground covered RCC RO Stage I Permeate sump having two compartments. The effective capacity of each compartment shall be min 3500 cum. The common suction sump housing all the pumps shall have dedicated fire water storage required as per TAC norms. However the dedicated storage capacity for fire water shall be minimum 3500 cum.
b) Two (2) (1W+1S) horizontal RO Stage II Supply pumps installed in filtered water pumphouse.
c) Two (2) (1W+1S) horizontal Potable water pumps installed in filtered water pumphouse.
d) Two (2) (1W+1S) horizontal Service Water pumps installed in filtered water pumphouse.
e) Two (2) (1W+1S) horizontal AHP Seal Water Make Up Pumps installed in filtered water pumphouse.
f) Two (2) (1W+1S) horizontal HVAC Make up water pumps installed in filtered water pumphouse.
g) Two (2) (1W+1S) horizontal APH/ ESP Water wash pumps installed in filtered water pumphouse.
h) Provision shall be kept in the filtered water pumphouse for installation Two (2) (1W+1S) horizontal FGD Make up Pumps at a later date. The capacity of these pumps shall be approx 200 cum/hr.
i) Fire Water pumps as described in Fire protection chapter shall also be installed in this pumphouse and they shall have a dedicated storage in the permeate sump.
j) Piping and instrumentation as indicated in the P & ID for filtered water system.
k) The pumphouse shall also accommodate the following equioment facilities
   - All auxiliary equipment related to pumpsets such as discharge piping complete with valves and specialties, electric motors etc.
   - Ventilation system for pumphouse.
   - Separate bays for unloading and maintenance.
   - Cranes and hoists as specified in Vol III, Chapter 17.
   - Gates & screens located suitably.
   - Necessary toilets with basin & mirror and operator's cabin with drinking water facility.

25.3 GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMNETS

25.3.1 The filtered water system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Vol III, Chapter 13.

25.3.2 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.

25.3.4 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.

10. Motorized discharge butterfly valves. Gate valves/ check valves as required.
11. 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 contractor during detailed engineering stage.
12. Scour or drain valves at suitable locations for adequate drainage of pipelines.
13. Pipe supports/ racks complete with all accessories as required.
14. Any other accessories as required for safe and reliable operation of respective pumping system.
15. All pump houses accommodating the vertical wet pit pumps shall be designed by the bidder in accordance with the following layout criteria as generally specified below :
    - The pump sumps shall be designed in strict conformance to the recommendations of Hydraulic Institute Standard/ BHRA.
    - If not specified elsewhere in this specification, the invert level of a particular sump shall be guided by the minimum submergence required for the respective pumps. The highest water level in a sump shall be such as to ensure a clearance of 300 mm below the lowest concreted portion of the floor in the pump house. Under all circumstances the net positive suction head available shall be sufficiently greater than the net positive suction head required, by each pump.
    - Adequate provision shall be made in each of the pump sumps so as to facilitate insertion of isolation gates as and when required. Gates shall be 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 pump house overhead crane/ hoist.

25.4 **OPERATIONAL & CONTROL PHILOSOPHY**

25.4.1 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 DDC systems for monitoring the parameters in DDC workstations located in Central Control Room.

25.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

25.4.3 An interlock shall be provided to trip the vertical pumps from very low level of water in the respective sump compartment of the pumps 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 for pump start permissive from normal water level in respective pump compartment.

25.4.4 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.

25.4.5 All pumps shall have the following safety features:

- Sump level high and low – annunciation
- Sump level very low – annunciation and trip
- Any other protective feature deemed necessary for safe and reliable operation.
- Pressure on pump discharge due to accidental closure of valve – trip and annunciation.

25.4.6 Refer clause 12.0.00 of Annexure ‘C’ volume V Instrumentation and Control works.

DATA SHEET FOR RO STAGE II SUPPLY PUMPS

Sl. 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.	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		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 2062 epoxy painted

DATA SHEET FOR HVAC MAKE UP WATER PUMPS

Sl. 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.	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		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 2062 epoxy painted

DATA SHEET FOR AHP SEAL WATER MAKE UP PUMPS

Sl. 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.	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		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 2062 epoxy painted

DATA SHEET FOR APH/ ESP WATER WASH PUMPS

Sl. 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
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 2062 epoxy painted

DATA SHEET FOR POTABLE WATER PUMPS

Sl. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	75
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.	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		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 2062 epoxy painted

DATA SHEET FOR SERVICE WATER PUMPS

Sl. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S)
2.	Pump capacity (approx.)	M^3/ hr	100
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 2062 epoxy painted

CHAPTER 26

26.0 POTABLE WATER SYSTEM

26.1 INTRODUCTION

26.1.1 This section presents the system description, basic design criteria and performance requirements, broad scope of supply and operation and control philosophy of the Potable Water System.

26.1.2 **SYSTEM DESCRIPTION**

The potable water system shall convey water from the RO Stage I Permeate Storage Tank for further distribution into the plant as indicated in the potable water P & ID. The RO Stage I Permeate shall be stored in RO Stage I Permeate sump. Horizontal split casing type pumps shall be installed on the filtered water pumphouse located on the RO Stage I Permeate Sump. Chlorination shall be done in the RO Stage I permeate sump.

26.2 SCOPE OF SUPPLY

a) Distribution as indicated in Potable water P & ID. However the distribution shown is only tentative. Bidder to distribute water as per requirement and layout finally developed.
b) Booster pumps as and where required to pump water to higher levels.
c) Two (2) RCC drinking water tanks, each of 50 cum effective capacity on power house building deaerator floor.
d) RCC drinking water tank of 5 cum effective capacity on DM Plant Building roof.
e) HDPE tanks, each of 1 cum capacity conforming IS - 12701 as and where required and as indicated in the potable water flow diagram.
f) Piping and instrumentation as indicated in the Flow diagram for potable water system
g) The pumphouses shall also accommodate the following equipment facilities
   - All auxiliary equipment related to pumpsets such as discharge piping complete with valves and specialties, electric motors etc.
   - Ventilation system for pumphouse.
   - Separate bays for unloading and maintenance.
   - Cranes and hoists as specified in Vol III, Chapter 17.
   - Gates & screens located suitably.
   - Necessary toilets with basin & mirror and operator's cabin with drinking water facility.

26.3 GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMNETS

26.3.1 The potable water system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Vol III, Chapter 13.

26.3.2 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.

26.3.4 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.

a) Motorized discharge valves. Gate valves/ check valves as required.
b) 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 contractor during detailed engineering stage.
c) Scour or drain valves at suitable locations for adequate drainage of pipelines.
d) Pipe supports/ racks complete with all accessories as required.
e) Any other accessories as required for safe and reliable operation of respective pumping system.
f) All pumphouses accommodating the vertical wet pit pumps shall be designed by the bidder in accordance with the following layout criteria as generally specified below :
    - The pump sumps shall be designed in strict conformance to the recommendations of Hydraulic Institute Standard.
    - If not specified elsewhere in this specification, the invert level of a particular sump shall be guided by the minimum submergence required for the respective pumps. The highest water level in a sump shall be such as to ensure a clearance of 300 mm below the lowest concreted portion of the floor in the pumphouse. Under all circumstances the net positive suction head available shall be sufficiently greater than the net positive suction head required, by each pump.
    - Adequate provision shall be made in each of the pump sumps so as to facilitate insertion of isolation gates as and when required. Gates shall be 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.

26.4 **OPERATIONAL & CONTROL PHILOSOPHY**

26.4.1 All pumps and motorized valves shall be controlled and operated from the DM plant DCS through operator workstations located in DM plant control room.

26.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

26.4.3 An interlock shall be provided to trip the vertical pumps from very low level of water in the respective sump compartment of the pumps to achieve the above interlock there shall be One (1) nos. of level transmitter shall be used for pump start permissive from normal water level in respective pump compartment.

26.4.4 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.

26.4.5 All pumps shall have the following safety features :

- Sump level high and low – annunciation
- Sump level very low – annunciation and trip
- Any other protective feature deemed necessary for safe and reliable operation.
- Pressure on pump discharge due to accidental closure of valve – trip and annunciation.

26.4.6 In addition to the above, all other field instruments such as Transmitters, Gauges, RTDs, etc shall be provided for safe operation of plant.

26.4.7 The detailed specification of Distributed Control System (DCS) and other C&I items are mentioned in the Volume – IV

26.4.8 Refer clause 12.0.00 of Annexure 'C' volume V Instrumentation and Control works.

DATA SHEET FOR POTABLE WATER BOOSTER PUMPS

Sl. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S) as and where required and indicated in flow diagram
2.	Pump capacity (approx.)	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 Split Casing
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		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 2062 epoxy painted

CHAPTER 27

27.0 SERVICE WATER SYSTEM

27.1 INTRODUCTION

27.1.1 This section presents the system description, basic design criteria and performance requirements, broad scope of supply and operation and control philosophy of the Service Water System.

27.1.2 **SYSTEM DESCRIPTION**

The Service water system shall filtered water from filtered water pumphouse located on RO Stage I Permeate Storage Tank for further distribution as indicated in service water P & ID by means of vertical wet pit type pumps.

27.2 **SCOPE OF SUPPLY**

a) Two (2) nos. RCC Tank, each of 50 cum effective capacity on deaerator floor of powerhouse building.
b) RCC tank of 5 cum effective capacity located on roof of DM plant building.
c) Distribution as indicated in service water P & ID. However the distribution shown is only tentative. Bidder to distribute water as per requirement and layout finally developed.
d) Booster pumps as and where required to pump water to higher levels.
e) HDPE tanks of 0.5 cum capacity as and where required and as indicated in the Service water P & ID.
f) Piping and instrumentation as indicated in the P & Id for service water system.
g) The pumphouse shall also accommodate the following equipment facilities
   - All auxiliary equipment related to pumpsets such as discharge piping complete with valves and specialties, electric motors etc.
   - Ventilation system for pumphouse.
   - Separate bays for unloading and maintenance.
   - Cranes and hoists as specified in Vol III, Chapter 17.
   - Gates & screens located suitably.
   - Necessary toilets with basin & mirror and operator's cabin with drinking water facility.

27.3 **GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMNETS**

27.3.1 The Service water system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Vol III, Chapter 13.

27.3.2 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.

27.3.4 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.

a) Motorized discharge valves. Gate valves/ check valves as required.
b) 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 contractor during detailed engineering stage.
c) Scour or drain valves at suitable locations for adequate drainage of pipelines.
d) Pipe supports/ racks complete with all accessories as required.
e) Any other accessories as required for safe and reliable operation of respective pumping system.
f) All pumphouses accommodating the vertical wet pit pumps shall be designed by the bidder in accordance with the following layout criteria as generally specified below :
    - The pump sumps shall be designed in strict conformance to the recommendations of Hydraulic Institute Standard/ BHRA.
    - If not specified elsewhere in this specification, the invert level of a particular sump shall be guided by the minimum submergence required for the respective pumps. The highest water level in a sump shall be such as to ensure a clearance of 300 mm below the lowest concreted portion of the floor in the pumphouse. Under all circumstances the net positive suction head available shall be sufficiently greater than the net positive suction head required, by each pump.
    - Adequate provision shall be made in each of the pump sumps so as to facilitate insertion of isolation gates as and when required. Gates shall be 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.

27.4 **OPERATIONAL & CONTROL PHILOSOPHY**

27.4.1 All pumps and motorized valves shall be controlled and operated from the DM plant DCS through operator workstations located in DM plant control room.

27.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

27.4.3 An interlock shall be provided to trip the vertical pumps from very low level of water in the respective sump compartment of the pumps to achieve the above interlock there shall be one nos. of level transmitter shall be used for pump start permissive from normal water level in respective pump compartment.

27.4.4 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.

27.4.5 All pumps shall have the following safety features :

- Sump level high and low – annunciation
- Sump level very low – annunciation and trip
- Any other protective feature deemed necessary for safe and reliable operation.
- Pressure on pump discharge due to accidental closure of valve – trip and annunciation.

27.4.6 In addition to the above, all other field instruments such as Transmitters, Gauges, RTDs, etc shall be provided for safe operation of plant.

27.4.7 The detailed specification of Distributed Control System (DCS) and other C&I items are mentioned in the Volume – V.

27.4.8 Refer clause 12.0.00 of Annexure 'C' volume V Instrumentation and Control works.

DATA SHEET FOR SERVICE WATER BOOSTER PUMPS

Sl. No.	Item	Units	Description
1	Quantity	Nos.	2 (1W + 1S) as and where required and indicated in flow diagram
2.	Pump capacity (approx.)	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 Split Casing
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		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 2062 epoxy painted

CHAPTER 28

28.0 HOTWELL MAKE UP SYSTEM

28.1 INTRODUCTION

28.1.1 This section presents the system description, basic design criteria and performance requirements, broad scope of supply and operation and control philosophy of the Hotwell Make up System.

28.1.2 **SYSTEM DESCRIPTION**

The hotwell make up system shall convey DM water from condensate storage tank for normal cycle make up and boiler fill purpose. The DM water shall be pumped by means of horizontal pumps.

28.2 SCOPE OF SUPPLY

a) Two (2) Condensate Storage Tanks, each of 750 cum effective capacity.
b) Two (2) (1W+1S) hotwell make up pumps for each 660 MW unit. Total number of hotwell make up pumps is four.
c) Two (2) (1W+1S) boiler fill pumps.
d) Two (2) (1W+1S) CST Make Up pumps
e) Piping & valves as indicated in Flow Diagram for hotwell make up system.
f) Instrumentation (min) as indicated in Flow Diagram for hotwell make up system.

28.3 GENERAL DESIGN CRITERIA AND PERFORMANCE REQUIREMNETS

28.3.1 The hotwell make up system shall be capable of conveying the rated capacities as per pipe sizing criteria indicated in Vol III, Chapter 13.

28.3.2 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.

28.3.4 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.

a) Motorized discharge valves. Gate valves/ check valves/ as required.
b) 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 contractor during detailed engineering stage.
c) Scour or drain valves at suitable locations for adequate drainage of pipelines.
d) Pipe supports/ racks complete with all accessories as required.
e) Any other accessories as required for safe and reliable operation of respective pumping system.

28.4 OPERATIONAL & CONTROL PHILOSOPHY

28.4.1 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 DDC systems for monitoring the parameters in DDC workstations located in Central Control Room.

28.4.2 Starting and stopping of pumps shall be suitably interlocked with the opening and closing of motorized valves at the discharge of the pumps.

28.4.3 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.

28.4.4 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.

28.4.5 All pumps shall have the following safety features :

- Tank level high and low – annunciation
- Tank level very low – annunciation and trip
- Any other protective feature deemed necessary for safe and reliable operation.
- Pressure on pump discharge due to accidental closure of valve – trip and annunciation.

DATA SHEET FOR HOTWELL MAKE UP PUMPS & BOILER FILL PUMPS

SL. NO.	PUMP DESIGNATION ITEMS	UNITS	HOTWELL MAKE UP PUMPS	CST MAKE UP Up PUMPS	BOILER FILL PUMPS
1.0	**GENERAL DATA**				
1.1	NO. OF PUMPS	Nos.	Four (4) (2W+2S)	Two (2) (1W+1S)	Two (2) (1W+1S)
1.2	LOCATION	Indoor / Outdoor	Outdoor	Outdoor	Outdoor
1.3	DUTY OF PUMP	Continuous © / Intermittent(I)	C	C	I
1.5	LIQUID HANDLED		DM water	DM water	DM water
2.0	***DESIGN DATA***				
2.1	DESIGN CAPACITY	m^3/hr	By Bidder 45 (min)	By Bidder 45 (min)	200 (or filling boiler in one hour whichever is higher)
2.2	TDH	Mlc	By Bidder	By Bidder	Bidder
2.4	MAX. RATED SPEED	RPM	1500	1500	1500
2.5	ACCEPTABLE NOISE LEVEL		AS PER HYDRAULIC INSTITUTE STANDARDS	AS PER HYDRAULIC INSTITUTE STANDARDS	AS PER HYDRAULIC INSTITUTE STANDARDS
3.0	**CONSTRUCTION FEATURES**				
3.1	TYPE OF PUMP		Horizontal centrifugal	Horizontal centrifugal	Horizontal centrifugal
3.2	TYPE IMPELLER		Open / Enclosed	Open / Enclosed	Open / Enclosed
3.3	DRIVE TRANSMISSION		Direct	Direct	Direct
3.4	SEAL		Mechanical	Mechanical	Mechanical
3.5	TYPE OF COUPLING		----------☐ BY BIDDER ☐----------		
3.6	FLANGE DRILLING		ANSI B16.5	ANSI B16.5	ANSI B16.5
3.7	PRIME MOVER		AC electric motor	AC electric motor	AC electric motor
4.0	**MATERIALS OF CONSTRUCTION**				
4.1	CASING		SS 304	SS 304	SS 304
4.2	IMPELLER		SS 304	SS 304	SS 304

SL. NO.	PUMP DESIGNATION ITEMS	UNITS	HOTWELL MAKE UP PUMPS	CST MAKE UP Up PUMPS	BOILER FILL PUMPS
4.3	SHAFT		SS 304	SS 304	SS 304
4.4	SHAFT SLEEVES		SS	SS	SS
4.5	STUFFING BOX PACKING		Asbestos free	Asbestos free	Asbestos free
4.6	BASE PLATE		MS to IS 2062	MS to IS 2062	MS to IS 2062
4.7	FLEXIBLE COUPLING		SS	SS	SS
4.8	BOLTS AND NUTS		SS 316	SS 316	SS 316
5.0	**ACCESSORIES**				
5.1	COMPANION FLANGES		YES	YES	YES
5.2	FOUNDATION BOLTS		YES	YES	YES
5.3	RECOM. SP. MAINT. TOOLS		YES	YES	YES
5.4	RECOM. SPARE PARTS		YES	YES	YES
5.5	ERECTION SUPERVISION		YES	YES	YES

CHAPTER 29

29.0 LABORATORY EQUIPMENT

Laboratory equipment and furniture 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 to Engineer's approval.

29.1.1 Laboratory Size & Furniture

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 M2. The laboratory area shall be air conditioned in addition to providing exhaust system with fume hoods for applicable equipment located in the premises.

The laboratory premises 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 is 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

Size (inches)	Qty. (Nos.)
65 L x 28 H x 40 W	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)

29.1.2 **Laboratory Equipment – Water Analysis**

S. No	**Item**	**Qty.**	**Make**
1.	pH meter (Bench Top) pH meter (Portable)	Two (2) One (1)	WTW/ORION/DKK/HACH
2.	Conductivity meter (Bench Top) Conductivity meter (Portable)	Two (2) One (1)	WTW/ORION/DKK/HACH
3.	UV-VIS double beam Spectro Photometer	One (1)	SHIMADZU/B&L/THERMO
4.	Dissolved Oxygen meter	One (1)	WTW/ORION/SWAN/YSI
5.	Turbidity Meter	One (1)	HACH 2100AN/HF SCIENTIFIC
6.	Balances	Four (4)	METTLER/SARTORIUS/SHIMADZU
7.	Flame photometer	One (1)	BUCK SCIENTIFIC PFP-7
8.	Selective Ion-Analyser	One (1)	ORION/KENT/DKK/METROHM
9.	Oil Content Analyser	One (1)	OCMA-2000 HORIBA INSTRUMENTS
10.	Water Purification System	One (1)	MILLIPORE
11.	Magnetic Stirrer cum Hot Plate	Two (2)	HACH/IKEA
12.	Water Bath	One (1)	REMI

S. No	Item	Qty.	Make
13.	Refrigerator	One (1)	LG/KELVINATOR
14.	Vacuum Pump	One (1)	INDIGENOUS MAKE
15.	Residual Chlorine Meter	One (1)	DKK HRC-110P/ HF/HACH/ORLAB
16.	Jar Test Apparatus	One (1)	HACH
17.	Potable Water Quality Checker	One (1)	HORIBA INSTRUMENTS/YSI
18.	Incubator	One (1)	INDIGENOUS MAKE
19	Gas Chromatograph	One (1)	THERMO ELECTRON/ SHIMADZU
20	Atomic Absorption Spectrophotometer	One (1)	THERMO ELECTRON /PERKIN ELMER
21	TOC Analyser	One (1)	SIEVERS/SHIMADZU

29.1.2.1 **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
Calibration buffers
Spare pH combination electrode
Electrode holding stand

b) 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

29.1.2.2 **Conductivity Meter**

a) 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 1200C,
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.

b) 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

29.1.2.3 **Spectro Photometer**

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

29.1.2.4 **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.

29.1.2.5 **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.

29.1.2.6 **Balances**

Analytical balance (Electronic type) - 2 Nos.

Capacity	:	230 gm
Accuracy	:	0.1 mg
Type of display	:	backlit LCD

Balance should be supplied with breeze shield

Table top balance - 2 Nos.

Capacity	:	500 gm/1000 gm
Accuracy	:	0.1 gm

29.1.2.7 **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%

29.1.2.8 **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.

29.1.2.9 **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.

29.1.2.10 **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 CarbonL1-5 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 W x H x D 12 x 17.1 x 19 inches (30.5 x 43.5 x 48.3 cm)

29.1.2.11 **Magnetic Stirring cum hot plate**

Plate surface area	-	7x7 inch (approx.)
Stirring speed	-	60 to 1000 rpm
Temperature range	-	50o to 500o, accuracy within +3oC
Plate material	-	Stainless steel

Accessories

Spare element
TFE coated stirrer
Temperature sensor

29.1.2.12 **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 100oC. 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

29.1.2.13 **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.

29.1.2.14 **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. 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.

29.1.2.15 **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 should be supplied with 4 Nos. measuring cells, free chlorine reagents for 1000 tests

29.1.2.16 **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.

29.1.2.17 **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 deg C
Resolution	:	0.01 deg C
Repeatability	:	±0.10 deg. C (at calibration point)
Accuracy	:	JIS class B platinum thermometer sensor (±0.3 + 0.005 I t I)

Instrument should deliver along with the below sensors:
pH, ORP, Conductivity, Dissolved Oxygen and temperature

Turbidity (TURB)

Measurement principle transmission/scattering	:	LED forward 30 deg method
Range	:	0 to 800 NTU
Resolution	:	0.1 NTU
Repeatability greater	:	±5% (reading) or ±1 NTU whichever is

Water Depth

Measurement principle	:	Pressure method
Range	:	0 to 30 m
Resolution	:	0.5m
Repeatability	:	±1% F.S.

Accuracy	:	±0.3m

29.1.2.18 **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 220 V150 Hz, single phase AC supply.

Other Specifications

Temp. range	-	5 to 500C
No. of shelves	-	2
Storage Capacity	-	6-7 cubft (0.16-019 M3)
Storage area	-	0.7 M2 (approx.)
Control accuracy	-	+ 0.5oC

It should be supplied with instruction manual (including maintenance).

29.1.2.19 **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- 400oC
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	:	300oC to 50oC in 6 mins.

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 m2/min
Steps	:	7

Flame Thermonic Detector

(FTD)	:	4000C

29.1.2.20 **Atomic Absorption Spectrophotometer**

Double beam Atomic Absorption Spectrophotometer with full multi-element capability controlled by data workstation running under windows and having manual override with local controls. It should be easily usable with all applications like flame absorption / emission, graphite furnace, hydride vapour or mercury cold vapour absorption modes and should 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.

Al, 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.

Computer 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 220 VAC 50 Hz single phase supply). – 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.

29.1.2.21 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).

29.1.3 **Laboratory Equipment – Coal Analysis**

S. No.	Item	Qty.	Make
1.	Coal Analyser	One (1)	LECO TGA-701/NAVAS
2.	Automatic Oxygen Bomb Calorimeter	One (1)	LECO AC-500/PARR
3.	Carbon & Sulphur Analyser	One (1)	LECO CHN 628 WITH SULPHUR ATTACHMENT / THERMO/ ANALYTICAL
4.	Ash fusion Furnace	One (1)	LECO/ AF-700
5.	Muffle Furnace	Two (2)	INDIGENOUS MAKE
6.	Oven	Two (2)	INDIGENOUS MAKE
7.	Lab Pulverizer	One (1)	INDIGENOUS MAKE
8.	Sieve set with nine (9) sieves	Two (2)	INDIGENOUS MAKE
9.	HGI measuring equipment	One (1)	INDIGENOUS MAKE
10.	Riffle Sampler	One (1)	INDIGENOUS MAKE
11.	Sieve Shaker	One (1)	INDIGENOUS MAKE

29.1.3.1 **Coal Analyser**

Thermo gravimetric Analyzer should be analyze 19 samples of coal, coke at a time. The Thermo gravimetric Analyzer should have the following specifications:

Should be analyze 1 to 19 samples unattended (19 samples + 1 reference)

Determination of moisture, volatiles, fixed carbon, ash, LOI

Temperature Range	:	50 – 1000 deg C
Sample Size	:	0.1 – 10 gms
Standard Deviation	:	±0.0002 gms
Weight Loss / Gain Range	:	0-100% etc.
Temperature stability : ranges		±1 0C at 105-1070C and ±2 0C at all other
Selectable atomospheres	:	N2, O2 or Air
All heated parts metallic	:	carousels, crucibles, pedestal, covers
Ceramics optional : corrosive		Ceramic crucibles can be used for analyzing materials

Instrument should Automatically restart after power failure
Mains power failure support, only 300 watts

Balance display	:	Sartorius 120 gr 0.1 mg and the balance has 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-linear regression 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 0C to 107 0C 5 ~ 300C/min, 104 0C to 1000 0C 5 ~ 50 0C / min. can be upgraded to Automatic model.

Instrument should be supplied with Metallic crucibles, Softwares and user manual.

29.1.3.2 **Automatic Oxygen Bomb Calorimeter**

Instrument should 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	:	0.2% RSD or better
Resolution	:	0.0001 Cal/gm
Analysis Mode mode	:	Equilibrium mode / Dynamic mode or any other
Temperature Measuring: Resolution		0.0001 0C
Display Interface	:	Color touch screen with graphical user
Correction Sulpher	:	Spiking, Ash / Nitrogen or Acid, Fuse wire, 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 (Part – 2), 1970, ASTM D-5865/04 & DIN 51900 Methods.

Oxygen bomb	:	The oxygen combustion bomb should make with special stabilized stainless steel to resist the mixed nitric acid and sulphuric acid produced in combustion. It should 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.

29.1.3.3 **Carbon and Sulfur analyzer**

The Instrument should 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 0C (1800 0C 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.

29.1.3.4 **Ash Fusion Furnace**

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 : 14000C

Working Temperature : 13000C

Chamber size : 100x100x225 mm

29.1.3.5 Muffle Furnace

Electrically heated muffle furnace for general use and coal analysis upto a maximum temperature of 1200oC 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.

29.1.3.6 **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 to 250oC
Twelve (12) Protection crucibles of 50 ml capacity with aluminium covers
Temperature sensor
Heating element

29.1.3.7 **Lab Pulverizer**

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

29.1.3.8 **Sieve set with nine (9) sieves**

Electrically operated Ro-Tap sieve shaker will be furnished to accommodate eight (8) 50 mm highx200 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 will 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 eight sieves; 850 microns, 710 microns, 600 microns, 500 microns, 400 microns, 325 microns, 250 microns, 212 microns

29.1.3.9 **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

29.1.3.10 **Riffle Sampler**

Riffle Sampler should be with adjacent slots to deliver coal to opposite side and to divide it into two identical halves. Slots should be of 25 mm size and number of total slots should be 36. The sampler should 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.

All details given in (1) above except the slot size shall be 12.5 mm and total number of slots shall be 24. Qty – 1 No.

29.1.3.11 **Sieve Shaker**

Electrically operated Ro-Tap sieve shaker shall be furnished to accommodate eight (8) 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

29.1.4 **Laboratory Equipment – Oil Analysis**

S. No.	Item	Qty.	Make
1.	Red Wood Viscometer	One (1)	PETROTEST
2.	Automatic Flash Point Apparatus	One (1)	PETROTEST

3.	Dean & Stark Moisture Determination Apparatus	Two (2)	INDIGENOUS MAKE
4.	Flash Shaker	One (1)	INDIGENOUS MAKE
5.	Centrifuge	One (1)	INDIGENOUS MAKE
6.	Automatic K-F (Karl-Fisher) Titrimeter	One (1)	METROHM/ SI ANALYTICS
7.	Portable Purge Gas Analyser	One (1)	ENDEE
8.	Multi-Gas Detector	One (1)	ENDEE/MSI
9.	Orsat Gas Analyser	One (1)	INDIGENOUS MAKE
10	Heating Mantle	One (1)	INDIGENOUS MAKE

29.1.4.1 **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 to 44^oC; 37.8^o to 82^oC; and 76^o to 122^oC respectively

Uniform temperature water bath

An auto regulating transformer

Flask receiver encased in teak wood case

29.1.4.2 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 : + 40oC to +3700oC
Accuracy : ± 0.5oC

Accessories:

Oil cup/Test vessel, Detector Electrodes Temp. Measuring probes

29.1.4.3 **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.

29.1.4.4 **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.

29.1.4.5 **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)

29.1.4.6 **Automatic K-F Titrimeter**

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 should 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 0C 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 should deliver along with:

One generator electrode with frit

One Indicator electrode it should be dual platinum electrode

Accessories

KF reagents

Water standards

Instructions Manual

Measuring range should be : 10µg to 100 mg (or) 1 ppm to 5%

Instrument should accept local KF reagents.

29.1.4.7 **Portable Purge Gas Analyser**

It should be a thermal conductivity detector based analyzer for the monitoring of hydrogen purity in turbine generators. The instrument should 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 should 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	0-52oC
Electrical requirement	220 V, 50 Hz, single phase AC

It should 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.

29.1.4.8 **Multi-Gas Detector**

Instruments should measure NO2, SO2, CO, NO, O2 in flue gas

Parameters	Gas Sensor	Range Resolution

NO2	Electrochemical	0-100 PPM	1 PPM
NO	Electrochemical	0-4000 PPM	1 PPM
SO2	Electrochemical	0-1000 PPM	1 PPM
CO	Electrochemical	0-1000 PPM	1 PPM
O2	Electrochemical	0-25 %	0.1

Accuracy : ± 2%

Response : 20 sec. for 90% attenuation

Display : Digital – Backlit LCD

Calibration : Auto Zero for all gases & auto span for Oxygen. Span cal. With stand. Cal gas.

Alarms : Audio-visual for Two level (adjustable) Fault & ILO-bat

Sampling : Automatic thru built in pump.

Power : Rech battery with 220 VAC Charger

29.1.4.9 **Orsat Gas Analyser**

Portable Orsat gas analyzer for the determination of CO2, CO & O2 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.

CaCl2 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.

29.1.4.10 **Heating Mantle**

Mantle should fit snugly against spherical/flat bottom flasks upto 2000 ml capacity. It should heat up to 3500C through flexible, knitted, glass wool fabric with coiled heating elements, supported in solid aluminium housing.

29.1.5 **Laboratory Equipment – Meteorological & Pollution**

S. No.	Item	Qty.	Make
1.	Electrical Amenograph	One (1)	GLOBAL WE/ENVIROTECH/DAVID
2.	Dew Point Meter	One (1)	OKATON/ENDEE/CHEMICA
3.	Rain Gauge	One (1)	INDIGENOUS MAKE
4.	Mercury Barometer	One (1)	INDIGENOUS MAKE
5.	Maximum & Minimum Thermometer	Two (2)	INDIGENOUS MAKE
6.	Dry & Wet Bulb Thermometer	Two (2)	ZEAL
7.	High Volume Sampler	One (1)	ENVIROTECH/VAYUBODHAN
8.	Stack Monitoring Kit	One (1)	VAYABODHAN/ENVIROTECH
9.	Portable Gas Analyser	One (1)	ENDEE/MADUR
10.	Stop Watch	Two (2)	RACER/CHEMICA
11	Assman Psychrometer	Two (2)	INDIGENOUS MAKE

All laboratory equipments shall be of latest models of the above makes.

29.1.5.1 **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.

29.1.5.2 **Dew Point Meter**

Portable dew point meter with below specification

Humidity	:	10% to 95% RH
Temperature	:	0 to 50 0C
Temp. unit	:	oC, oF 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

29.1.5.3 **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.

29.1.5.4 **Mercury Barometer**

For atmospheric pressure measurement (FORTIN TYPE). Tube of uniform bore 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 double scale deg.C & deg.F. It shall be calibrated to National Bureau of Standards

29.1.5.5 **Maximum & Minimum Thermometer**

The thermometer should register both maximum and minimum temperature range – 43oC to +55oC 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

29.1.5.6 **Dry & Wet bulb Thermometer**

This is shall be mercury filled wet and dry Bulb thermometers mounted on scales with amended graduations in 2ºC intervals. Nominal range 10ºC to 50ºC. 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.

29.1.5.7 **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 motor	:	Continuous duty blower with brushless
Sampling time Record in	:	Time totalizer recorder for running time 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.”

Stack Monitoring Kit

Measures total quantity / volume of emissions. Determines velocity of gases Stack temperature Range

Ambient to 600 deg 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 3lpm collection in a set of borosilicate glass impingers. Filter Holder : Fabricated from SS 304 tube suitable to hold either cellulose filtration thimble (Size 28 mm IDx 100mm long) or glass micro fiber thimble (Size 19mm

IDx90mm long) Probe set and set of interconnection hose pipes. Vacuum pump assembly

Portable Gas Analyser

Application	:	For field determination of the individual quantities of carbon monoxide, oxygen, NO, NO2, SO2 and hydro carbons from flue gas samples.
Accuracy	:	O2 - better than + 1%
		CO/SO2/NO/NO2 - better than + 4%

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

29.1.5.11 **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.

29.1.6 Laboratory Equipment – Miscellaneous

S. No.	Description	Quantity	Make
1.	Personal computer	One (1)	HP/DELL
2.	Sample cooler	One (1)	
3.	Density Hydrometer	One (1)	
4.	Hot Air Dryer	One (1)	
5.	Hydrometers	One (1)	
6.	Heating Mantel	One (1)	REMI
7	Stainless Steel Filter Holder	One (1)	

29.1.6.1 Personal Computer

Operator Station (Personal Computer) for Gas chromatography & UV visible spectrometer shall have minimum 64 bit computers (on WINDOWS-8), 4 GB MB RAM, 1 TB Hard Disk and Intel I7 processor. All the peripherals such as CD-ROM, IJPrinter etc shall be provided for operator stations. There shall be VGA graphics cards. 17 inch size CRT-monitor shall have resolution of 1024 x 768 or 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.

29.1.6.2 Sample cooler

Sample cooler should 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 400oC. 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/cm2 on the outer shell.

Max. operating pressure	:	420 kg/cm2
Max. operating temperature	:	400oC.
Sample connections	:	½" NPT
Net weight	:	Approx. 3.5 kgs.
Shell maximum WP	:	----
Pressure Drop – Shell	:	0.2 kg/cm2 at 700 lit. per hour (water flow)
Coil	:	3.88 kg/cm2 at 115 kg/hr (water flow)

29.1.6.3 **Density Hydrometer**

Hydrometer should 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:-

Sl. 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.

29.1.6.4 **Hot Air Dryer**

Electrically operated and portable type hot air dryer for general drying purpose. It should 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 – 700C.

Air delivery: 3-4 cubic feet per minute.

It should be supplied with 7 feet 3 conductor cord & 3 prong plug for use at 220 V, 50 Hz AC supply.

29.1.6.5 **Hydrometers**

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.

Sl. 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 should be supplied with a thermometer (0 to 500C x 0.10C) in a leather case.

29.1.6.6 **Heating Mantel**

Mantle should fit snugly against spherical/flat bottom flasks upto 2000 ml capacity. It should heat upto 450^{o}C 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

29.1.7 **Laboratory Equipment – Glass Ware**

S. No.	Description	Capacity (ml)	Quantity (Nos.)
1.	Beaker with spout/non spout	50 100 250 500	6 6 6 6
2.	Graduated Beaker	50 100 250 500	6 6 6 6
3.	Measuring Cylinder Graduated	50 100 250 500	6 6 6 6
4.	Burette Automatic	25 50	4 4
5.	Burette Straight mounted on reservoir (capacity 2000 ml)	25 50	4 4
6.	Measuring pipet with bulb	1 2 5 10 25	6 12 12 12 12
7.	Volumetric pipet with bulb	2 5 10 25 50	6 6 6 6 6
8.	Volumetric flask	50 100 250 500	12 12 12 12

S. No.	Description	Capacity (ml)	Quantity (Nos.)
		1000	12
9.	Dropping Bottle	100	12
10.	Burette stand	-	4
11.	Glass funnel	50 100	6 6
12.	Reagent Bottle	100 500 1000	12 12 12
13.	Test tube stand for 6 tubes		4
14.	Conical flask	100 250 500	12 12 12
15.	Pipet Stand	-	4
16.	Wash Bottle	500 1000	2 2

All glass-ware shall be of 'BOROSIL' make.

29.1.8 **Laboratory Equipment – Reagents**

S. No.	Items	Qty.
1.	Ammonium molybdate	500 gm
2.	1N H_2SO_4/Hcl (ampul)	12 Nos. each
3.	Tataric acid	500 gm
4.	Sodium metabisulphate	100 gm
5.	Anhydrous sodium sulphate	250 gm
6.	1. Amino 2. Nepthol 4. Sulphonic acid	500 gm
7.	1N NaOH (ampul)	12 Nos.
8.	Methyl orange	25 gm
9.	1N – Sodium carbonate (ampul)	12 Nos.
10.	Phenolpthalein Indicator	100 gm
11.	Silver nitrate	100 gm
12.	Potasium chromate	500 gm
13.	1N – Nitric acid (ampul)	12 Nos.
14.	Sodium thiosulphate	500 gm
15.	1N – EDTA (Ampul)	12
16.	EDTA powder	100 gm
17.	Ammonium chloride	500 gm
18.	Ammonium hydroxide 25%	1000 ml
19.	Erichrom Black-T	50 gm
20.	Hydroxyl amine hydrochloride	500 gm
21.	Isopropyl Alcohol	500 ml
22.	Murexide indicator	50 gm
23.	1N sodium hydroxide (ampul)	12 Nos.
24.	$KMnO_4$ crystal	500 gm
25.	Oxalic acid	500 gm

All reagents shall be of 'AR' grade.

CHAPTER 30

30.0 RAIN WATER HARVESTING SYSTEM

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:

- Hydrogeology of the plant area including nature and extent of aquifer, soil cover, topography, depth of water levels and chemical availability of ground water.
- 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.
- Hydro – metrological characters like rainfall duration, general pattern and intensity of rainfall.

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 (approx. 2 months) will be collected and stored.

Water from the RWHP will be 100% recycled in the raw water reservoir in dry season. The pond will 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.

The following portions are 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.

- Cooling Tower
- Clarifier / CMB / RWHP areas
- Coal Stock Pile Area
- Boiler / ESP area
- Fuel oil handling and storage area

The total rainfall runoff collected in 2 (two) consecutive months of heavy rains will be stored in RWHP. As rainwater carries some pollutants as suspended solids, RWHP will act as a settling basin for the same.

From the outlet of this pond, water will be pumped out to cooling tower sump for use as supplement to sea water.

Each pit in rain water harvesting system shall have 2 x 100% capacity pumps. The material of construction of the pumps shall be similar to MOC of service water pumps.

CHAPTER 31

31.0 SEWAGE TREATMENT PLANT

31.1 The sanitary waste streams from the 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.

31.2 The sewage treatment plant shall be designed as per guidelines of CPHEEO Manual. The anticipated no. of users shall be 2000 persons. The sewage treatment plant shall be designed to handle a flow of 75Kld considering average per capita consumption of 45lpcd 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.

31.3 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 Flow Diagram of Sewage Collection & Conveyance with treatment facility have been outlined in Drg No.111-12- 3512(Rev.0)

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 & Ash Water Recovery & Compressor Area
- CW & ACW Pump House
- Canteen
- Workshop Building
- Fire Station Building
- RO-II,DM plant, CPU Regeneration & N.Pit
- Fuel Oil Pump House & Tank Area
- Crusher House
- CHP Control Room
- Raw Water Pump House
- Ware House
- Security & Time Office
- Sea Water Intake System and Water Treatment Plant (RO Stage – I) located in NCTPS Stage II.
- Ash Water Pumphouse.
- Ash slurry pumphouse

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	300	5.4	Main Sewer line
2	Service Building	100	3.5	Main Sewer line
3	Transformer Yard	40		
4	DG Room Building	20		
5	Switch yard	30		
6	CW & ACW Pump House	50	10	Main Sewer line
7	Canteen	300		
8	Workshop Building	200		
9	Fire Station Building	50	1.6	Main Sewer line
10	DM plant , CPU Regn & N.pit Area	40		
11	ESP Control Room	40	3.0	Main Sewer line
12	Ash Water & Slurry Pump House	80		
13	Clarifier Ash water Recovery	20		
14	Ash Compressor House	20		
15	Pre Treatment Plant	120	2.2	
16	F.O. Pump House & Tank Area & Unloading Area	80	1.5	
17.	CHP control Room	150	1.0	
18.	Raw Water pump House	30	0.5	
19.	Administrative Building	100	7.8	
20.	Ware House	200		
21.	Security& Time office	30		
	Total No. of users	2000		

The above list is not exhaustive and bidder shall provide STP for all applicable areas like facilities located in NCTPS Stage II etc.

At the locations where the quantum of sewage generated is minimal it 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.

31.4 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.

INLET/OUTLET PARAMETERS FOR STP

SNo.	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	≤ 10^3
6.	Suspended Solids	ppm	300	≤ 20

DATA SHEETS FOR SEWAGE TREATMENT PLANT

S. No.	Description	Units	Parameter
1.0	Common Collection Sump		
i)	Numbers Required	Nos.	One
ii)	Capacity	M3	10
iii)	MOC:		RCC
1.01	Common Collection Sump Pumps		
i)	Numbers Required	Nos.	2 (1W+1S)
ii)	Type		Non clog sump Pumps
ii)	Flow	M3/hr	4.0
iii)	Head	MWC	As per process requirements
iv)	Particle Size		Upto 20 mm
v)	MOC		CI-Casing, Impeller-SS-304
1.02.	Screen Chamber		
i)	Numbers Required	Nos.	1(1w+0s)
ii)	Type		Perforated Sheet
ii)	Cleaning		Manual
iii)	Angle of inclination		60°
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	3.5
iii)	MOC:		RCC with baffle arrangements
1.04	Equalization Tank		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	3.5
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 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 (1W+1S)
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

S. No.	Description	Units	Parameter
v)	Accessories		NRV, Pressure Guage,Safety valves
1.06	FAB Feed Pumps		
i)	Numbers Required	Nos.	2 (!W+1S)
ii)	Type		Vertical Submersible Pumps
ii)	Flow	M3/hr	4.0
iii)	Head	MWC	As per process requirements
iv)	MOC		CI Body, SS 304 Impeller & Shaft
v)	Particle Size		Upto 10 mm
1.07	FAB Reactor		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	3.5
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
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
1.09	Secondary Settler		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	3.5
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		

S. No.	Description	Units	Parameter
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
iv)	Make		Std.
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	4.0, 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. 304 & 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	3.5
iii)	Surface Flow Rate	M3/hr/m2	10
iv)	Size		As per Process Requirements
v)	Design Pressure	Kg/cm2	6
vi)	MOC		FRP
vii)	Media		Graded quartz sand free from carbonates and other foreign material and anthracite.
viii)	Rising Space		100%
ix)	Make		Standard

S. No.	Description	Units	Parameter
1.14	Activated Carbon Filter		
i)	Quantity	Nos.	1
ii)	Capacity	M3/hr	3.5
iii)	Surface Flow Rate	M3/hr/m2	12
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	3.5
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)	Capacity & Head	M3/hr,M	4.0 , as per process requirements
iv)	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. 304 & SS316
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

S. No.	Description	Units	Parameter
1.18	Sludge Transfer Pumps	Nos.	Two (2) (1W+1S) 100%
i)	Numbers Required	Nos.	2
ii)	Type		Vertical 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-316
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.

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CHAPTER 32

32.00.00 LAYOUT REQUIREMENT

32.01.00 The general layout criteria to be adopted for this project are indicated below.

1.	Minimum clear working space around equipment	:	1200mm
2.	Clear Head room within Main Plant Building for pipes, ducts structures & cable trays etc.	:	2.5 m (Minimum)
3.	No. of Fire Escape staircases in the main plant with fire doors at each landing	:	Min-4 Nos. per unit - However the number shall meet the requirement of insurance companies.

4. Adequate space for handling/removal of pumps, heaters, heat-exchanger, fans, Mills, during maintenance.

5. Independent floor drains with separate down comers shall be provided where sprinkler system are provided.

6. Valves in the Bidder's scope shall be located in accessible positions. All piping shall be routed at a clear height of 2500 mm (min.) from the nearest access level to clear man movement.

7. Provision of monorail beams with chain pulley blocks/HOT cranes along with hoists, as required shall be decided during detailed engineering stage and are in bidder scope.

8. Approach for removal of equipment for maintenance shall be provided.

9. A/C and Ventilation ducts, Bus ducts, and Critical Piping routes to be identified at conceptual stage.

10. Fuel oil (F.O) piping shall be routed over trestles. The headroom for F.O. Trestle in Boiler/ESP area shall be 8.0M till the road behind chimney as per the layout requirement. The headroom for F.O. trestle in outlying area shall be 3.0M except at rail/road crossing where the headroom shall be 8.0M. F.O. trestle legs or supports shall be located so as to clear the road spaces, approach to maintenance bays of different equipment buildings located in the route of F.O. trestle.

11. Routing of cable trays & piping

i)	Trestle height in outlying area	:	3 Meters(BOS/BOP)
ii)	Trestle height from C-row to road Behind chimney /in front of XFMR Yard Boiler/ESP area	:	8 Meters(BOS/BOP)

iii) Cable/ Pipe trestles height at rail/ road crossings shall be 8M. (BOS/BOP)

iv) Head room below cable / pipe rack in transformer yard area for movement of spare GT shall be 12.0 Meters.

v) A walkway with hand rails & toe guards of 600mm (minimum) width 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.

vi) At the crossing of pipe/ cable trestles with the dry ash pipe rack/CHP cable rack trestle, pipe/ cable trestle shall be locally raised to provide a head room of 2.5 M over the walkways of dry ash pipe rack/CHP cable trestles.

vii) Head room below cable/pipe rack along Mill bay shall be 12.0 Meters.

viii) Head room for man movement shall be 2.5 m at ground floor, over all platforms etc.

ix) Minimum clear hand space required for

a) The application of thermal insulation 100 mm

b) Welding work 150 mm

c) Bolt tightening 150 mm

12. Piping in main plant area (i.e. boiler/ESP/ID fan/chimney/transformer yard) shall be routed above ground on trestles with a height of minimum 8M. Further, piping in outlying area shall be routed over trestles with a height of 3M. However, height of trestles at approach roads to various buildings/ facilities shall be 8M.

13. Fire water piping within the Plant boundary shall be routed above ground on pedestals. However, fire water pipes in Main Plant Island shall be routed in trenches filled with sand and covered with pre cast RCC covers. Fire water pipes shall be protected in main plant area as per TAC requirement. Fire water piping at road crossing shall be encased/culvert. Fire water pipe at rail crossing shall be on trestle of BOS 8M height from rail top.

14. All other safety requirements as per the factories act, National Electricity code shall be observed while developing the layout.

15. Insulation of equipment/piping for personnel protection is to be provided if the temperature exceed 60 deg C.

16. Chequered plate edges should have continuous supports/ stiffeners.

17. Each equipment room shall be provided with alternate exits in case of fire /accidents as per requirements of factory act and TAC.

18. Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.

19. Cubicle for operating personnel shall be located for all buildings at safe place near the equipment.

20. All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified elsewhere in this specification shall be complied with.

21. All gratings shall be of electro forged type with adequate bearing & locking on the supporting structure.

22. Approach to all elevated structures like Fans, Pumps, etc shall be through steel stairs with gratings & hand rail.

23. 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.

24. All fresh air ventilation louvers shall be 1000 mm from floor level and directed downward at an angle.

25. The VFD control equipment and transformers for ID fan shall be located along with the ESP control equipment in the ESP/ VFD control room.

26. Three (3) nos. of staircases per ESP of each unit shall be provided. Two (2) nos. of the staircase shall be located on the inlet side and one (1) no. on the outlet side of ESP.

27. The grating platform shall be provided in oil equipment room, control fluid room and valve room.

28. Approach platform shall be provided from ESP outlet to ID fan suction gate.

29. Minimum access opening required 3.5M wide x 4M high or, (with rolling shutter) transportation wherever entry of truck, for material more depending upon this envisaged equipment size to be handled.

30. Toilet and drinking water facility required in all buildings and on all floors wherever operating personnel are to be deployed.

31. Local Pits/trenches in Main Plant building are to 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 upto the nearest drainage network. Bidder shall provide required sump pumps/drainage pumps/submersible pumps & Piping etc.

32 Pump 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 may be provided.

33 Each pit/sump shall be provided with two numbers (2 x 100% Capacity) of respective type pumps so that the entire pit is evacuated within 15-20 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.

CHAPTER – 33

POWER CYCLE PIPING, VALVES, FITTNGS & TEHRMAL INSUALTION

33.0 POWER CYCLE PIPING, VALVES, FITTINGS & THERMAL INSULATION

This section 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.

33.1 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.

33.2 Line Sizing

33.2.1 Pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow:

Steam

(i)	Superheated Steam	:	60.0 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 Bypas Upstream	:	125 m/s
(vii)	HP Bypass Downstream	:	100 m/s
(viii)	LP Bypas Upstream	:	100 m/s
(ix)	LP Bypass Downstream	:	125 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)	HFO, HSD	:	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

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.

33.3 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 w rought 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 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.

33.4 **Scope of Supply**

Scope shall include all piping, valves & specialties as indicated in Annexure-I.of this chapter as a minimum. However all piping as required for the completeness of the system shall be supplied.

33.4.1 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 Blowdown 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.

   Line drains from Main Steam, Hot Reheat, Cold Reheat, L.P. bypass & high pressure (above 40 kg/cm^2) 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.

j. Bolts, nuts, washers, temporary and permanent gaskets, fasteners as required for interconnecting piping, valves & fittings.

k. Complete insulation material for piping, valves, specialties & auxiliary equipment specified in this specification and as called for in the specification for thermal insulation.

l. Painting of all piping, valves & specialties at site. Coating and wrapping for buried pipes.

33.4.2 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.

For conducting performance test of Turbo-Generator and Boiler, the required pressure, temperature, flow measurement points shall be provided.

(g) Provision for creep measurement on the piping operating in creep region.

33.4.3 Electrodes and filler wires required for stainless steel and alloy steel welding during shop fabrication at works and erection/installation at site.

33.4.4 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.

33.5 **SCOPE OF SERVICES**

a) 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.

b) 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.

c) Stress analysis and hanger selection for all piping specified else where, including piping attachment for hangers/supports, all auxiliary supporting structures are included in the scope of the Contractor.

d) 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.

e) 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.

"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".

f) 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.

g) 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.

h) 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.

i) 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.

j) All shop tests satisfying the requirements of Indian Boiler Regulations (IBR), ANSI standards, the standards enumerated herein and/or as specified.

k) Furnishing drawings, data, design calculations, stress analysis results.

l) 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.

m) 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.

n) Steam blowing or chemical cleaning of piping systems, as specified.

o) 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.

33.6 POWER CYCLE PIPING

33.6.1 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.

33.6.1.1 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 33.2.1.

(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.

33.6.1.2 Inside diameters this calculated for various piping systems shall be checked for the allowable pressure drop. Pressure drop in the main steam line shall not be moré 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.

33.6.2 **MATERIAL SELECTION**

Piping system shall be of carbon steel for design temperature upto 400 Deg C and alloy steel for design temperature beyond 400 Deg C.

33.6.3 **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 heaviercommercual wall thickness shall be selected from the thickness schedules (eg 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 cakculatred 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 dyring 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 spary 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.

33.6.4 **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/cm2 (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 2.5 meters above the walkaways /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. Thepiping shall not encroach oc withdrawal space of various equipment and walking space.
(d) Wherever there is possibllity of ingress of rain water through floor /celing opening at points where any pipe passes through floor /celing suitable weather protection hood shall be provided.

33.6.5 **STRESS ANALYSIS**

(a) Flexibility and stress analysis for various iping system shall be carried out by the contractor as per the requirement of ASMR B31.1 analysis results shall satisfy the following.

(1.) Calculating 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.
(2.) 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.

(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.

33.6.6 **HANGERS AND SUPPORTS**

All hangers and supports shall be erected such that they are vertical when piping is in hot condition (rated parameters). However in piping system connected to the rotating equipment nozzles, it may be required to design and erect the hangers/supports in the piping near the equipment nozzle as per the requirements/ recommendations, if any of rotating equipment manufacture(s).

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.

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.

33.6.7 **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 ^{0}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 outside the main plant building.

Maximum cladding temperature	60^0C
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

33.6.8 **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 selection for employer'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 flesh 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 flesh tanks open to atmosphere continuous spray through an orifice shall also be acceptable.

33.6.9 **SPECIFIC REQ UIREMENTS – 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 which they are located unless & until specified otherwise elsewhere.

Wherever ASTMA 106 Gr B/ Gr C or A – 105 material are used the maximum carbon content shall be limited to 0.3% (max)

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 Deg 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.

33.6.10 **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 eith 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.

33.6.11 **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 constriction 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.

33.6.12 **SPECIFIC REQUIREMENTS: FABRICATION**

33.6.12.1 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 employer. Complete document shall be submitted by the contractor in addition to the fulfillment of IBR requirement.

33.6.12.2 Where welded pipes and fittings are used the longitudinal weld seams of adjoining sections shall be staggered by 90 deg.

33.6.12.3 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.

33.6.12.4 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.

33.6.12.5 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.

33.6.12.6 Unless otherwise specified, for all welded lines with pressure above 7 kg/ cm2(g) and/or temperature above 2000C, branch connections for branch sizes upto 25% of welded mains shall be made with special forged steel welded fittings.

Piping shall be fabricated in the shop in the largest transportable sections to minimise 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.

All workmanship shall be carried out using methods and procedures of best recognised 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.

All high-pressure steam valves and accessories shall have welded connections.

Mitred 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.

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.

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.

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 shall be provided at no extra cost.

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.

Pipes of size 50 NB and above shall be shop fabricated and of size 40 NB and below shall be field run.

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.

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.

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.

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.

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.

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.

33.6.13 **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 expect 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 employer.

(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 are subject 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.

33.6.14 **End Preparation, Cutting etc.**

(a) For steel pipes, end preparation for butt-welding shall be done by machining/flame cutting.

(b) Socket weld end preparation shall be saw/machine cut

(c) For tees, laterals and other irregularities details, cutting template shall be used for accurate cutting and cutting shall follow the outline of the template.

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 boltholes being off centre.

33.6.14.1 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.

33.6.14.2 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 ally steel materials the preferred heat treatment process is full annealing.

33.6.15 SPECIFIC REQUIREMENTS: WELDING

In addition to the requirements spelt out elsewhere, the followings shall be taken into consideration:

33.6.15.1 Welding Process

(a) Welding under this specification shall be done by one of the following processes :

(i) Manual oxy-acetylene welding process

(ii) Manual shielded metal arc process (SMAW)

(iii) 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.

33.6.15.2 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

33.6.15.3 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.

33.6.17 **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.

33.6.18 **MARKING**

33.6.18.1 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.

33.6.18.2 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.

33.6.18.3 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.

33. 6.19 **SPECIFIC REQUIREMENTS- ERECTION**

33.6.19.1 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.

33.6.19.2 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 employer.

33.6.19.3 when C clamps are tack welded to the pipe for the purpose for the alignments of a joint, preheating for the lack welding shall be performed if the main joint adjacent to it to 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.

33.6.19.4 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.

33.6.19.5 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.

33.6.19.6 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.

33.6.19.7 **All gaskets shall be asbestos free material and suitable for the service application.**

33.6.20 **SPECIFICATION FOR POWER CYCLE PIPING & FITTINGS**

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

(1) 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

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.

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.

(2) 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
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. In case the design temperature is above 545 deg C, then P91 material only shall be applicable for both pipes as well as fittings.

Materials for fittings, specialties and valves shall be corresponding to piping material.

33.6.21 **SPECIFICATION FOR POWER CYCLE VALVES**

33.6.21.1 General Requirements

33.6.21.1.1 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 trype			
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.

33.6.22 **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 rainforced 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.

33.6.23 **SPECIFICATION FOR HANGERS/SUPPORTS**

Design and manufacture of hangers/supports shall conform to ANSI B 31.1 MSS-SP-58,MSS-SP-89

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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.

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.

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.

33.6.24 **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 1000C 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 ± 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.

(bb) Supports, guides and anchors shall be so designed that excess heat will not be transmitted to the building steel.

(cc) Tie rods/struts shall preferably be used for restraints to achieve low friction restraining.

(dd) 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.

(ee) 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.

(ff) Bottom support spring hangers to be avoided as far as possible.

33.6.25 **SPRING HANGERS**

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%.

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.

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%.

Variable spring hangers shall have supporting effort variation of not more than 25% throughout the total travel range.

All springs shall remain under compression throughout their operating regime and never under tension.

Spring hangers shall have provision of rlocking the hangers in any position of the travel.

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.

All spring hangers shall be locked before performing the hydro test. The locking shall be removed before the line is placed under operation.

33.6.26 **SNUBBERS**

Snubbers shall be designed to allow normal movement of pipe due to thermal expansion and shall require minimum maintenance.

Snubbers shall be of hydraulic type of Lisega/ ITT Girnell, Germany or owner approved eqvt.

Axes of anubbers/ restraints shall be parallel to the direction of the expected reaction force in operating condition.

33.6.27 **RESTRAINTS & ANCHORS**

All anchors shall be designed for direct rigid fastening to the structural steel member.

Anchors, guides and restraints shall be capable of withstanding the forces and moments due to thermal expansion and dynamic effects.

33.6.28 **STEAM STRAPS & STRAINERS**

Steam traps shall be of inverted bucket/ thermostatic type with integral or separate Y type strainers.

Traps shall have stainless steel internals.

All Y type strainers shal 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.

Strsiner shall have screwed blow off connection with removable plug.

Y type strainers shall be provided along with each steam trap in case the strainer does not form an integral part of the trap.

33.6.29 **SPECIFICATION FOR THERMAL INSULATION**

Insulation materials, cladding and 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 continuouslay 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 thicknest.

33.6.30 **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 employer for approval.

33.6.31 **OTHER ACCESSORIES**

The contractor shall also provide other accessories such as ceramic boards. Sealants and washers as required.

33.6.32 **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 tappings, 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.

33.6.33 **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

33.6.34 **CLADDING MATERIAL & ACCESSORIES SHALL BE AS SPECIFIED HERE UNDER:**

Sl. 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 where temperature 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 0.56 mm diameter wire

33.6.35 **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 atleast 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.

33.6.36 **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 can not 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.

33.6.37 **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. 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 employer 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.
d	Installation on vertical cylindrical vessel/tanks (including flash tanks etc.)
e	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 employer 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.
f	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.

33.6.38 **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 45^0C 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 sealded 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.

33.6.39 **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. Employer 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.

33.6.40 **SPECIFICATION FOR HYDROSTATIC TEST OF PIPING SYSTEM**

33.6.40.1 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 employer, 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.

33.6.40.2 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.

33.6.40.3 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.

33.6.40.4 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.

33.6.40.5 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.

33.6.41 **SPECIFICATION FOR CHEMICAL CLEANING OF PIPING SYSTEM AND EQUIPMENTS**

33.6.41.1 It is indented to chemically clean the following piping system

(a) boiler feed piping

(b) heater drains piping

(c) main condensate piping

(d) extraction steam piping

(e) The following equipment which form a part of the above system shall also be included in the cleaning operation.

i. H.P. heater
ii. L.P. heater
iii. Deaerator
iv. Gland steam cooler
v. Drain cooler

33.6.41.2 Before including 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.

33.6.41.3 How ever 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 employer.

33.6.42 **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.

33.6.43 **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 employer/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.

33.6.44 **SPECIFICATION FOR FLASH TANKS**

33.6.44.1 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.

33.6.44.2 **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.

33.6.44.3 **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 employer 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.

33.6.45 **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.

33.6.46 **SPECIFICATION FOR METALLIC EXPANSION JOINTS**

33.6.46.1 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.

33.6.46.2 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.

33.6.47 **CONSTRUCTION DETAILS**

(a) Bellows

i. The bellow shall be hydraulically or roll formed from perfect cylinders of single ply, 304 grade stainless steel.

ii. The number of longitudinal weld seams shall be minimum and there shall be no circumferential weld seam.

iii. Cold formed stainless steel bellows shall not be heat treated.

iv. All bellow elements shall be pickled after forming.

v. Equalizing rings, where required, shall be either from high quality casting of from fabrication metal.

vi. Flanged expansion joints shall be provided with adequate pipe stubs.

vii. Butt welded expansion joints shall have adequate length of pipe so that site welding dose not impair or reduce the joints efficiency.

(b) sleeves

i. Expansion joints will be furnishes with internal sleevs of the same material as the belloes and installed with sufficient clearance to allow full rated deflection. The sleeves shall be welded on the flow inlet end of the joint only.

ii. 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

i. 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.
ii. The rod on pressure balanced type expansion joints shall be adequately sized to prevent buckling in vacuum services or services either other external loads.

33.6.48 **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

33.6.49 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/sq.cm(g).
- Design pressure above 5Kg/sq.cm(g) and up to 10Kg/sq.cm(g) with or without vacuum.

33.6.50 **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.

33.6.51 **SPECIFICATION FOR SURFACE PREPARATION & PAINTING**

33.6.51.1 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 employer for using substitute material.

33.6.52.2 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.

33.6.52.3 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.

33.6.52.4 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.

33.6.53 **SURFACE PREPARTION**

33.6.53.1 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.

33.6.53.2 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.

33.6.54 **APPICATION OF PRIMER /PAINT**

33.6.54.1 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.

33.6.54.2 Surface prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surface

33.6.54.3 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.

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33.6.54.4 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 premed and finish painted before the grating is permanently secured.

33.6.54.5 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 ^{0}C – 600 ^{0}C) , IS -13183 Gr.-II (for temperature 200^{0}C -400^{0}C) and IS-13183 Gr.-III (for temperature up to 200^{0}C)
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.

33.6.54.6 All weld edge preparation for site welding shall be applied with one coat of wieldable.

33.6.54.7 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.

33.6.55 **Primer/painting schedule**

Sl. 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/ componantes, pipe clamps, vessels/tanks, equipments etc.		SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	as per NTPC colour shade/ coding scheme
2	All insulated piping's. Fittings/ componantes, 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 hanger (VLH) and other supports		SP4*	PS 19	1	40	-	-	-	PS17	1	30	70	
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	

Sl. No	Description		Surface preparation	Primer Coat			Intermediate coat			Finish coat			Total min. (microns)	Colour shade
				System	Coat									
5	All structural steel componants	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 coat	2	25	150	
										b)) final coat of paint PS1	1	30		
6	Weld edges		SP6(hand cleaning by wire brushing)	PS13 (weldable 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.														

33.6.56 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.

SR. 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 equalising line	:	From MS equalising 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 equalising 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.

SR. 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 /economiser 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

SR. NO.	NAME		DESCRIPTION
			(d) Water sealing of valves
			(e) Vacuum breaker line sealing
			(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 economiser 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

SR. NO.	NAME		DESCRIPTION
			(b) Stub for alkali flushing
			(c) HP By-pass spray
			(d) Blind Stub
			(e) Minimum re-circulation lines
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

SR. NO.	NAME		DESCRIPTION
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
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 atomizing
			(c) For F.O. Heating
53.0	Extraction line from CRH line	:	From CRH line to auxiliary steam header