STEEL AUTHORITY OF INDIA LIMITED
IISCO STEEL PLANT

BURNPUR, WEST BENGAL



4.08 MTPA EXPANSION (CRUDE STEEL)

TENDER SPECIFICATION (TECHNICAL) FOR

CAPTIVE POWER PLANT

VOLUME – II
(TECHNOLOGICAL AND BALANCE OF PLANT)
(PACKAGE NO. CPP - 1)

MECON LIMITED
RANCHI – 834 002

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1. INSTRUCTIONS TO TENDERER

1.1. General

M/s IISCO Steel Plant (ISP) a flagship unit of SAIL, having 2.5 MTPA crude steel production capacity, is now planning for a brown field capacity expansion of its Burnpur Works via BF-BOF route to increase its production capacity by 4.08 MTPA of crude steel.

The existing Power & Blowing Station (PBS-2) consisting of three (03) nos. mixed fuel fired Boilers, three (03) nos. Steam Turbine Generators, one (01) no. Back Pressure Turbine Generator and three (03) nos. Steam Driven Turbo Blowers is presently meeting the cold blast air, process steam and emergency power requirement of the existing facilities in the steel plant.

MECON have been appointed by ISP for providing Consultancy for Procurement and Contract Engineering Services for 4.08 MTPA Expansion.

In order to meet the requirement of cold blast air, process steam and power for the 4.08 MTPA expansion project, a new Captive Power Plant (CPP) comprising of mixed gas fired Boilers, Steam Turbine driven Turbo-Blowers (STB) and Steam Turbine Generators (STG) has been envisaged.

Also, the high pressure (HP) steam to be generated in CDQ units of the new Coke Oven Plants shall be fed into the new CPP for utilization in STGs, STBs and process needs. Brief descriptions for the CPP package pertaining to major equipment/ systems/ facilities envisaged are indicated below:

i) Three (03) nos. mixed gas (BFG, BOFG, COG, CBM/ Natural Gas, LPG/ PROPANE) fired Boilers along with associated auxiliaries.
ii) Three (03) nos. Extraction cum Condensing type Steam Turbine Generators along with associated auxiliaries.
iii) Three (03) nos. Steam Turbine Driven Blowers along with associated auxiliaries.
iv) Circulating cooling water system including cooling tower, CW pumps, ACW pumps etc.
v) DM Plant
vi) Air Conditioning & Ventilation System
vii) Cranes, Hoists & Elevators
viii) FDA System
ix) Fire fighting System including hydrant, MVWS, HVWS, Inergen system, etc.
x) Compressed Air System
xi) Emergency DG Set
xii) Communication and IT networking
xiii) Laboratory Equipment
xiv) Associated Electrical System up to power evacuation
xv) Associated Control & Instrumentation

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This specification is based on Discrete Turnkey basis including erection of the plant and equipment. The Tenderer shall ensure the completeness of the total system/ plant & equipment in all respect.

Tenderer shall have to agree and adhere to all the terms and conditions of the Tender Specification (Technical as well Commercial Volume) and deviation, if any shall have to be categorically stated clause-wise separately in writing during submission of their offer.

1.2. Plant Site Location, Metrological Data & Infrastructure Facilities

The plant location, land availability for the proposed expansion, climatic condition, availability of infrastructure facilities, yard services, and necessary have been discussed in this chapter. The infrastructures such as road and rail linkages, for expansion are also discussed in this chapter.

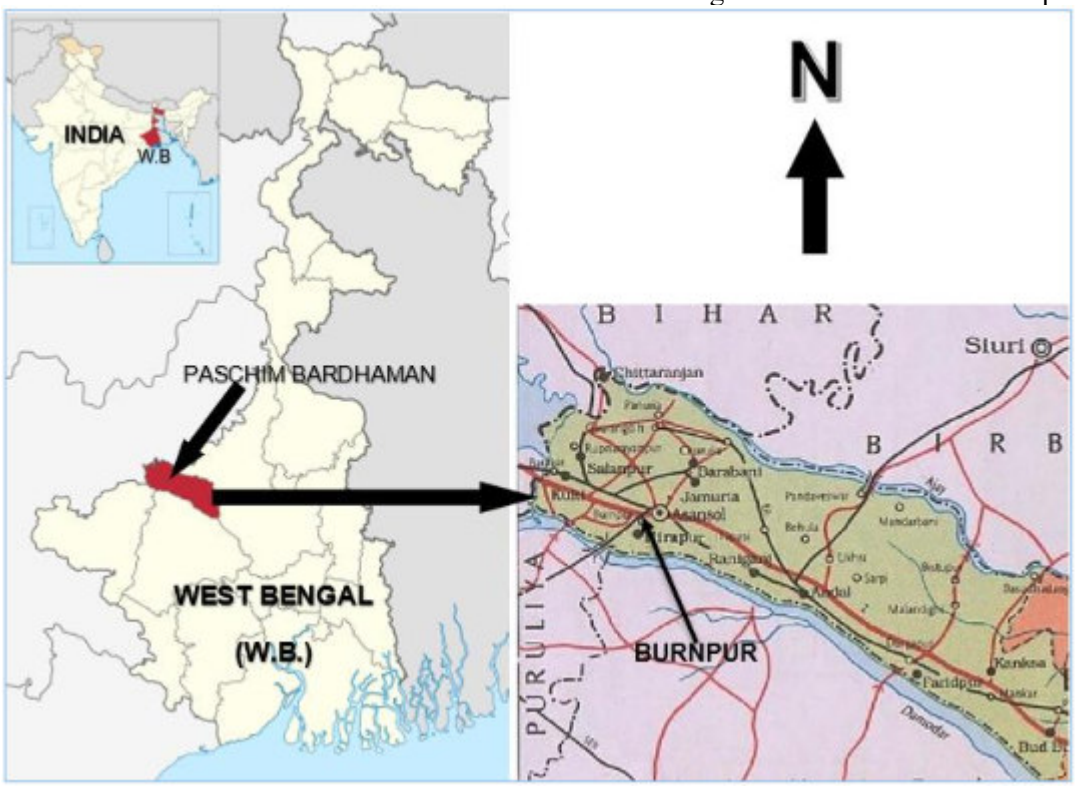
1.2.1. Plant Site

Location

SAIL is having integrated steel plant at Burnpur, situated at about 200 km from Kolkata (District - Pashchim Bardhaman) on the eastern bank of the Damodar River in West Bengal, India. Nearest major town Asansol is next to Burnpur. The location of Burnpur and existing ISP plant is shown in below :

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Figures 1.1 : Location of Burnpur



Plant Area

The areas available for expansion within the existing plant boundary are scattered and located near Damodar yard, Jhoraburi area, east of existing Sinter Plant, north of existing LDCP, back shunt yard, CHP area after keeping the coal storage (2 storage yards) and handling area for COB-10 and various plots on eastern and southern side. The total area of existing works' is about 1510 acre, out of which about 620 acre is available for expansion facilities. In addition to the above, ISP suggested to consider New Town and some adjacent area which is about 218 acres. Further to the above areas, an area of about 6.7 acre at Santa village shall also be available which is adjacent with the existing plant boundary. To have the contiguous land, the boundary wall between the existing land boundary and the additional land shall be dismantled.

Damodar River flows about 1.5 km west of the existing works' boundary. ISP is well connected by both South-Eastern and Eastern Railways. National Highway 19 (formerly NH-2), passes along north of the plant, is connected with the plant, through Asansol and Niamatpur. The distance is about 4.8 km and 10.5 km through the former and later route respectively. Asansol – Chittaranjan highway, parallel to NH-19, is passing in between, which is about 2 km north of works' boundary. Location of plant site is shown on satellite image, in below key features of the plant site are listed in Table 1-1.

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Figure 1-2 : Plant Sit eof ISP, Burnpur (Satellite Image)

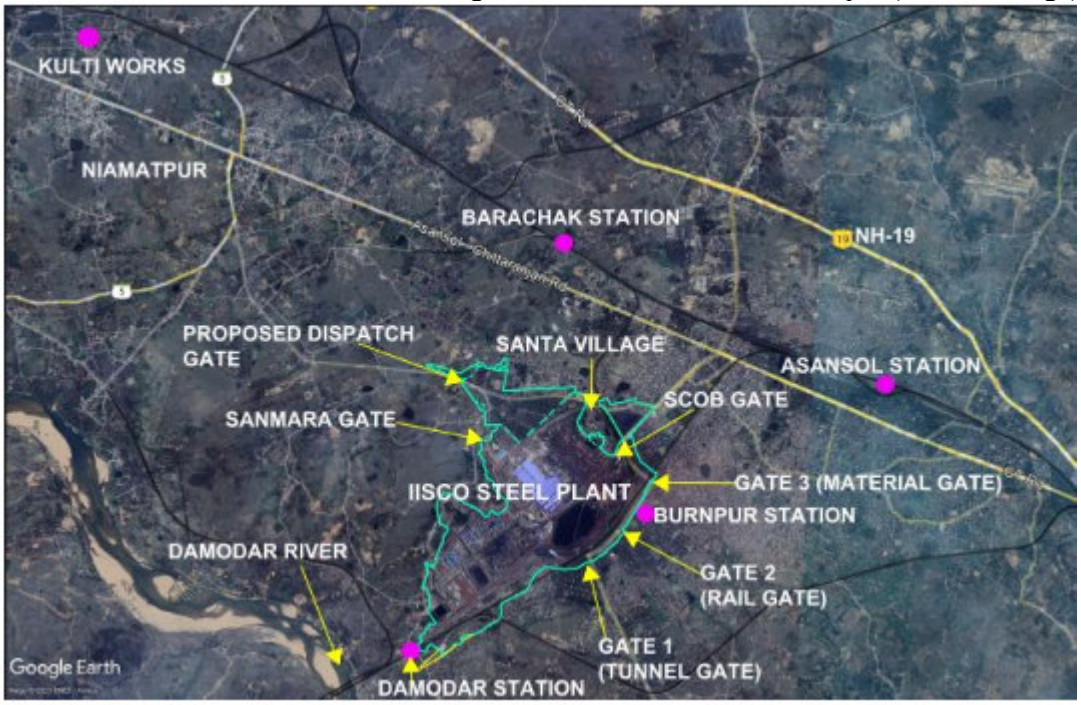


Table 1-1 : Key Features of the Site

Features	Description
Location	Latitude : 23°40' N ; Longitude : 86°55' E
Nearest highway	Kolkata – Delhi National Highway NH-19 (formerly NH-2) This is also connected with Asansol – Chittaranjan road.
Nearest railway station	Damodar Station of South-Eastern Railway is located immediate south, Burnpur Railway Station under South-Eastern & Eastern Railway is located at immediate east and Barachak station is about 4km north of works. Asansol station of Eastern Railway is 5.3 km from plant.
Nearest seaport	Haldia Port: 320 km (by road) Kolkata Port: About 182 km from the plant site.
Nearest airport	Andal Airport (Durgapur): at a distance of about 47 km from plant site. Netaji Subhas Chandra International Airport at Kolkata: at a distance of about 220 km from the plant site
Nearest city	Asansol : At a distance of about 5 km from the plant site.
Source: Google Earth and DPR for 4.08 Expansion	

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1.2.2. Meteorological Information

The meteorological information at and nearby Burnpur/Asansol area are as follows:

Temperature

Burnpur has hot and dry summers and mild winters. In summers temperatures soar above 40°C with dry hot air blowing known as 'loo' while in winter temperatures go below 10°C. Monsoon lasts from June to September. In winter, there is much less rainfall than in summer.

Rainfall

The highest rainfall occurs during Mid-June to September and the least in December. The average in this month is 8 mm. The area's average annual rainfall is 1286 mm most of it occurs during the monsoon. The variation in the precipitation between the driest and wettest months is 285 mm.

Wind Direction

The average hourly wind speed in Asansol experiences significant seasonal variation over the course of the year. Predominant wind direction for the period October to April is observed from NW to SE and for the period May to September from SE to NW. The windier part of the year lasts for 4 to 5 months, from May to September 8, with average wind speeds of more than 6.7 miles/hr. The windiest month of the year in Asansol is June, with an average hourly wind speed of 8.3 miles per hour. The calmer time of year lasts for 7.7 months, from September 8 to April 29. The calmest month of the year in Asansol is October, with an average hourly wind speed of 4.9 miles.

Earthquake Intensity

Zone – II as per Indian Standard.

Humidity

The month with the highest relative humidity is August (85.17 percent). The month with the lowest relative humidity is March (45.41 percent). The wettest month is July (26.33 days). The driest month is December (1.13 days).

1.2.3. Land Allocation

SAIL has identified few vacant plots/areas within the present works area of ISP, which would be available for the proposed expansion shown in Figure 5-3 (marked in magenta colour). The available areas are not contiguous and comprise of different sizes and shapes and are situated at different locations within the present works' boundary. Among

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the available plots, some areas would only be made available for the expansion project after dismantling of a few units like COBP-8 and 9, diesel loco repair shop, old SMS & mills, SMS slag dump area, old cooling towers, ED office premises near SCOB gate, CHP area after keeping the coal storage (2 storage yards) and handling area for COB-10 etc. and after filling up of existing ponds (2 nos.). ISP is in the process of making the spaces free from any encumbrances. However, as decided COB-10 along with its associated facilities like storage (at North Yard), coal conveyors, pipe conveyor for coke, electrical sub- station etc. to be retained during planning for expansion.

In addition to the above plots within the existing works' boundary, New Town area (ISP township) and the adjacent land to north & east of this area shall be made available for expansion by occupying the present road along the east of the New Town area connected with NH 19 and part of road by which Sanmara Gate is connected with NH 19. Hence, Sanmara Gate can be shifted to the proposed Gate envisaged at the north of proposed CRM. For received of construction material separate gates have been proposed adjacent to existing Sanmara gate and North Yard. An area at Santa village shall also be available for expansion. A narrow stretch of additional land along the south of Damodar yard boundary towards external main line (Sini - Asansol main line), is required for laying tracks for additional raw material unloading stations for proposed expansion. The tentative profile of modified plant boundary is shown in Figure 5-3 showing the available land within plant boundary.

For raw water reservoir and raw water treatment plant, Rangapara land shall be available which is approx. 1 km away from Burnpur works' boundary.

In order to locate the service center for mills, primarily Kulti works was thought of. It was informed later that the required space is not available at Kulti. However, as additional land is available in continuation with township area, hence service facilities has been planned within the additional land which is at the north-east of the proposed CRM.

1.3. Design Basis

1.3.1. Mixed Fuel/ Gas Fired Boilers

The Boilers shall be of natural circulation with single/ bi-drum, water tube, balanced draft, radiant type, suitable for outdoor installation and designed for firing Blast Furnace Gas (BFG) and Basic Oxygen Furnace Gas (BOFG) as main fuel. Coke Oven Gas (COG), Coal Bed Methane (CBM) / Natural Gas, Liquified Petroleum Gas (LPG)/ Propane shall be used as supporting fuel, initial start-up, flame stabilization and as emergency fuel. The type of fuel/ gas burners to be provided by the Tenderer shall be of proven design and capable to fire all the fuels in the different combination modes as mentioned in Technical Specification.

The main technical particulars of the boilers shall be as follows:

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Quantity	:	Three (03) nos. (2W+1S)
Steam Capacity	:	300 TPH at 100% BMCR (each)
Super heater outlet pressure	:	90 ata
Super heater outlet temp.	:	525 °C ± 5 °C
Main fuel	:	BFG & BOFG
Support Fuel	:	COG, CBM/ Natural Gas, LPG/ Propane
Start-up Fuel	:	COG, CBM/ Natural Gas, LPG/ Propane

The boilers shall operate on the above pressure and temperature in the range of 60% to 100% BMCR load. Feed water temperature at economizer inlet shall be 230 °C.

The design of boilers shall be carried out considering different fuels/ fuel combinations as mentioned below:

BFG + Support Fuel - Up to 100 % BMCR (with maximum 10% support fuel)
BFG + BOFG + Support Fuel - Up to 100 % BMCR (with maximum 10% support fuel)
COG – Up to 60% BMCR
CBM/ Natural Gas – Up to 60% BMCR
LPG/ Propane – Up to 60% BMCR

Requirement of fuel gases based on the above load shall be indicated by the Tenderer in their offer. Tenderer shall also confirm the minimum Boiler load (t/hr) with any fuel/ combination of fuels.

BFG and BOFG shall be mixed after availability of the same at the battery limits. Separate gas skid, if required shall also be considered by the Tenderer. In the normal scenario, total COG gas available for three (3) Nos. Boilers shall be considered as 65 Nm3/hr having NCV 4200 Kcal/Nm^3 in combination firing mode.

The COG line sizing to each Boiler shall be based on 60% BMCR load. However, at 100% BMCR, only available COG as supplementary fuel may be used, if required.

Typical gas analysis and the pressure, temperature, etc. at which all the gases are available for the boilers is indicated in the Table-1.

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Typical Gas Analysis (Percentage By Volume)

Table-1

Sl. No.	Items	Unit	BFG	BOFG	COG	CBM/Natural Gas	LPG/ PROPANE
1.	CO	% (v/v)	21 - 25	69	6.6	ISO Condition	ISO Condition
2.	CO_2	% (v/v)	17 - 19	16	1.4		
3.	N_2	% (v/v)	Balance	15	7.6		
4.	H_2	% (v/v)	3 - 6		55		
5.	CH_4	%			26		
6.	C_2H_6	%					
7.	O_2	%			0.8		
8.	C_nH_n	%			2.6		
9.	Net Calorific value	kcal/Nm^3	880	1700	4200	8000	23000
10.	Water vapour	%	Saturated	Saturated	Saturated		
11.	Gas temperature	^0C	<60	<60	<60	amb	amb
12.	Gas pressure	mmWC	800-1100	1000-1500	800-1500	2 - 2.5 kg/cm^2g	1 - 1.5 kg/cm^2g
13.	Dust content	mg/Nm^3	<5				
14.	Quantity	Nm^3/h	2,57,855	42,805	65*	22,050	7,670

* During operation, the quantity of COG to CPP can be increased suitably by curtailing COG flow to other areas.

Considering the scenario of BF & BOF shutdown, 60 percent of boiler load shall be maintained by support fuel.

In addition to the availability of BFG & BOFG, maximum 10% support fuel shall be considered by the Tenderer in the Boiler design.

Calorific Value of fuel gases indicated above is on dry basis. The boiler burners shall be designed for any combination of the fuels as per the requirement of TS.

1.3.2. HP Steam from CDQ Boilers

HP steam shall be made available from CDQ boilers of Coke Oven Battery at the CPP battery limit. The same shall be connected with two nos. main steam headers of CPP with motorized isolation valves by the Tenderer.

Steam parameters of the CDQ boilers shall be as follows:-

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Steam Quantity	:	124 TPH
CDQ Boiler Super heater outlet pressure	:	95 ata
CDQ Boiler Super heater outlet temp.	:	535 °C

1.3.3. Steam Turbine Generators

The Steam Turbines shall be of impulse reaction type with extraction cum condensing system comprising of surface condenser, steam jet air ejectors, condensate extraction pumps (CEP), lubricating oil system, LP heaters, HP heaters, deaerator, etc.

The main technical particulars of the Steam Turbine Generators (STG) shall be as follows:-

Quantity	:	Three (03) nos.
Generation Capacity	:	40 MW at 100% TMCR (each)
Inlet Steam Quantity	:	To be decided during detail engineering
Inlet steam pressure	:	85 ata
Inlet steam temperature	:	515 ± 5 °C
Generator Voltage	:	11 kV
Type	:	Extraction cum Condensing
Extraction Steam Quantity	:	91 TPH (from each turbine)
Extraction steam pressure & temperature	:	To be decided during detail engineering
Bleed steam for HPH, LPH & Deaerator	:	To be decided during detail engineering

Steam Turbines with controlled extraction should be capable for handling variable extraction flow requirement. Steam turbines shall be designed for maximum flow passing VWO Condition as per OEM's design standards.

1.3.3. Steam Turbine Driven Turbo Blowers

The Steam Turbines shall be of impulse reaction type with full condensing system comprising of surface condenser, steam jet air ejectors, condensate extraction pumps (CEP), lubricating oil system, uncontrolled extraction for LP heaters & HP heaters, etc.

The main technical particulars of the **Steam Turbine** shall be as follows:

Quantity	:	Three (03) nos. (2W+1S)
Inlet Steam Quantity	:	To be decided during detail engineering
Inlet steam pressure	:	85 ata
Inlet steam temperature	:	515 ± 5 °C
Type	:	Full Condensing

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Bleed steam parameters for HPH & LPH	:	To be decided during detail engineering

Steam turbines shall be designed for maximum flow passing VWO Condition as per OEM's design standards.

The Turbo Blowers shall be of multistage, axial type complete with suction filter, suction & discharge silencer, anti-surge controller, lubrication system, etc.

The main technical parameters of the **Turbo Blowers (STBs)** shall be as follows:

Total Cold Blast Requirement in BF (Flow & Pressure)

Peak	:	10,000 Nm^3/min & 6.5 ata
Normal	:	9,000 Nm^3/min & 6.25 ata
Quantity of STB	:	Three (03) nos. (2W+1S)
Configuration	:	3 X 50%
Cold Blast Flow (Peak)	:	5000 Nm^3/min (each)
Cold Blast Flow (Normal)	:	4500 Nm^3/min (each)
Cold Blast Flow (Minimum)	:	3500 Nm^3/min (each)
Cold Blast Pressure (Peak)	:	6.5 ata
Cold Blast Pressure (Normal)	:	6.25 ata
Cold Blast Pressure (Minimum)	:	5.6 ata
Type	:	Multistage, Axial
Drive unit	:	Steam Turbine

Duty Point	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Discharge Flow (Nm^3/min)	5000	5000	5000	4500	4500	4500	3500	3500	3500
Discharge Pressure (ata)	6.5	6.25	5.6	6.5	6.25	5.6	6.5	6.25	5.6

Each blower shall be selected considering the requirement during stove filling control mode over and above the cold blast requirement of the Blast Furnace.

Tenderer shall also indicate the minimum cold blast flow and pressure to be achieved by the each Turbo Blower without blow-off.

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1.3.4. Pressure Reducing and De-Super Heating Stations (PRDS)

Requirement of the process steam shall be met normally from the extractions of the Steam Turbines. In case of any unforeseen condition when the extraction cum condensing turbines shall not be able to meet the requirement of the process steam, the same shall be met from the PRDS units.

PRDS shall be envisaged in parallel to the extraction of STGs in order to meet the process steam requirement.

Also, PRDS shall also be envisaged to meet the auxiliary/ in-house steam requirement of CPP.

1.4. Special Instructions to Tenderer

It shall be the responsibility of the Tenderer to obtain the necessary approval from the concerned inspecting authority / Chief Inspector of Boilers for the design, design calculation, manufacturing, erection, testing, commissioning as called for under the Indian Boiler Regulations and any other applicable statutes. Necessary official fees for inspection/ approval shall be paid by the tenderer at their works and by SAIL-ISP at Burnpur.

Design not meeting the stipulations of the codes and standards shall not be acceptable.

All statutory clearances for plant design, manufacturing and construction like IBR formalities, Department of Explosive act, electrical inspectorate etc. (as applicable) shall be obtained by the Tenderer. Purchaser as required shall provide necessary documents, as applicable for further fulfilling the obligations by the Tenderer. The final registration of the boiler shall be arranged by the Tenderer. However, following clearances shall be obtained by the Purchaser.

A. MOEF
B. Aviation
C. Pollution control
D. Factory inspectorate.

All necessary documents and supporting engineering calculations as required for the above clearances shall be provided by the Tenderer.

1.5. The following points shall also to be taken into account by the Tenderer while designing Boiler, Steam Turbine Generator, Steam Turbine driven Turbo-Blower, pipelines and other system:-

1. Corrosion allowance of 1.5 mm for steam services and 2.0 mm for water services shall have to be considered for all pipes.

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2. Bore of any pipes/ tubes shall not be less than 20 mm except for instrumentation lines.

3. Two separate approaches (stair cases) from ground to all platform levels of the boilers shall have to be provided. All the boilers shall have interconnecting platforms with each other and also with the control room at operating level.

4. All by pass valves of control valves shall be inching type motorized valves.

5. All isolating valves of steam & feed water lines having pressure more than 40 ata, shall have two valves in series. In all the by-pass lines, out of these two valves, one shall be manual and other shall be inching type motorized valve.

6. All drains/ vents, root valves shall have two isolation valves in all water & steam lines having pressure more than 40 ata.

7. All pipes, valves, drains, pumps, fitting, tanks etc. for all dosing systems shall be S.S.

8. All vents shall be terminated at safe height and distance above roof/ nearest roof.

9. All drains shall be terminated at nearest specified drain/ trench of the plant.

10. All gas line drains shall be connected to seal pots.

11. Upstream isolation valves of all feed water flow control valves shall be motorized.

12. All steam pipes below 50 NB shall have minimum thickness of Schedule 80.

13. Heat resistant paint shall be applied on all surfaces which are insulated.

14. All gaskets for steam, feed water & condensate pipe lines shall be of graphite impregnated SS spiral wound.

15. All expansion bellows shall be universal type with inside liner sleeve.

16. There shall be 2 x 100 % (1 AC + 1 DC) Scanner Cooling Air Fans.

17. Discharge pipe to atmosphere of start-up vent/ safety valve shall preferably be straight. Any bend more than 15^0 shall not be acceptable.

18. Following points shall be considered for Chimney design:

a) Suitable drain arrangement for condensate or rain water.
b) Suitable lightening arrestor & aviation lamp.

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c) Intermediate platform at intervals of 15.0 m.

d) Height of Chimney shall be decided as per norm and stipulation of State & Center Pollution Control Board and type of fuel fired.

e) Chimney design shall be as per IS 6533 (latest edition) and IS 800 with life of minimum 25 years.

19. All purge and vent valve in BFG/ BOFG and COG gas line after SOV in main header upto burner front shall be remote control from DDCMIS operation.

20. Flow, pressure & temperature measurement in main steam pipe lines and in individual headers/ pipelines connected to each STG & STB as applicable shall be supplied by the Tenderer.

21. Flash steam from CBD shall be taken to Deaerator.

22. Safety valve set pressure shall be atleast 105 % of maximum working pressure.

23. Total pressure part of boiler and other pipelines shall be designed accordingly taking into consideration the allowable over pressure for safety valve also.

24. Leakage class of all valves shall be as per EN 12266-1 Rate A.

25. All Butterfly valves up to 20” diameter shall be lugged wafer type with zero leakage. However, Butterfly valves greater than 20 inch diameter shall be flange ended.

26. Any lugs, plate directly welded to pressure parts shall be of heat resistant equivalent material.

27. Corrosion allowance of 2.0 mm shall be considered for all tanks, headers, drums for all services.

28. Google valve shall be enclosed type with hydraulic power pack for clamping & de-clamping and flame proof electric actuator for disc movement. Gears and chains with wheel shall also be provided for disc movement and hand pump for clamping and de-clamping.

29. U seal (water seal) shall be quick dump type. Necessary arrangement including inlet/outlet/ over flow water connection, etc. shall be provided.

30. Discharge isolation valve for each Turbo Blower shall be triple eccentric type (metal to metal contact) Butterfly valve as per EN 12266-1 Rate A.

**** End of Clauses ****

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2. TECHNICAL INSTRUCTIONS TO TENDERER

2.1. The Tenderer shall furnish all the drawings, documents, load data, utility data and other information/ data like fault diagnosis, operation and maintenance manuals, general details and layout drawings, design calculations, specification of plant and equipment, together with 'As built' drawings for all mechanical, electrical and instrumentation & control.

All civil and structural work (except the technological structures of the equipment) including civil foundation shall be arranged by the Purchaser. However, all feedback design data / drawings for the equipment supplied, loading both static as well as dynamic, outline drawings, details of embedment and detailed assignment drawings etc. shall be furnished by the Tenderer for this package for design of the stated civil works as well as foundations by the Purchaser.

2.2. Commissioning spares shall be supplied by the Tenderer till the commissioning of the plant as mentioned in SBD. A list of commissioning spares shall be furnished by the Tenderer as per requirement of SBD. However, Tenderer shall ensure the availability of adequate commissioning spares before carrying out the commissioning activity in all respect for successful and timely completion.

Tenderer shall also submit an itemized price-list of two years Operation and Maintenance spares as per requirement of SBD.

2.3. The Tenderer shall include in their scope the requirement of oils, grease, lubricants and consumables for the plant & equipment to be supplied by them. All consumables till commissioning shall be in the scope of the Tenderer in line with the SBD. List of initial fills of oils, grease and lubricants shall be submitted by the Tenderer. Quantities and specification of the same shall be furnished by the Tenderer after placement of work order.

2.4. The Tenderer shall supply complete new and unused set of all special tools and tackles required for equipment installation, operation and maintenance of the plant/ equipment supplied.

2.5. Any work/ equipment and material which may not have been specifically mentioned in this Technical Specification but are required to make the plant complete in every respect in accordance with Tender condition and necessary for safe operation and guaranteed performance of the plant shall be deemed to have been covered under the scope of this Technical Specification and shall be provided by the Tenderer within the quoted price.

2.6. Any loss of plant and equipment due to imprudence, negligence and/or unsuitable treatment and handling shall be replaced by the Tenderer at his own cost.

2.7. The Tenderer shall satisfy the Purchaser by possessing the necessary technical experience and has at his disposal, suitable facilities and staff to ensure that the contract shall be executed with the best quality material and workmanship within the stipulated time.

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2.8. The Tenderer shall not off-load the contract or part thereof to any Sub-Vendor without written permission of the Purchaser. In the event of subletting of any part of the work is permitted by the Purchaser, the fact that such permission has been accorded shall not establish any contractual relationship between approved Sub-Vendor from any of his obligations and liabilities under the contract.

2.9. The Tenderer shall have to furnish drawings, documents etc. as per Chapter 13.00 and general and technical particulars of plant & equipment in the Performa given in Chapter-15.00 of this Technical Specification.

2.10. Stainless steel name plates with letters engraved in English language shall be provided by the Tenderer for each equipment. The name plate shall indicate make, identification number, capacity, rating & weight of equipment. The name plate shall be fitted at a prominent place in the body of each equipment with the help of stainless-steel screws.

2.11. All documents, instruction, catalogues, brochures, pamphlets, design, data, norms & calculations, drawings, operation & maintenance manuals, reports, labels, correspondence and any other data shall be in English language and metric system.

2.12. **Meteorological Data**

Maximum Temperature	:	48 ^{0}C
Minimum Temperature	:	9 ^{0}C
Maximum Relative humidity	:	90%
Minimum Relative humidity	:	20%
Altitude (Average elevation above MSL)	:	135 m
Seismic Zone	:	Zone – II as per IS

Temperatures inside shop premises are generally taken as 5^{0}C above ambient, unless otherwise specified.

Design ambient condition of 40 ^{0}C Temp. & 60% RH shall be considered for mechanical plant & equipment. However, all the equipment should be capable to deliver their rated capacity at maximum & minimum ambient conditions as indicated above.

2.13. **Foreign Exchange**

Generally, equipment from indigenous sources shall be offered. Imported equipment shall be included only when it is absolutely necessary and shall be listed separately with their prices. In case of import the Tenderer shall have to arrange their own "Actual import licence" from the concerned authorities unless otherwise mentioned.

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2.14. Completion Schedule

The Tenderer shall submit a PERT chart/Time Bar chart indicating the duration and completion schedule of major activities such as submission of design data and drawings for approval, manufacturing of components/units supply at site etc. PERT chart/Time Bar Chart shall form part of the contract and cannot be altered arbitrarily except Force Majeure conditions as may be agreed with the Purchaser. All equipment along with all auxiliaries shall be supplied within **Thirty (30) months** from the effective date of contract. However, Commissioning of entire plant & equipment shall be completed within **Thirty Nine (39) months** from the effective date of contract. PERT chart/Time bar chart, etc. shall be prepared accordingly.

2.15. Price Bids

a) The Tenderer shall submit price bid in a separate format as may be instructed by the Purchaser separately elsewhere in the Tender document.

b) The Purchaser reserves the right to accept or reject the offer in full or part thereof for all or any of the items/sub-items indicated above.

c) The Tenderer shall inspect the site and satisfy himself with regard to the nature of work, exact site conditions, etc. before submission of offer. Any claim, what so ever, made for extra payment submitted by Tenderer on this account after acceptance of his offer, shall not be considered.

d) While scrutinising the "Techno-Commercial" part of the tender, the Consultant/ Purchaser may require certain clarifications/ confirmations from the Tenderers for complete and proper evaluation of the tender. The Tenderers shall submit such clarifications/ confirmations in a week's time from the date of receipt of such queries.

2.16. Workmanship and Quality Control

a) The plant and equipment supplied shall be new and best of their kind and of latest technology on the date. All materials and equipment shall comply with the latest Indian Standards, statutory requirements of the concerned State Governments. In absence of relevant Indian Standards/practices, other standards which are internationally accepted, acceptable to the Purchaser, could be followed. Necessary certificates from the competent authorities, as applicable, shall be furnished for different equipment as supporting documents.

b) The plant and equipment shall be designed to have maximum reliability and ease of operation and maintenance as primary consideration. The plant offered shall be of a family having basic design as per which other plants have already been supplied and which have operated efficiently and reliably elsewhere at least three years under similar climatic and operating conditions.

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c) The Tenderer shall avoid offering sophisticated and complicated equipment where simple and proven equipment shall achieve the specified requirements. The Tenderer shall offer the best and proven design of plant and the equipment which can be capable of delivering its guaranteed output continuously. Latest trends, philosophies, state of the art technology, proven, efficient and reliable equipment shall be given preference.

2.17. Inspection & Works Testing

a) The plant and equipment shall be subjected to inspection and witnessing of shop tests by the Purchaser/ Consultant or the agency mutually agreed between Purchaser and the Tenderer/ Supplier. The supplier shall inform the Purchaser/his Consultants at least fifteen days in advance of the date when the plant and equipment shall be made available for inspection and testing. The Purchaser and/or his Consultant shall be given full access to the tests and testing premises and can inspect the factories and offices of the supplier or sub-Contractor, if so required. After inspection and testing the Tenderer shall submit all the certificates/ documents as required by the Purchaser / Consultant for approval before obtaining clearance for despatch of equipment.

b) For plant and equipment for which tests at works may not have been witnessed by Purchaser/ Consultant, the tests and quality certificates duly signed by appropriate authority acceptable to Purchaser shall be submitted to the Purchaser for approval, within one month of conducting the test and 6 weeks in advance of the despatch.

c) Inspection by the Purchaser or his representative shall not relieve the Tenderer of his liability for rectifying any defects which may subsequently appear or be detected during or after erection and during guarantee test. After rectification, the testing of equipment shall be repeated to the satisfaction of the Purchaser.

2.18. Drawings/ Data to be submitted with the Tender

In order to enable the Purchaser/ Consultant to properly evaluate the tenders, the drawings/ documents as indicated in Chapter - 12.00 of this specification shall be submitted along with the tender.

2.19. Approval of Drawings and Documents

a) The Tenderer shall supply the following documents/drawings as indicated in Chapter-13.00 of this Technical Specification.

b) All drawings supplied by the Tenderer shall have name plate and drawing nos. of the Purchaser / Consultant. The name plate sample and drawings nos. shall be provided to the Tenderer after placement of order.

c) All drawings and data shall be submitted in soft (PDF) form or as agreed otherwise. After scrutiny of drawings, the Purchaser/ Consultant shall return the drawings to the Tenderer

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marked with stamp as given in the following article.

d) The following monograms shall be used by the Purchaser / Consultant and shall be stamped on each drawing and data sheet which shall be sent by the Tenderer for approval.

i) Approved
ii) Approved As Noted
iii) Commented
iv) Not Approved
v) Retained for Reference

The Tenderer shall confirm their compliance with the above stamps of approval.

e) Drawings under category – ii, iii and iv above shall be revised to incorporate the comments and resubmitted for final approval with proper compliance. All revisions shall be marked on the drawings, together with date, reference, location / area, and details of changes made. Reasons for not incorporating any of the comments made by the Purchaser / Consultant shall be clearly brought out to the attention of the Purchaser / Consultant while submitting the revised drawings.

f) The Tenderer shall also submit to the Purchaser/ Consultant any other / further details / drawings of plant and equipment that may be required, in order to fully assess the design and its compliance with the specifications.

g) Final approved copies of drawings in four (04) sets in hard copy shall be submitted by the Tenderer for Purchaser's reference and records.

h) As built drawings for the items /systems under scope of supply of the Tenderer shall be prepared and furnished by the Tenderer in four (04) sets in hard copy and also in PDF form.

i) Tenderer shall hand over the original IBR isometric drawings/ documents (duly approved by statutory authority) to the Purchaser after successful commissioning of the plant.

j) Approval of any drawing / document by the Purchaser or his representative shall not relieve the Tenderer of his liability for supply of all the plant & equipment / system complete in all respect and performance of all the plant & equipment and systems to the satisfaction of the Purchaser.

2.20. Digital Project Management Solution (DPMS)

SAIL-ISP is in the process of implementing a Digital Project Management Solution (DPMS) for all ongoing and upcoming projects. The solution envisages mapping of all activities during the project cycle (initiation to closure) and shall act as a central repository of various documents created during a project lifecycle. Progress of all projects shall be monitored in DPMS.

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After placement of order, required login access in DPMS shall be provided to the authorized representative(s) of the successful Tenderer. Broadly following activities are required to be carried out in DPMS by the successful Tenderer during the Contract period:

i) Submission of a Detailed Work Programme/L-2 Schedule in Primavera (.XML format) using the critical path methodology. Subsequent corrections and necessary revisions as per comments from the Employer.
ii) Submission of the billing schedule, linking the billing schedule with the Approved L-2 schedule.
iii) Submission of PBG, insurance documents etc.
iv) Submission of drawings and datasheets for the employer's approval, along with subsequent corrections and necessary revisions as per comments from the Employer.
v) Submission of 3D model, wherever applicable, for monitoring by higher management.
vi) Regular updating of ongoing work activities as per the approved L-2 schedule, either through the web application or the mobile app of DPMS. The Tenderer shall also upload photographs from the site at regular intervals in DPMS for monitoring progress by higher management.
vii) Raising any site issues/hindrances being faced at the site and maintaining hindrance register.
viii) Raising inspection and dispatch clearance before dispatching materials to the site through the submission of supporting documents.
ix) Submission of invoices along with all supporting documents (hard copies also to be submitted).
x) Request for approval of sub-vendors and additional makes for items, etc.
xi) Request for PAT, Commissioning tests, and PG tests, and subsequent issuance of milestone certificates including FAC.
xii) Request for extension of completion time and issuance of change orders, if any.
xiii) Request for PVC payment, if applicable.
xiv) Request for the release of PBG, etc.

A dedicated DPMS cell has been created to provide necessary training and support to the authorized representatives of the successful Tenderer. The successful Tenderer shall coordinate with the DPMS cell and the Project Manager for any queries or technical issues faced in the system. They shall perform all the tasks mentioned above, as well as any new tasks communicated, in compliance with the SOP of DPMS.

2.21. Painting & Finishing

a) The surface of plant & equipment shall be suitably cleaned and coated with anti - rust primer to protect against corrosion and damage during transit and transportation to the site.

b) Painting shall be done as per details indicated in Chapter-08.00 of this Technical Specification.

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2.22. Packing, Despatch, Handling & Transportation

a) All equipment, pipes, valves, instruments etc. shall be suitably packed for protection against mechanical damages and climatic conditions during transit and storage. Packing and weather proofing shall be subject to approval of the Purchaser/ Consultant. This approval shall be general and may not be required every time for an article to be despatched. However, the Purchaser reserves the right to examine the packing for any particular consignment at supplier's/manufacturer's works before despatch.

b) The Tenderer shall be entirely responsible for the insurance, shipment, handling and transportation of all plant & equipment, construction tools, labourers and materials including unloading at destination, transportation to site, off-loading, storing and procurement at site till erection.

c) The equipment shall not be dispatched by the Tenderer from the place of manufacture to the site until the equipment is inspected by the Purchaser or his representative and the despatch instructions are issued by the Purchaser.

2.23. Erection, Testing & Commissioning and Demonstration of Performance Guarantee

a) All the plant and equipment, units / sub units supplied by the Tenderer shall also be erected by the Tenderer. Testing and commissioning of plant and equipment individually as well as in integrated manner shall be the under the scope of the Tenderer. It is the responsibility of the Tenderer to ensure proper installation and satisfactory performance of the plant and equipment supplied by them.

b) During site testing and commissioning, the Tenderer shall be required to formulate and operate a safety clearance system. The details of these systems are to be approved by the Purchaser / Consultant.

c) The Tenderer shall perform the performance guarantee test of all the equipment supplied by them within a period of 6 months from the date of successful commissioning.

2.24. Guarantee and Penalties

All the plant and equipment supplied shall be guaranteed for quality workmanship and compliance with the specified requirements for performance to deliver rated outputs. Non-compliance and non-performance shall be subjected to penalty to be paid by the Tenderer to the Purchaser. The details of guarantee and penalty stipulation shall be as described in Chapter-11.00 of this contract agreement.

2.25. Drawings & Documents for Purchaser's use and archives

The Tenderer shall submit requisite number of sets of all the final approved drawings and documents/ manuals for Purchaser's use and reference/record required during course of operation and maintenance of the plant. The details are described in Chapter 13.00.

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2.26. Codes and Standards

a) All plant and equipment supplied shall be in conformity with codes and standards as applicable and nationally/internationally acceptable for the type of equipment/system supplied. All codes and standards used/referred to shall be to their latest edition/version.

b) All equipment as may be necessary shall conform to the provision of statutory and other regulations in force, such as Indian Explosive Act, Indian Factories Act, Indian Petroleum Act and also those of State Government.

c) All electrical equipment supplied shall comply with the latest revision of Indian Electricity Rules and within the statutory requirement of the Government of India and State Government as regards safety, earthing and other provisions specified therein for installation and operation of electrical equipment.

2.27. Any contradiction between the provisions called for in the Technical Specification and other documents enclosed with the tender enquiry, shall be a matter of clarification to be sought for by the Tenderer from the Purchaser / Consultant. However, on any contradiction/difference of opinion/ambiguity arising during the course of tendering due to any unclarity on such account and not settled during the Tender stage, the interpretation of the Purchaser / Consultant shall be final and binding on the Tenderer.

2.28. Training

In totality, Two hundred (200) man-days training covering various functional areas like Boiler, STG, STB, C&I, Electrical, etc. at the works of the Tenderer/ Manufacturer are to be provided by the Tenderer. For details, refer GCC (Commercial Volume).

2.29. Exclusions Battery Limit

Tenderer shall clearly mention exclusions, if any and battery limit to further design by the Purchaser to make the system complete in all respect.

2.30. Defect Liability Period

Defect Liability Period shall be as per SBD.

**** End of Clauses ****

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3. SCOPE OF WORK AND BATTERY LIMITS

3.1. Scope of Work

Tenderer's scope of work shall include design, engineering, manufacture, procurement, shop painting, assembly, testing at manufacturer's works, inspection, packing, transportation to site, unloading and storage, preservation, handling at site, insurance, complete erection/ installation of mechanical, electrical, instrumentation and other associated works, pre-commissioning, commissioning, handing over and performance guarantee testing.

Civil and structural works including foundation of equipment shall be executed by the separate agency (appointed by Purchaser) under supervision of Tenderer. The plant and equipment shall be designed for safe and trouble-free continuous operation and with adequate maintenance facility as per latest modern engineering practices. All feedback design data / drawings for the equipment supplied, loading (both static as well as dynamic), outline drawings, details of embedment, equipment & piping layout with load data, assignment drawings shall be furnished by the Tenderer for preparation of civil & structural drawings by Purchaser/ Consultant. Tenderer shall also furnish their concurrence/ clearance on the civil and structural drawings prepared by the Purchaser/ Consultant.

However, Technological structure for the plant & equipment shall be supplied and erected by the Tenderer.

The scope shall also include obtaining of all necessary approval / statutory clearances from the concerned authority / agencies including IBR. However, Necessary official fees for the same shall be paid by the Purchaser for site activities.

The design, manufacture and performance of the equipment shall comply with the latest codes / standards.

The package covers mainly the following plant/ equipment/ system along with all their associated auxiliaries including technological structures and excluding Civil and Structural works on Discrete Turnkey basis:

i) 3 X 300 TPH mixed gas fired Boilers & auxiliaries
ii) 3 X 40 MW Extraction cum Condensing type STGs & auxiliaries
iii) 3 X 5000 Nm^3/min STBs & auxiliaries
iv) Circulating cooling water system including cooling tower, CW pumps, ACW pumps etc.
v) DM Water Plant
vi) Air Conditioning & Ventilation System
vii) Cranes, Hoists & Elevators
viii) Fire Detection & Alarm System
ix) Fire fighting System including hydrant, MVWS, HVWS, Inergen system, etc.
x) Compressed Air Facilities
xi) Emergency DG Set

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xii) Communication and IT networking
xiii) Laboratory Equipment
xiv) Associated Electrical System up to power evacuation including GIS
xv) Associated Control & Instrumentation

3.1.1 Mixed Gas Fired Boilers and Auxiliaries

Broadly each boiler shall comprise of but not limited to the following major items:

a) Boiler pressure parts consisting of evaporation system (steam drum with internals, boiler banks, water walls, headers, supply pipes, riser tubes, etc.), connecting pipes, superheaters with attemperator and economizer with necessary headers and connections.

b) Boiler integral piping with set of valves, mountings, instrumentation, etc.

c) Tubular air pre-heater comprising of air preheater tubes, tube sheets, casing, dampers etc. Tubular air pre-heater shall have 10% plugging margin.

d) Pipes / tubes with necessary supports and hangers, mountings, valves and fittings for steam generation system as per IBR including safety valves for drum and superheaters with silencer, main steam stop valve, non-return valve and start-up steam blow-off valve with silencers.

e) Boiler soot blowing system with drains, piping, valves, fittings and necessary accessories.

d) Boiler vents and drains.

e) Steam and water sampling system.

f) Draft system consisting of 2x60% electric motor driven F.D. fans, 2x60% electric motor driven I.D. fans with control system, including dampers, flue gas and air ducts, suction ducts, supporting structure etc. All controls and isolation dampers at inlet and outlet of fans including drives required for the completeness of the system shall ensure operational flexibility and on load maintenance of any of the equipment of air/ flue gas path. ID & FD fans shall have direct (resilient) coupling. VVVF drives shall be considered for I.D. fans.

g) Boiler insulation work and refractory work including material, fixing material for the equipment. All hot surfaces above 60 ^{0}C temperature shall be insulated. Asbestos is not allowed for insulation purpose.

h) Thermal insulation for steam pipes, hot air duct, flue gas duct, hot water pipes, steam drum, headers, air pre heater, etc.

i) Feed control station comprising of 2x100% and 1x30 % control valves with 1x 30% inching type motorized bypass valve shall be provided. All the upstream & downstream

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isolation valves shall be motor operated.

j) Four (04) nos. Boiler Feed Pumps shall be provided considering 2 working + 1 maintenance + 1 standby, multistage, electric motor driven. The capacity of each pump shall be suitable for 110% MCR of each boiler output including the spray water requirement of the attemperators and desuperheaters. This pump shall generate necessary head to overcome the system resistance and shall be able to supply feed water even under abnormal operating conditions. VVVF drives shall be considered for Boiler Feed water pumps.

k) Spray water line including valves, fittings, supports, etc.

l) Chemical Dosing System

Chemicals shall be dosed into the boiler water loop at appropriate points for control of boiler water quality. Two types of dosing systems shall be considered - the high pressure and the low pressure systems and these shall comprise of tanks for solution preparation, pumps and agitators with motors.

The H.P. dosing system for dosing phosphate solution comprising of metering tank with agitator mechanism, storage tank, two numbers (1 working + 1 standby) plunger type dosing pumps with AC motors through gears, 0 to 100% variable control range unit per boiler and pipes, valves etc. for chemical & water pipe line. All tanks, pipes, valves, etc shall be of stainless steel.

The L.P. dosing system for dosing hydrazine solution comprising of metering tank with agitator mechanism, storage tank, two numbers (1 working + 1 standby) plunger type dosing pumps with AC motors through gears, 0 to 100% variable control range unit per boiler and pipes, valves etc. for chemical & water pipe line. All tanks, pipes, valves, etc shall be of stainless steel.

m) One (01) no. common tri-flue chimney enclosed with RCC shell shall be considered for three nos. boilers. The chimney shall be complete with ladder, rack & pinion type elevator, platforms at various elevations, insulation work for flue can, aviation lighting, lightening arrestor, flue gas analysis system (CEMS), etc.

n) Boiler Firing System

Adequate number of burners with suitable HEA ignitors complete with actuators assemblies, transmitters, etc. for remote and local operation through BMS/ FSSS suitable for firing multi fuel gases. Gas burners and valves shall have suitable handling facilities. Common burner for LPG/ Propane shall be envisaged but proper isolation valves are to be provided in the two lines near boilers to avoid intermixing.

CBM/ Natural Gas, COG & LPG/ Propane burner system complete with all accessories for cold start up shall be considered by the Tenderer.

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Flame monitoring system.

Ignitor system.

Flame scanner.

Two (02) nos. Scanner Air Fans (1AC + 1DC) for flame scanners.

N_2 purging system for the burners.

o) Provision of on-line SOx, NOx and CO (Carbon Monoxide) monitoring system.

p) Portable handsets for CO (Carbon Monoxide) monitoring.

q) Furnace Safeguard Supervisory System (FSSS)/ Burner Management System (BMS)

A fully proven microprocessor/ PLC/ DCS based Furnace Safeguard Supervisory system/ Burner Management System with sequential fuel igniters, flame stabilization, etc. The system shall be suitable for BFG, BOFG, COG, CBM/ Natural Gas, LPG/ Propane gases for start up, normal/ abnormal operation and shut down.

r) Boiler blow down system including one number CBD tank and one number IDB tank with pipes, mountings, valves, fittings, boiler wash water neutralizing tank/ pit etc. for each Boiler. IBD and CBD tanks shall be fabricated from boiler quality plate.

s) Provision of one no. drainage tank common for three nos. boilers with 2x120% capacity pumps for initial boiler filling, with associated level controller. Provision for one no. direct boiler filling line by-passing pumping system shall also be considered for all the three boilers.

t) Complete piping system comprising of IBR and non-IBR pipelines including valves, fittings, accessories, etc.

u) BFG, BOFG, COG, CBM/ Natural Gas and LPG/ Propane gas piping from battery limit to the boiler burners with necessary U-seals, valves, fittings, drip pots in drain system, etc. shall be provided. Tenderer to note that nitrogen as well steam purging system (with interconnection), instrumentation etc. for all fuel gas lines in boiler area shall be considered in their scope.

v) For each Boiler isolation purpose, Tenderer shall consider U-seal + Goggle Valve (motorized) arrangement for pre-mixed BFG+BOFG pipeline and U-seal for COG pipeline. However, for isolation at battery limit, U-seal + Gate valve (motorized) shall be considered for BFG, BOFG and COG pipelines. Apart from above, any other valve in BFG, BOFG and COG pipelines fuel gas line shall be butterfly valve. For isolation at battery limit, ball valve (motorized) shall be considered for CBM/ Natural Gas, LPG/

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Propane pipelines.

w) Technological supporting structures comprising of supporting structures for boiler, economizer, air preheater, flue gas & air ducts, all pipes and all accessories including stairs, platforms, walkways, penthouse and roofing sheeting for proper operation and maintenance of all parts of the plant & equipment.

x) All the drains from equipment and piping to be routed up to the nearest drain channel of the plant.

y) Piping, valves, specialties including gaskets, nuts, bolts, washers, hangers/ supports/ secondary steel structures for all pipe supports within CPP battery limit.

z) Main steam pipeline from boiler superheater outlet to two nos. main steam headers and from main steam headers up to the individual steam turbine including non-return valve, motor operated main steam stop valve with equalizer at SH outlet of Boiler and inlet of steam turbine, orifices, flow nozzles. Flexibility analysis/ stress analysis of complete steam pipelines shall be under the scope of Tenderer.

aa) Feed water lines from discharge of BFPs to economizer inlet header comprising feed control/ drum level control station complete with motor operated valves, feed check valves and isolating valves before economizer and water injector system from boiler feed discharge pipe to desuperheater with necessary control, isolating valves, check valves, flow meter, etc. Flexibility analysis/ stress analysis of complete feed water pipelines shall be under the scope of Tenderer.

bb) Entire auxiliary steam for the boiler, water to chemical dosing system, soot blowing, chemical feed, sampling, instrumentation impulses etc. as required. Auxiliary steam pipe line for Boiler, with valves, fittings, supports, drains, steam trap, etc. including PRDS.

cc) Service air and instrument air piping, valves, fittings, accessories etc. from battery limit up to consumer points.

dd) All drains, vents etc. with valves, steam traps etc.

ee) Electrical System as per Chapter –05.00 of this Technical Specification.

ff) Control & Instrumentation as per Chapter –06.00 of this Technical Specification.

gg) Obtaining all necessary approval/ clearances from Regulations/ Statutory bodies as per Technical Specification.

hh) Drain & vent lines having pressure greater than or equal to 40 ata shall have double isolation valves.

ii) Flow measuring devices for main steam line and process steam line shall be provided.

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jj) One (01) no. Passenger Cum Goods Elevator of capacity 2T for each Boiler (total 3 nos.) and one no. Rack & Pinion Type Elevator for common chimney of capacity 500kg complete with associated auxiliaries, electrics, control & instrumentation shall be provided. Landing elevation of the elevators shall be decided by Tenderer during detailed engineering.

3.1.2. Steam Turbine Generators and Auxiliaries

Broadly, the major equipment and materials to be supplied with each STG shall include but not limited to the following:

a) Emergency stop valve with strainer, servo motor, control valves, nozzles, turbine exhaust to condenser complete with all integral accessories. Hydraulic Quick closing non-return valves and gate valve on bleed steam line for controlled/ uncontrolled extractions shall be provided. Safety relief valve shall be considered in controlled extraction line from STG.

b) Turbine supervisory, protection and governing systems.

c) Complete turbine integral piping, auxiliary steam piping including all valves such as isolating, regulating, non-return, etc. hand operated and / or motorized valve.

d) Motor operated/ hydraulically operated turning/ barring gear with provision for hand barring. DG back-up shall also be considered for turning gear motor. Motion feedback to DCS shall also be considered by the Tenderer.

e) Complete high-pressure lube/ control oil system comprising of two (02) nos. AC motor driven oil pumps (2X100%), one (01) no. DC motor driven emergency oil pump, main oil tank, emergency overhead lube oil tank, 2x100% capacity duplex type lube oil coolers, 2x100% capacity duplex type lube oil filters, one no. oil centrifuge along with necessary piping, valves, fittings, controls for each STG shall be provided. Oil centrifuge shall be sized for 1% of normal oil flow through lube oil circuit or 1000 LPH whichever is higher. Jacking oil pump shall be considered as per manufacturer's requirement. Two (02) nos. Jacking Oil Pumps for each turbine shall be considered out of which one shall be with DG back-up.

f) Lube oil system shall be as per manufacturer's standard considering the provisions laid down in the Technical Specification. Emergency overhead lube oil tank shall be sized for safe coasting down period of the Steam Turbine Generator. View glass in lube oil vent line shall be considered.

g) Gland sealing system including PRV system for steam supply and header pressure draining control system.

h) Turbine local gauge board.

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i) Generator with all integral accessories and supervisory instruments, excitation system including AVR shall be as explained in Electrical Chapter (05.00) of TS.

j) Governing system shall be as per details mentioned under Control & Instrumentation Chapter (06.00) of the TS.

k) Step down gear box between turbine and generator, if required.

l) Complete thermal insulation, cladding, acoustic enclosure etc. The noise level of turbine shall be less than 85 dBA at one meter distance from running equipment. Acoustic enclosure required in case of STG for meeting noise level specified as per Central and state pollution norms shall be included in the Tenderer's scope.

m) Steam turbine generator sole / base plates with all embedment details.

n) One no. controlled extraction of capacity 91 TPH from each STG shall be provided to meet the process steam requirement. Uncontrolled extraction for HP heater, LP heater and Deaerator shall also to be considered.

o) Tenderer shall provide separate turbine extractions for process steam and internal/ auxiliary steam consumption for CPP.

p) Condensate System for each Steam Turbine-Generator

Two pass surface condenser with CW inlet and outlet piping including valves, expansion joints, etc.

Vertical canister type Condensate extraction pumps 2 nos. (1W+1S) with drives.

Two nos. (1W+1S) multi stage independent steam jet air ejectors each 100% capacity and 1no. starting/ hogging steam jet air ejector of 100% capacity.

Condenser re-circulation control system with bypass arrangement.

Hot well level control system with bypass arrangement.

One (1) No. Gland Steam Condenser (GSC) and 2x100% (1W+1S) capacity GSC fans.

All integral piping, valves, drains, vents, fittings, etc.

All IBR / non-IBR pipe lines, vents etc.

On-line condenser back washing system for the STGs and one no. trolley mounted high pressure jet pump for STGs for off-line back washing.

Condenser air relief valve.

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All valves of condenser cooling water system including backwashing line valves shall be motor operated. In cooling water circuit all equipment shall have isolation valves at inlet and outlet besides header valves.

q) Electrical System as per Chapter – 5 of this Technical Specification.

r) Control & Instrumentation as per Chapter – 6 of this Technical Specification.

3.1.3. Steam Turbine Driven Turbo Blowers (STB) and Auxiliaries

Broadly, the major equipment and materials to be supplied with each STB shall include but not limited to the following:

a) Axial blower with variable speed control.

b) Complete suction air intake system comprising of suction air filter, suction silencer, suction damper, suction pipe, expansion bellow.

c) Complete discharge air system comprising of discharge silencer, non-return valve, isolation valves, expansion bellow, discharge pipe and discharge common header up to the battery limit. Isolation valves shall be motorized triple eccentric (metal to metal contact) butterfly valves.

d) Complete blow off system comprising of minimum 2x100% blow off valves, silencers, etc.

e) Anti surge regulators and suction / discharge air volume / Pressure regulators with constant pressure and constant volume control.

f) Anti choke control system comprising choke control valve and associated auxiliaries, as required.

g) Complete lubricating oil system and control oil system comprising oil tank, pumps, coolers, filters, centrifuge, emergency overhead lube oil tank, pipes, valves, fittings, strainers, nuts, bolts, gaskets, etc. common for steam turbine and blower.

h) Electro Hydraulic / Electric motor operated turning / barring gear with manual operation facility, if required.

i) Two (02) nos. Jacking Oil Pumps for each turbine shall be considered out of which one shall be with DG back-up.

j) All anchor bolts / foundation bolts, nuts, base plates with holding down washers, etc for equipment under scope of supply.

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k) Couplings between blower and steam turbine (without gearbox).

l) Complete thermal insulation, cladding, acoustic enclosure etc. The noise level of turbine shall be less than 85 dBA at one meter distance from running equipment. Acoustic enclosure required in case of STB for meeting noise level specified as per Central and state pollution norms shall be included in the Tenderer's scope.

m) Flexibility/ stress analysis of cold blast pipeline from each blower discharge to the takeover point of common header with fixed support.

n) One (01) no. cold blast blow-off system with control valve and silencer in the common cold blast header before TOP.

o) Steam Turbine for turbo blower shall be similar to the STG comprising of surface condenser, ejectors, gland steam condenser, turning gear, condensate extraction pumps, uncontrolled extraction for HP & LP heaters (except controlled process steam extraction and deaerator extraction), lube as well as control oil system and integral piping with valves, fittings, accessories, etc. complete in all respect.

p) Electrical System as per Chapter –05.00 of this Technical Specification.

q) Control & Instrumentation as per Chapter –06.00 of this Technical Specification.

3.1.4. Deaerators

a) Total three nos. deaerators with storage tank common for the three nos. boilers shall be supplied. The deaeraors shall be constant pressure type.

b) All integral piping, valves, drains, vents, fittings, accessories up to deaerator.

3.1.5. Pressure Reducing and De-superheating Stations

PRDS shall be envisaged in parallel to the extraction of STGs in order to meet the process steam requirement. Also, PRDS shall be envisaged to meet the auxiliary/ in-house steam requirement of CPP. Each PRDS shall comprise of control valve, by-pass motorized valve (inching type), isolation valve, de-superheating nozzle, safety valve with silencer complete with piping, fittings, accessories, etc.

3.1.6. Condensate Storage Tank

One no. condensate storage tank with necessary pumping arrangement shall be considered by the Tenderer based on the overall thermal scheme of the CPP.

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3.1.7. Balance of Plant

Complete balance of plant comprising of following systems/ facilities/ equipment shall be under the scope of Tenderer:

a) Circulating Cooling Water System comprising of CW pumps, ACW pumps, Cooling Tower, etc.
b) DM Water Plant
c) Heat Ventilation and Air Conditioning System
c) Cranes, Hoists and Elevators
d) Fire Detection and Alarm System
e) Fire fighting System including hydrant, MVWS, HVWS, Inergen system, etc.
f) Compressed Air System comprising of Air Compressors, Air Dryers, Air Receivers, etc.
g) 750 kVA Emergency DG Set (minimum rating)
f) Communication and IT networking

Details of the above systems/ facilities/ equipment are elaborated in the subsequent chapters/ clauses of this Technical Specification.

3.1.8. Miscellaneous Equipment/ System/ Facilities

a) Complete IBR and non-IBR piping system along with valves, fittings, accessories within the battery limit.

b) Flexibility/ stress analysis for steam and cold blast pipeline within battery limit. Tenderer shall furnish stress analysis report along with load data comprising of forces, moments & displacements on the piping supports.

c) Special lifting devices and special tools & tackles required for erection, testing, commissioning, operation and maintenance.

d) One no. quick raising type boiler maintenance scaffolding common for all the three nos. boilers to be supplied by the Tenderer.

e) Electric bolt heating equipment or hydraulic equipment for turbine and blower casing flange bolts.

f) Cleaning brush for heat exchanger.

g) All technological supporting structures including critical pipe supports, hangers, springs, restraints, anchors, saddles, brackets, etc.

h) All matching flanges, nuts, bolts, gaskets etc. for all the equipment supplied by the Tenderer.

i) All consumables such as lube oil, control oil, grease, chemicals and relevant consumables

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up to commissioning of the plant in line with SBD.

j) Commissioning spares in line with the SBD.

k) All relevant drawings/ documents required for safe and proper erection of the plant & equipment shall be supplied by the Tenderer. Tender shall also submit the assignment drawings for preparation of civil and structural drawings by Purchaser/ Consultant.

l) Erection, testing, commissioning of all equipment and material under scope of supply of the Tenderer.

m) Demonstration of Performance Guarantee parameters of the complete plant & equipment under scope of supply.

n) List of spares for 2 years normal operation & maintenance.

o) Laboratory Equipment as per Chapter – 4.8.

p) Electrics as per Chapter – 5.

q) Control & Instrumentation as per Chapter – 6.

r) Any other equipment/ item/ system but not mentioned above, however, required for completion of the system.

s) Dual headers shall be provided for common Main Steam Headers, PRDS, Auxiliary PRDS and Feed water system (common header at discharge of Boiler Feed Pumps).

t) One (01) no. vertical drilling machine, one (01) no. hand Grinder, one (01) no. vice, one (01) no. portable welding machine, two (02) nos. manual hydraulic trolley, one (01) surface table with V-blocks.

u) Training at at the works of the Tenderer/ Manufacturer.

3.2. Battery Limits

The battery limits for Tenderer's scope of work shall be as shown in the enclosed drawings. All utilities shall be provided as indicated below:-

a) Main Steam Pipeline

Entire main steam pipelines including drains, vents, steam traps, valves, fittings, accessories shall be under the scope of Tenderer. One HP steam pipeline shall be made available from CDQ boilers of Coke Oven Battery at the CPP battery limit. The same shall be connected with two nos. main steam headers of CPP with motorized isolation valves.

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b) Process Steam Pipeline

Entire process steam pipeline including PRDS, drains, vents, steam traps, valves, fittings, accessories shall be under the scope of Tenderer. Three (03) nos. process steam pipelines shall be terminated by the Tenderer at the CPP battery limit with following steam parameters:

Line # 1 for By-Product and CDQ Plant: 100 TPH, 11 - 13 ata pr. & 250 °C - 300 °C temp.
Line # 2 for RH-OB: 54 TPH, 16 - 18 ata pr. & 250 °C - 300 °C temp.
Line # 3 for balance consumers: 118 TPH, 11 - 13 ata pr. & 200 °C - 250 °C temp.

No process steam return has been considered in this Tender.

c) Auxiliary Steam Pipeline

Entire auxiliary steam pipeline including PRDS, drains, steam traps, valves, fittings, accessories shall be under the scope of Tenderer.

d) BFG, BOFG & COG

BFG, BOFG and COG shall be made available separately by purchaser at one point in CPP boundary. Necessary isolation with Gate Valve and U-seal shall be under the Tenderer's scope.

e) CBM/ Natural Gas and LPG/ Propane

CBM/ Natural Gas and LPG/ Propane shall be made available separately by purchaser at one point in CPP boundary. Necessary isolation valve shall be under the Tenderer's scope.

f) Feed Water

Entire Feed Water system including BFP, pipelines, valves, drains, vents, fittings, accessories shall be under the scope of Tenderer.

g) Industrial water

Industrial quality make-up water shall be made available to the Tenderer at only one point within 300m(approx) from circulating water pump house (distance tentative and shall be finalized during engg.) at a pressure of approx. 1.0 kg/cm2 gauge for the proposed Captive Power Plant. The centre line of the pipeline (MS) shall be 6.0m above the area ground level on common pipe trestle.

Tenderer shall extend the same from battery limit with an isolation valve and pressure gauge along with magnetic flow meter to their proposed systems for the entire plant and

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the Tenderer shall indicate the make-up water quantity requirement, pipe size, end connection, MOC of pipeline, etc. at the battery limit.

h) Drinking water

Drinking water shall be made available to the Tenderer at only one point at a pressure of 1.0kg/cm² within 300m(approx.) from circulating water pump house (distance tentative and shall be finalized during engg.) for the proposed Captive Power Plant. The centre line of the pipeline (DI - GI) shall be approx. 6.0m above the area ground level on common pipe trestle.

Tenderer shall extend the same from battery limit with an isolation valve and pressure gauge to their proposed systems/ shops, offices, toilets, drinking water platforms, water coolers, etc. for the entire plant and the Tenderer shall indicate the drinking water quantity requirement, pipe size, end connection, MOC of pipeline, etc. at the battery limit.

i) Fire-fighting water

Industrial quality water shall be made available to the Tenderer at one point i.e within 300m(approx) from circulating water pump house (distance tentative and shall be finalized during engg.) for the proposed Captive Power Plant. The top of the pipeline (carbon steel) shall be approximately 6.0m above the area ground level on common pipe trestle.

Tenderer shall extend the firewater pipeline from battery limit to the entire area.

j) Flue Gas

Entire flue gas exhaust system including Chimney shall be under the scope of the Tenderer.

k) Service Air, Instrument Air and Nitrogen

Service air of industrial quality, instrument air for pneumatic application and nitrogen for purging as well as pneumatic application shall be made available at one point near CPP. Interconnection of service and instrument quality air as well as nitrogen lines from TOP to each consumer including pipes, valves, fittings, accessories, etc. shall be under Tenderer's scope.

In addition to the above, dedicated compressed air facilities comprising of air compressors, air dryers and air receivers shall be considered by the Tenderer for supply of service as well as instrument quality air for this package.

l) Blow down Water

Blow down water of DM quality shall be taken to pre-treatment sump of DM Plant.

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Necessary pumps, pipes, valves, fittings, accessories, etc. shall be under Tenderer's scope.

m) Cold Blast Air

Common header of cold blast air from discharge of Turbo Blowers shall be terminated by the Tenderer at one point outside the CPP area with fixed support.

n) Drains

All drains connected with the individual equipment/ unit/ piping shall be terminated at nearest drain trench.

Gas condensate/ drains/ drips shall be disposed in the phenolic sewerage drain. This drain shall be connected to the RCC pit inside the CPP area.

o) Vents

All gas line vents shall be terminated 2.0 m above the boiler roof.

All steam line vents shall be terminated 2.0 m above the roof of boiler and power house building along with necessary sound attenuation/ silencer.

Take Over Points for all utilities and services shall have isolating valves and mating flanges within the scope of Tenderer.

p) Electrical System – Refer Chapter 5.

q) Control & Instrumentation – Refer Chapter 6.

3.3. Codes and Standards

All equipment, systems and works supplied shall comply with applicable latest statutes, regulations and safety codes as applicable in the state of West Bengal and India. All systems and equipment shall comply in all respects with the requirements of the latest editions of codes and standards applicable for proposed type of equipment and system.

It shall be the responsibility of the Tenderer to obtain the necessary approval of the concerned inspecting authority / Chief Inspector of Boilers for the design, design calculation, manufacturing, erection, testing, commissioning as called for under the Indian Boiler Regulations and any other applicable statutes. Necessary official fees for inspection/ approval shall be paid by the Tenderer at their works and by Purchaser at site. Design not meeting the stipulations of the codes and standards shall not be acceptable.

All statutory clearances for plant design, manufacturing and construction like IBR formalities, Chief Controller of Explosive, Electrical inspectorate, Tariff Advisory

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Committee etc. shall be obtained by the Tenderer. Purchaser as required shall provide necessary documents, as applicable for further fulfilling the obligation by the Tenderer. The final registration of the boiler shall be arranged by the Tenderer. However, following clearances shall be obtained by the Purchaser.

i) MOEF
ii) Aviation
iii) Pollution Control Board
iv) Factory Inspectorate.

All necessary documents and supporting engineering calculations required for the above clearances to be obtained by the purchaser shall be provided by the Tenderer.

Apart from various codes and standards mentioned below, Tenderer shall comply with other requirements of codes and standards and requirements mentioned in the Technical Specification for detailed design, manufacture, shop & site testing, etc.

Equipment/ Unit/ Facility	Codes
Boiler and Pressure Vessel	ASME Section VIII, IBR, NEPA, ASME PTC 4.0
Dampers	API 560, IS 800
Heat Exchangers	TEMA 'R', ASME Sec VIII Div 1, IBR, ASME PTC 12.2
Metering/ Dosing pumps	API 675 (Positive displacement pumps – controlled volume) and API 676 (Positive displacement pumps - rotary)
Centrifugal pumps	API 610
Lube oil System	API 614
Gear box	API 613 & AGMA
Coupling	API 671
Vibration Monitoring System	API 670
Structurals	IS 1893, IS 875 & IS 800
Piping	ANSI B 31.1/ 31.3, IBR
Fittings	ANSI B 16.9 / 16.5 / 16.11/16.25, ASTM A234
Valves	ANSI B 16.34/ API / BS, IBR
Tanks	API 650
Electrodes	AWS
Painting	IS/ Manufacturer's Standard
Turbo Blower	API 617
STG	IEC 60045-1

In case of any conflict between a statute/ regulatory like IBR Code and the equivalent

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applicable code/ norm, the former shall prevail.

Mandatory codes/ local regulations to be followed for safety, design, fabrication and operation of the plant shall be, but not limited to as follows:

- Petroleum Rules
- Static and Mobile Pressure Vessels (Unfired) Rules 1981 (Requirement for installation of Pressure Vessels for a storage in bulk).
- Indian Boiler Regulations & Act.
- Indian Electricity Act & Rules.
- Fire protection manual of Tariff Advisory Committee.
- State Pollution Control Board Regulations.
- Central Pollution Control Board Regulations.
- Chief Controller of Explosives Regulations.
- The Factory Act - 1948
- Fire Insurance Regulation
- Regulation by Chief Electrical Inspector
- Directorate General of Civil Aviation Regulation (DGCA)
- Directorate General of Mines & Safety (DGMS)
- Tariff Advisory Committee (TAC)
- Oil Industry Safety Directorate (OISD)

**** End of Clauses ****

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##

STEEL AUTHORITY OF INDIA LIMITED
IISCO STEEL PLANT (ISP) – 4.08 MTPA CS EXPN

TECHNICAL SPECIFICATION FOR CAPTIVE POWER PLANT
MAIN PLANT & BALANCE OF PLANT PACKAGE

##

DIVISION OF WORK	
LEGEND	
ISP	**IISCO STEEL PLANT/ IT'S REPRESENTATIVE**
CPP1	**PLANT & EQUIPMENT (TECHNOLOGICAL & BOP) SUPPLIER**
CPP2	**CONTRACTOR FOR CIVIL & STRUCTURAL WORK OF ENTIRE CPP(PURCHASER'S SCOPE)**
BD	**BASIC DATA**
BE	**BASIC ENGINEERING**
DE	**DETAILED ENGINEERING**
SUP	**SUPPLY**
ST	**STORAGE**
ERE	**ERECTION**
TEST	**TESTING**
COM	**COMMISSIONING**
PGT	**PERFORMANCE GUARANTEE TEST**

SL. NO.	PLANT/ UNIT	DESCRIPTION	BD	BE	DE	SUP	ST	ERE	TEST	COM	PGT	REMARKS
A	**Technological Package (Package - 1)**											
1.0	**Boiler & Auxiliaries**											
1.1		Boiler proper including drum, pressure parts	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.2		Air and flue gas ducts	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.3		FD Fans, ID Fans, Scanner Air Fans	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.4		Boiler Firing System including pipe, valves, fittings & accessories within Battery Limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.5		Technological structures including boiler structures, air & flue gas duct support	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.6		Chimney (except civil works)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.7		Civil works for Chimney	CPP1	CPP1	CPP1	CPP2	CPP2	CPP2	-	-		
1.8		Boiler Feed Pumps including feed control station	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.9		Chemical Dosing System (HP & LP)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.10		CBD & IBD Tanks	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	
1.11		IBR and non-IBR pipe lines including valves, fittings, accessories, etc. within battery limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.12		Piping Stress/ Flexibility Analysis	CPP1	CPP1	CPP1	-	-	-	-	-		
1.13		Critical Pipe supports viz. hangers, springs, saddle, anchor, bracket, etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.14		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
1.15		Thermal Insulation & Aluminium Cladding	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
1.16		Boiler & Chimney Elevators	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.17		Deaerators and CST	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
1.18		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-		Only dimensional & locational review under the scope of CPP1
2.0	**STG & Auxiliaries**											
2.1		Steam Turbine Generator proper	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.2		Surface Condenser	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.3		CEP	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.4		Turbine integral piping, valves, fittings & accessories	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.5		Lube and Control Oil System	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.6		IBR and non-IBR pipe lines including valves, fittings, accessories, etc. within battery limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.7		Piping Stress/ Flexibility Analysis	CPP1	CPP1	CPP1	-	-	-	-	-	CPP1	
2.8		Critical Pipe supports viz. hangers, springs, saddle, anchor, bracket etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
2.9		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
2.10		Thermal Insulation & Aluminium Cladding	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
2.11		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-		Only dimensional & locational review under the scope of CPP1
3.0	**STB & Auxiliaries**											
3.1	**Steam Turbine**											
3.1.1		Steam Turbine proper	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.1.2		Surface Condenser	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		

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SL. NO.	PLANT/ UNIT	DESCRIPTION	BD	BE	DE	SUP	ST	ERE	TEST	COM	PGT	REMARKS
3.1.3		CEP	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	
3.1.4		Turbine integral piping, valves, fittings & accessories	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.1.5		Lube and Control Oil System	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.1.6		turning / barring gear	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.1.7		IBR and non-IBR pipe lines including valves, fittings, accessories, etc. within battery limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.1.8		Piping Stress/ Flexibility Analysis	CPP1	CPP1	CPP1	-	-	-	-	-		
3.1.9		Critical Pipe supports viz. hangers, springs, saddle, anchor, bracket etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.1.10		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
3.1.11		Thermal Insulation & Aluminium Cladding	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
3.1.12		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-		Only dimensional & locational review under the scope of CPP1
3.2	**Blower**											
3.2.1		Blower proper	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	
3.2.2		Suction filter with silencer	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.3		Cold blast discharge system comprising of discharge silencer, non-return valve, isolation valves, expansion	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.4		Complete blow off system comprising of minimum 2x100% blow off valves, silencers, etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.5		Lube and Control Oil System	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.6		turning / barring gear	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.7		Cold blast pipelines including valves, fittings, accessories, etc. within battery limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.8		Piping Stress/ Flexibility Analysis	CPP1	CPP1	CPP1	-	-	-	-	-		
3.2.9		Critical Pipe supports viz. hangers, springs, saddle, anchor, bracket etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
3.2.10		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
3.2.11		Thermal Insulation & Aluminium Cladding	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-		
		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-		Only dimensional & locational review under the scope of CPP1
4.0	**Critical Piping**											
4.1		Complete steam piping including valves, fittings, accessories, etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
4.2		Complete condensate drain piping including valves, fittings, accessories, etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
4.3		Complete steam piping supporting structure within boiler island	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
4.4		Complete steam piping supporting structure within power house building	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
4.5		Cold blast piping valves, fittings, accessories within battery limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
4.6		Cold blast piping supporting structure within battery limit	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
4.7		Complete fuel gas piping including U-seals, seal pots, drains, valves, fittings, accessories within battery limit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
4.8		Fuel gas piping supporting structure within boiler island	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
4.9		Fuel gas piping supporting structure outside boiler island	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
4.10		Critical Pipe supports viz. hangers, springs, saddle, anchor, brackets, etc. for all critical piping	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
4.11		Piping Stress/ Flexibility Analysis	CPP1	CPP1	CPP1	-	-	-	-	-	-	
4.12		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
4.13		Thermal Insulation & Aluminium Cladding	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
4.14		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	Only dimensional & locational review under the scope of CPP1
5.0	**Water Supply System**											
5.1		Condenser CW Pumps	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
5.2		Aux. CW Pumps	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	

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SL. NO.	PLANT/ UNIT	DESCRIPTION	BD	BE	DE	SUP	ST	ERE	TEST	COM	PGT	REMARKS
5.3		SSF & Pumps	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
		Cooling Water Pump House (excluding civil work)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
		Civil work for Cooling Water Pump House	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
5.4		Cooling Tower (excluding civil works)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
5.5		Ciivil works for cooling tower	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
5.6		DM Plant (excluding civil works)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	
5.7		Ciivil works for DM Plant	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
5.8		ETP & recycle plant (excluding civil works)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
5.9		Civil works for ETP & recycle plant	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
5.10		Piping, valves, fittings & accessories	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
5.11		Pipe supports viz. saddle, brackets, etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
5.12		Fire Hydrant System	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
5.13		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
5.14		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	Only dimensional & locational review under the scope of CPP1
6.0	**Air Conditioning & Ventilation System**											
6.1		Air Handling Unit	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
6.2		Chilled water piping including valves, fittings, accessories, etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
6.3		Chilled water piping supporting structure within battery limit	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	
6.4		AC ducts including supporting structures	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
6.5		Ventilation fans	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
6.6		Ventilation ducts including supporting structures	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
6.7		Air washer units	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
6.8		Exhaust fans	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
6.9		Civil foundation	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	Only dimensional & locational review under the scope of CPP1
7.0	**Handling & Hoisting Facilities**											
7.1		Cranes	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
7.2		Hoists	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
7.3		Fork lift	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
7.4		Elevators (other than boiler & chimney)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
8.0	**Fire Protection System**											
8.1		HVWS & MVWS	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
8.2		Automatic Clean Agent System	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
8.3		Portable Fire Extingusher	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
8.4		Passive Fire Protection	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
8.5		Manual low expansion foam flooding system	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
8.6		Civil work	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	Only dimensional & locational review under the scope of CPP1
9.0	**Compressed Air Facility**											
9.1		Air Compressor	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
9.2		Air Dryer	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
9.3		Air Receiver	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
9.4		Pipe, valves, fittings & instruments	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
		Painting	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
9.5		Civil work	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	Only dimensional & locational review under the scope of CPP1
10.0	**Diesel Generator Set**											
10.1		DG Set	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
10.2		Day oil tank	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
10.3		AMF Panel	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
10.4		Exhaust stack	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
10.5		Supporting structure for exhaust stack	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
10.6		Civil work	CPP1	CPP1	ISP	CPP2	CPP2	CPP2	-	-	-	Only dimensional & locational review under the scope of CPP1

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SL. NO.	PLANT/ UNIT	DESCRIPTION	BD	BE	DE	SUP	ST	ERE	TEST	COM	PGT	REMARKS
11.0	**Laboratory equipment and instruments**		CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
12.0	**Commissioning Spares**		CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	
13.0	**Special tools & tackles**		CPP1	CPP1	CPP1	CPP1	CPP1	-	-	-	-	
14.0	**Control & Instrumentation**											
14.1		DDCMIS (SG-C&I, TG-C&I, TB-C&I, STATION-C&I & BOP Packages)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.2		Hardwired Control Panel	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.3		AI based Condition Based Monitoring System (CBMS) - TSI and VMS	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.4		Continuous Emission Monitoring System (CEMS)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.5		Process Gas Analysers	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.6		Steam and Water Analysis System (SWAS) for CPP and associated BOP Packages	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.7		Furnace and flame viewing system	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.8		Online early tube leak detection system	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.9		Online ambient hazardous gas detectors	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.10		Field Instrumentation (Transmitters, Temperature Elements with thermowell, Process Actuated Switches,	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.11		Flow elements and other instruments which require OEM or CPP1 for erection supervision	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.12		Regulating type Control valves and dampers with SMART positioners	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.13		All types of cables for Instrumentation usage	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
14.14		All C&I equipment erection material (transmitter boxes, LIE, cable trays, cable glands, junction boxes, impulse pipe/tube, fittings, fasteners, gaskets, structural supports, etc.)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
14.15		Calibration and Maintenance Equipment	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
14.16		Earthing System for C&I equipment	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1		
14.17		Furniture	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-		
15.0	**Electrics**											
15.1		33kV GIS	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.2		Generator Electrics along with Realy Panel, Control Panel, Synchronising Panel, DAVR etc.	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.3		Generator Transformers	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.4		Power Trnsformers (UT, ST, Emergency LBSS)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.5		Auxiliary/Distribution Transformers	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.6		Lighting Transformers	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.7		Power Hookup from TRT 33kV GIS (TRT GIS by Others) to 33kV GIS of CPP along with Synchronisation	CPP1 & ISP	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1 & ISP	CPP1 & ISP	-	
15.8		6.6KV HT Switchgears/HT Switchboards/HT LBSS	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.9		415V LT Boards/PMCCs/MCCs/PDBs/ACDBs	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.10		HT & LT Busduct	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.11		HT Motors for all drives	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.12		LT Motors including actuators for all drives	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.13		HT cables including jointing/termination kits	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.14		LT Power and control cables	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.15		Signal and instrumentation cables, special cables, screened cables, fire optic cables etc	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.16		SAS (Substation Automation System)	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.17		DC Battery and Charger, DCDB	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.18		DC motors and associated DC starter panels	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.19		UPS, Battery, UPSDB	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.20		FDA & FAP	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.21		Telecommunication	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.22		CCTV	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	

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SL. NO.	PLANT/ UNIT	DESCRIPTION	BD	BE	DE	SUP	ST	ERE	TEST	COM	PGT	REMARKS
15.23		Plant Earthing system	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.24		Plant Ligtning protection	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.25		Road/Street, Area, Building illumination system	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.26		LPBSs / LCPs	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.27		All Erection Materials/Hardwares required for erection of all electrical items/equipment under the scope of the package	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.28		Spares	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	
15.29		Special Tools and Tackles	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	CPP1	-	

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4. TECHNICAL SPECIFICATION – PLANT & EQUIPMENT

4.1. Technological Plant & Equipment

4.1.1. Mixed Fuel/ Gas Fired Boilers and Auxiliaries

4.1.1.1. Gas Fired Boilers

All the three nos. boilers shall be of natural circulation with single/ bi-drum, water tube, balanced draft, radiant type, suitable for outdoor installation and designed for firing BFG & BOFG as main fuel and COG, CBM/ Natural Gas and LPG/ Propane for initial startup, flame stabilization, support and as emergency fuel. The design of boilers shall be carried out considering different fuels/fuel combinations as mentioned in Clause 1.3.1. of Technical Specification.

Each Boiler rating and duty conditions

Sl. No.	Description		Parameters
1.	Steam flow at superheater outlet, TPH (BMCR)	:	300
2.	Steam pressure at superheater outlet, ata	:	90
3.	Steam temperature at superheater outlet, ^{0}C	:	525 °C +/- 5
4.	Feed water temperature, ^{0}C		230

4.1.1.2. Furnace & Boiler Pressure Parts

i) The furnace shall be sized to ensure complete combustion of the fuel within the proper furnace zone and at the same time it shall provide adequate heating surface to cool down the flue gases to suitable temperature at the inlet of superheaters in order to avoid possible surface fouling on superheaters. The furnace shall be adequately sized to ensure sufficient residence time and heat release rates within permissible values. The residence time for flue gases in the furnace shall be sufficient in order to ensure full combustion of BF gas. The furnace shall be adequately protected against possible explosions/ implosions.

ii) The furnace shall be designed to avoid direct flame impingement at any load on any part of the heat absorption surface. All heating surfaces shall be arranged to prevent accumulation of slag on the walls, burners, tubes, hopper duct.

iii) Firing system shall be designed to attain following purposes consistent with firing of multi fuel gases viz. BFG, BOFG & COG and supporting/ supplementary fuel viz. CBM/ Natural Gas and LPG/ Propane:

a) To maintain constant flame temperature as possible along the whole height of the furnace.

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b) To avoid the occurrence of the high local temperature near water walls (i.e. maintenance of maximum possible symmetry of the temperature zones in all horizontal sections of the furnace) as well as to secure as high a temperature gradient as possible between the control furnace zone and the walls. The burner area shall be provided with refractory lining to maintain the temperature in that area.

iv) The design and construction of furnace shall prevent any distortion of steel work due to thermal expansion and deterioration of insulation. The Boiler wall and buck stay construction shall be designed to provide intrinsic strength against explosion/implosion without permanent deformation.

v) The furnace design shall incorporate features to ensure freedom from undue erosion.

vi) The furnace shall be designed such that no film boiling occurs under any operating conditions. Towards this the Tenderer shall submit DNB (Departure from Nucleate Boiling) curves for circuits subjected to lowest circulation ratio, lowest mass flow and highest heat absorption. The ratio of steam and water at various points in the thermal circulation system of the Boiler shall be optimized in order to ensure maximum heat transfer. The piping system shall have blanking arrangement for completely isolating any boiler.

vii) NOx, SO_x & PM shall be limited to 100 mg/ Nm^3, 50 mg/ Nm^3 and <5 mg/ Nm^3 respectively in line with the guidelines of the State & Central Pollution Control Board.

viii) Boiler tube thickness shall be designed as per IBR guidelines.

4.1.1.3. Enclosure

The entire Boiler shall be constructed to form an air and gas tight envelop from air inlet to flue gas outlet to prevent infiltration of extraneous air into the combustion chamber and gas passes. In areas where welded wall construction is used, no skin casing is required but skin casing of a minimum of 12-gauge steel plate shall be used for all closures and behind all wide spaced tubes where refractory is used.

4.1.1.4. Boiler Casing & Framing

Provision shall be made in the Boiler casing and access platforms for convenient installation of the furnace inspection scaffolding furnished for maintenance and inspection and also the inter connection platforms/walkways with the adjacent unit/operating premises.

Suitable explosion vents/diaphragms shall be provided to avoid damage to the Boiler. Tenderer shall indicate in detail how such explosion occurrences shall be taken care of in the design offered.

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4.1.1.5. Access and Observation Openings

The Boiler shall be provided with adequate number of access doors and observation openings at different levels and various positions. Doors shall be provided to permit access to the furnace, superheaters, other enclosed pressure parts and any other area requiring access. All doors shall be hinged and air tight insulation of manhole opening with removable refractory bricks.

Design shall also include peep hole at all levels to facilitate observation of the furnace, including inside furnace of burners, ignitors, thermocouple connections and the burner flame.

All such openings e.g. manholes, peepholes, etc. shall have suitable approach platforms and stairs extended from the nearest platform level. This shall ensure easy and safe approach during operation and maintenance.

4.1.1.6. Water Walls

Furnace shall be made by membrane type water walls with seamless steel tubes construction having composition proved to give satisfactory operating life under the conditions to which they shall be subjected. Water wall headers shall be sized generously. They shall be provided with suitable openings for inspection and chemical cleaning. All headers shall be located outside the gas path. Water wall system shall be fed by downcomers/ supply pipes.

The Tenderer shall ensure that any imbalance of flow, in any case is not more than 0.02 times the average flow for headers in low temperature Zone. The water walls shall be constructed in such a way that welds in the High Heat Zone, shall be avoided, to the extent possible to minimize failures.

4.1.1.7. Drum

Steam generator shall be provided with single/ bi-drum. The drum(s) shall be of fusion welded construction with welds on hemispherical/ semi ellipsoidal dished ends designed as per the applicable regulation of Indian Boiler Regulations (IBR). The circumferential and longitudinal ligament efficiencies shall be as per IBR. The longitudinal and circumferential welds shall be properly heat treated and 100% radiographed and 100% ultrasonically tested during manufacture. Material of construction of boiler drum shall be SA516Gr70.

The steam drum shall be equipped with suitable moisture eliminators, screens and other necessary internals to ensure that the amount of dissolved solids carried over with the saturated steam leaving the Boiler drum do not exceed 0.02 ppm in the condensate steam sample when the total dissolved solids content in the drum do not exceed 20 ppm/specified value for the system supplied.

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The arrangement and fabrication of the drum internals shall permit easy removal and replacement through drum manholes. The fixing of internal fittings to the drum shall prevent their displacement during operation. Unless and otherwise specifically approved they shall not be welded directly to the internal surfaces of the drum.

The drum dished ends shall be provided with properly sized manholes and hinged manhole covers of forged steel secured by forged steel yokes and bolts. Suitable sampling connections shall be provided to facilitate collection of representative samples of boiler water from drum and of condensed steam from the saturated steam outlets.

All tubes or attachments to the drum shall be full strength welded or expanded.

Two (02) nos. safety valves at both end of the steam drum shall be provided.

All necessary nozzles and connections including steam outlets, safety valves, feed water inlet downcomers, blow down nozzles, drum level indicators, chemical feed, pressure gauges, vents and drains, sampling connections, manholes, saturated steam connection, acid washing connection, etc. shall be provided on the drum. The nozzles for welding to the drum shall be heat treated by normalizing. All nozzles shall be full penetration welds. They shall be ground flush with the internal diameter of the drum. Suitable and adequate area compensation shall be provided at the places of opening/nozzles in the drum. It is preferable to have multiple downcomers. All the feed tubes should be connected to steam separating devices, screen dryer.

Adequate number of level indicators and pressure & temperature gauges shall be provided but in no case the quantities shall be less than that specified in IBR to meet requirement of local and remote measurements. Drum metal temperature measurement is to be provided.

The independent sets of tapping points for level shall be used at both ends of the drum for remote control and measurement purpose in addition to local level gauge and Fireman floor panel gauges. Pressure tapping for local, remote measurement and control shall be provided by the Tenderer. Provision of additional tapping points shall be kept to cater for requirements during detail engineering stage.

4.1.1.8. Superheaters

The superheater shall be of a combination of convection and radiant type to ensure rated steam temperature at superheater outlet. Design shall take into account the variation of fuel and also combination firing.

Tenderer shall elaborate design features for preventing thermal stresses during start-up, shutdown and severe load transients. Adequate provision shall be made in the arrangement of support and spacers to take care of differential expansion of various

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components. Superheater supports exposed to hot gases shall be heat resisting material suitable for long service under operating conditions.

Maximum skin temperature to which tubes shall be subjected shall not exceed the oxidation limit as applicable to the material.

Spacing of superheater elements shall be selected such that spacing shall be larger in high temperature section. The transverse pitch of elements in heating surface shall be adequately provided depending upon the zone temperature.

The superheater shall be designed with the saturated and superheated steam headers outside of the boiler setting for maximum accessibility and tubes so arranged as to permit easy replacement/repair.

The total depth of SH tube banks shall be such as to keep the same within the radius/ range of the soot blowers for effective cleaning.

Superheater outlet temperature shall be maintained at specified value by attemperation from minimum 60% MCR to 100% MCR of the boiler by means of automatic control.

Spray system for attemperation consisting of valves, pipelines and accessories shall be adequately sized for the maximum requirement. Suitable electric/ pneumatic actuated valves shall be provided in the spray header, which shall close when unit is tripped to prevent any water leakage. Spray water for Superheater attemperation shall be taken from feed water header.

Arrangement of de-superheating shall ensure complete evaporation of spray water and avoid water carry over in the superheater. Inner removable lining shall be fitted in the attemperator. All control valves including bypass valves shall have isolating valves upstream and downstream with suitable drains for depressurization and on-line maintenance.

A suitable number of permanent thermocouples for use in observing tube metal temperature shall be installed. These thermocouples shall be wired to a point outside the furnace casing, terminated in a suitable terminal block. Necessary tapings to remote measuring and control instruments including performance test tapping points shall be provided in the headers. Sampling points with probes shall be provided for manual sampling as well as remote conductivity analyzers of saturated and superheated steam.

Thermocouple type retractable temperature probes (2 nos.) shall be provided at the superheater inlet to enable control the firing rate at start up so that the flue gas temperature can be contained within safe limit when there is no steam flow through the superheater tubes. The probe shall be interlocked to be retracted when the temperature of the flue gases exceeds the safe limit of operation of the probe.

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Adequately sized drain and vent lines with isolating valves shall be provided. All vents/relief/drains shall be suitably taken out of the operating premises through common/individual systems as considered necessary.

Safety valves shall be provided for superheater outlet header.

Electromatic impulse type safety valves shall also be provided.

The additional 5% space for any future increase in heating surface shall be provided in the gas path for Superheater.

4.1.1.9. Economizer Section

The economizer shall be arranged in sections and blocks with counter flow arrangement and be provided with plain tube elements, headers, connecting tubes, casing and accessories required for complete installation.

The economizer shall be of non-steaming type with provision for circulation of water while starting, if required. The flue gas velocity shall not exceed 20 m/sec. The economizer tubes shall be arranged to permit the installation of soot blowers. The design shall ensure elimination of water hammering in economizer and feed line during cold start-up.

The casing shall be gas tight and be provided with access doors for entrance to locations between each section of the economizer for inspection and easy replacement of tubes. All economizer headers shall be located outside the gas passes.

Maximum skin temperature to which the tubes shall be subjected shall not exceed the oxidation limit as applicable to the material.

Additional 10% space for any future increase in heating surface area shall be provided in gas path of economizer.

The tube thickness shall be designed as per IBR guidelines.

4.1.1.10. Gas Burners

The burners shall be of multi fuel type designed to fire mixed BFG & BOFG for normal period and COG, CBM/ Natural Gas, LPG/ Propane for start-up and during unstable period. The burners shall effectively and efficiently promote mixing of the fuel with the combustion air without relying on pressure drop to provide mixing.

The burners shall have latest design with low NOx features. Burners to be supplied shall have NFPA compliance.

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4.1.1.11. Air Heater

The Tenderer shall furnish tubular type air heaters. Capacity of each air heater shall be suitable to cater requirement of the Boiler under all operating regime and shall have 10% plugging margin.

The design of the air heater shall take care of problems of corrosion at low temperature end. The arrangement shall lend itself to easy removal and replacement of tubes.

Adequate heat transfer area of the air heaters shall be provided to have optimum efficiency. Flue gas temperature leaving the air heater shall be calculated keeping in view the acid dew point and consequent back-end corrosion. The design shall be such that the minimum cold end metal temperature of the air heaters shall be at least 10 ^{0}C higher than the acid dew point over the entire operating load range of the boiler firing. At low loads possibility of cold end corrosion shall be checked and suitable arrangement shall be made to prevent the same. Minimum design ambient temperature shall be taken as 9 ^{0}C.

Design of air and gas ducts to and from the air heater shall be of suitable design for even distribution of gas and air across the air heater at all loads.

Suitable access door for inspection, cleaning and maintenance shall be provided.

4.1.1.12. Draft System

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

The design of the ID fan shall take into account the following: -

(i) Suction effect of chimney to be neglected.

(ii) Adverse operating conditions such as excess air requirements, leakage of air heater, furnace and ducting and fouling of the heating surfaces.

(iii) Deterioration in the capability of the fans due to wear over extended periods of service.

The design of F.D. fan shall take into account the static pressure requirements without the use of velocity recovery section.

Sizing of the fans shall be based on the following margins:

F.D. Fan	Margin on flow rate	20%
	Margin on pressure	44%
I.D. Fan	Margin on flow rate	20%

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Margin on pressure 44%

The above margins shall be considered over and above the calculated figures corresponding to maximum duty condition including the leakage into the system and FD fan air inlet temperature of 50 ^{0}C. Calculations for the flow rate, pressure and motor rating for both I.D. and F.D. fans shall be submitted. ID and FD Fan motor rating shall be with 10% margin over the maximum shaft power requirement.

The F.D. and I.D. fans shall be capable of maintaining balanced draft condition in the furnace over the entire load range and should take in to account different types of gases fired in the boiler.

The draft system shall include flow measuring devices in the air system for flow measurement from FD fan and control with adequate number of tapping points. The Tenderer shall furnish the requisite different pressure versus flow characteristic curves for the air flow measurement device.

Fan bearing pedestals shall be provided with suitable pads to mount vibration sensors for monitoring the fan bearing vibration. Sensors and monitoring instruments shall also be provided.

The materials of construction of fan components shall be so chosen as to give long life and highest availability and to obviate frequent repairs and replacement of parts.

The fan blades shall be of streamlined aerofoil shaped section and designed to withstand temperature of 200 ^{0}C, high bending and axial load. A high strength alloy steel shall be used. RPM of ID fan should be 740 as far as possible.

Fan components shall be designed for torsional stresses of 3 times the normal full load motor torque at all speeds.

Pulsations shall be avoided by suitable design of fan and the connected duct work.

The fan shall be statically and dynamically balanced before shipment. Balancing of each fan shall be checked and adjusted at site, if necessary. 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 speed. The fan shaft shall be designed in such a way that the critical speed shall not fall below 125% of the operating speed.

Housing shall be designed, for the shut off head of the fan, ease of maintenance and access to the fan wheel or impeller. However, in no case the fan inlet boxes, diffuser and intermediate pieces shall be fabricated with sheets of minimum 6.0 mm thick for FD fan and a minimum 8 mm thick for ID fan. The casing shall be split to provide easy removal of the fan wheel or impeller for replacement and repairs. The sections shall have gasketed

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joints to ensure air tight sealing. Access doors shall be provided in each chamber, casing and diffuser.

The casing of ID Fans shall be made of carbon steel and casing volute chamber shall be provided with renewable carbon steel liners. ID fan impeller blades shall be provided with renewable high hardness wear liners. Drain connection shall be provided at the bottom most point of the housing.

Adequate number of duplex RTD's and temperature indicators shall be provided for remote and local monitoring of the bearing metal temperature of fans, motors, etc.

Base plate and foundation bolts for fan motor shall be made of cast iron or welded steel.

4.1.1.13. Forced Draft (FD) Fan

Each boiler shall be equipped with two (2) nos. (capacity 2 x 60%) Forced Draft fans. The forced draft fans shall be of constant speed, horizontal and centrifugal flow type with single end suction and inlet guide vane (IGV) control. The fans shall be designed to meet the service requirements specified. In particular, the Tenderer shall indicate the minimum load of the fan at which it can operate in parallel without knocking or bumping.

The flow control of fan shall be accomplished by inlet guide vane (IGV). The control drive furnished shall be complete in all respects including actuating and control link mechanisms.

Silencers shall be provided at the suction of the fans to limit the noise level as per pollution control norms. The F.D. fan suction shall be provided with rigid rodent and trash screen assembly and shall have suitable arrangement to avoid rain water from directly entering the fan. The rotor assembly shall be supported over a grease/ oil lubricated bearing assembly consisting of bearings adequately designed to take care of radial and thrust loads. All grease lubrication points shall be easily accessible. The variation in the pitch of blades shall be achieved by means of servo-mechanism incorporating suitable link mechanism.

The suction damper and discharge damper of FD fans shall be multi-Louver for Isolation, motor operated type. IGV shall be provided for control application for FD fans at the inlet of the fans. The IGV shall be operated by providing suitable electrical Actuators.

Backward curved/ aerofoil designs for FD fans are acceptable. However, design and material selected for fan blades shall meet the requirement specified in Technical Specification. Lubrication system design shall be as per Fan vendor’s design standard.

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4.1.1.14. Induced Draft (ID) Fan

Each boiler shall be equipped with two (2) nos. (capacity 2 x 60%) Induced Draft fans with VVVF drive. The fans shall be of centrifugal type, horizontal. The fans shall be designed to meet the entire service requirement specified. The control drive furnished shall be complete in all respect including actuating and controlling link mechanism. The range of control shall be such as to facilitate the draft regulation for the entire range of rated flow through the fan.

Motor operated Multi Louver Damper shall be provided at inlet of ID fans for Isolation purpose. Multi Louver Dampers shall be operated by providing suitable electrical Actuators. ID Fan outlet dampers shall be Guillotine type motor operated.

Backward curved/ aerofoil designs for ID Fans are acceptable. However, design and material selected for fan blades shall meet the requirement specified in Technical Specification. Lubrication system design shall be as per Fan vendor's design standard.

4.1.1.15. Oil Lubrication of Fans and Drives

Adequate lubrication system for FD/ ID fans shall be provided. The system provided shall be efficient and simple in operation and up keep. The system provided shall serve both the purposes of lubrication and cooling of bearings.

Sequential controls for the complete draft plant equipment in the Unit Control Board shall be provided. This shall include all equipment mounted, local instruments, sensors, switches etc. to meet the final requirements of sequential control scheme. The Tenderer shall also provide the instruments, controls, protection and interlock scheme annunciation required etc. together with write-up and interlock diagrams.

Each bearing shall be provided with an oil bath to prevent bearing damage in case of complete loss of plant auxiliary power when the fans must coast down without power. Fan bearings shall be provided with temperature elements and thermometers for bearing temperature measurement as stipulated elsewhere in the Technical Specification.

4.1.1.16. Ducts and Flues

All air ducts and wind box shall be fabricated from sheet steel not less than 5 mm thick and all flue gas ducts of 6 mm plate. All flue and air ducts shall be designed for 500 mm w.c. Duct shall be properly reinforced and of welded construction for gas and air tightness. Suitable supports, expansion joints and access doors with bolted and hinged covers shall be provided in all duct where required. Hangers for duct and connections to the supporting steel for ducts and hoppers shall be included. Ducts shall have bolted connections to equipment, expansion joints and access door frames. While designing hangers/supports adequate load must be considered. Required ladder/staging for maintenance work inside shall also be included. The velocities in ducting shall be

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optimally designed. Design shall ensure uniform distribution to various sections and prevention of accumulation at any point. Turning vanes, splitter plates etc. shall be used, if required to streamline the flow.

Design of duct work shall ensure freedom from vibration and noise. Vibration isolators shall be used for preventing transmission of vibration from adjoining equipment.

Ducting from I.D. fans to stack shall be done taking into account other service facilities, roads, pipe racks, trenches etc. The height of this duct shall be adequate to allow maintenance crane to pass below.

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

Expansion joints in BFG duct near burner shall be of SS. For air and flue duct expansion bellows shall be of metallic (CS)/fabric based on temperature with suitable corrosion and erosion resistant material. Internal sleeve plate shall also be used.

Provision shall be made in the gas ducts for taking of samples.

All hot air and flue gas duct work shall be insulated and the duct design shall include adequate fixing cleats for the purpose.

4.1.1.17. Dampers

Sufficient number of power operated dampers shall be provided. The dampers shall be suitably mounted to take care of boiler expansion without affecting its normal operation.

All dampers shall have provision for local manual operation from a gallery of floor level. The main isolating dampers shall be fitted with a locking device in the full closed positions. All necessary platforms and access ladders for damper operation shall be supplied by the Tenderer.

4.1.1. 18. Chimney

The flue gas from the boilers of CPP shall be vented off to the atmosphere through chimney. One (01) no. common tri-flue chimney enclosed with RCC shell shall be considered for three nos. boilers.

The chimney shall be complete with ladder, rack & pinion type elevator, platforms at various elevations, insulation work for flue can, expansion joints, aviation lighting, lightening arrestor, flue gas analysis system (CEMS), etc. The height of stack shall be minimum 90m. However, Tenderer shall fulfill the norms/ requirement of state and central pollution control board on emission.

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Design, engineering, supply and erection of chimney complete with flue can, ladder, rack & pinion type elevator, platforms at various elevations, insulation work for flue can, aviation lighting, lightening arrestor, flue gas analysis system (CEMS), structural supports, expansion joints, etc. shall be under the scope of Tenderer. Tenderer shall also provide the detailed design and construction drawings for the chimney RCC shell. However, the civil work of chimney shall be carried out by a separate agency to be appointed by Purchaser under the supervision of Tenderer.

4.1.1.19. Soot Blowing System

The Tenderer shall supply soot blowers for the boiler, furnace, superheaters and economizer complete with all piping and accessories, including control valves, control panels, motor control centre complete with starter and wiring. The system supplied shall be a combination of long retractable and wall mounted deslaggers, water lances and soot blowers as required for burning the specific gaseous fuels.

The steam used as the blowing medium for soot blowers shall be taken from superheater header or as per the manufacturer's practice. Steam for soot blowers shall be arranged without affecting the boiler rated output. Necessary valves to reduce this steam pressure to the pressure required with standby valves for the blowers shall be provided.

In the steam supply system, separate motor operated isolating valve shall be provided before and after the pressure reducing valve. Manually operated isolating valves shall be provided for isolation of each elevation of blowers. Adequate number of motorised drain valves shall be provided to facilitate warming up the complete piping before startup of soot blowing operation. Suitable bypass with orifice shall also be provided. Temperature detectors in drain line shall be provided to sense that warming up is adequate and for initiation of soot blowing.

The soot blower elements shall be automatic sequentially operated and controlled. The retractable blowers shall be located on both side walls of the boiler and each shall cover little more than half the effective width of the boiler, when fully extended in order to ensure thorough deslagging/cleaning.

Constructional features of the retractable soot blowers shall be such that they can be retracted even during emergencies such as drop in steam supply pressure, etc.

Electric drives shall be provided for all rotary and retractable soot blowers.

The Tenderer shall furnish drawings showing blowing coverage of the heat transfer areas for approval of the Purchaser/ Consultant.

The Tenderer shall also state the quantity and pressure of steam required for soot blowing purpose.

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One closed, floor mounted control panel for remote automatic sequential operation of all soot blowers complete with all necessary switches, indicators, selector switches, alarm etc. shall be furnished. The control shall be so designed that it shall permit operation of any group of soot blowers repeatedly in sequence as necessary and also shall permit omission of any soot blower(s) in a cycle. There shall be clear indication in the panel as to which blower in sequence has completed operation and which blower is in service. Suitable mimic diagram shall be provided with indicating lamps showing position of each soot blower.

All soot blowers shall be suitable for local operation over and above remote automatic sequential operation. Emergency hand crank shall be provided for each.

4.1.1.20. Blow down Tanks

The blow down and drain system for the Boiler shall be provided complete with CBD & IBD tanks to which all blow-downs and drains from the Boiler shall be led. The blow-down vessels shall receive blow-down from the steam drum, drain from waterwall headers, attemperator headers etc. The blow-down tank shall be designed to receive drains from auxiliary steam lines and also from deaerator tank.

The blow-down tanks shall be designed and fabricated as per the latest applicable requirements of ASME SECV III/ IS-2825 (with latest amendments) or approved equivalents. All the inlet connections to the above tanks shall be tangential and wear plates shall be provided to take care of erosion.

The tanks shall be of proven design, and shall not discharge free water from the vent. Stub connection, where required, shall be welded to the tanks. Necessary cooling water connection pressure gauge tapings with isolating valves, safety valves as required, shall be provided on the tanks. The blow-down tanks shall be provided with level indicators, as required. The tanks shall be provided with manhole openings of suitable size and the bolted doors shall be hung on hinges for easy manipulation. Suitable mating flanges for level switches shall be provided.

The piping to the tanks shall be adequately supported and braced so that it is free from vibration and noise. The pipe work shall be given a uniform gradient from the inlet to the outlet and to facilitate complete draining.

Drain valves and drain piping system of the blow down tanks shall be provided with a suitable loop pipe arrangement so as to maintain a minimum water level inside tanks. The drain shall be cooled and the cold discharge shall be terminated at the Purchaser's nearest drain pit.

Vents shall be so located that the vent can be taken safely up to and out of the roof of the Boiler so that the vented steam can be safely discharged to atmosphere away from walk

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ways and galleries and at the same time not damaging the adjacent properties.

4.1.1.21. Chemical Dosing System

In order to have proper and better control of Boiler water regime, Hydrazine and morpholine dosing system for removal of Oxygen and Phosphate dosing system for control of pH and hardness shall be provided.

Hydrazine along with Morpholine shall be dosed at the suction side of the feed pumps.

Phosphate dosing shall be provided for proper control of pH and hardness in boiler water. It shall be dosed at boiler drum.

4.1.1.22. Chemical Preparation Tanks

One no. HP (Phosphate) metering tank, one no. HP (Phosphate) preparation cum storage tank, one no. LP (Hydrazine and Morpholine) metering tank and one no.LP (Hydrazine and Morpholine preparation cum storage tank for each boiler shall be provided. Each tank shall be conical bottom, SS construction minimum 6 mm thick with min. working volume twelve hours requirement of all units. The tanks shall be complete with all required connections, level indicators, level; switches, hinged manhole cover, agitators of stainless steel (SS) construction with motor drive and 30 mesh SS baskets of minimum internal volume of 10 liters. All pipes, valves, fittings shall be of SS material.

The tanks shall be tested for leak-tightness by filling them full with water.

4.1.1.23. Dosing Pumps

2 x 100% capacity HP dosing pumps and 2 x 100% capacity LP dosing pumps for each boiler shall be provided. Both categories of dosing pumps shall be adjustable stroke, positive displacement type, all stainless-steel construction, complete with built-in recirculation type safety valve, drive motor, snubber type discharge & suction pressure gauges, base plates, foundation bolts, etc., as required. The capacity of each pump shall be adjustable between zero & maximum capacity. The discharge pressure shall be as per the requirement of HP & LP dosing system.

4.1.2. Steam Turbine and Auxiliaries

The steam turbine shall be of impulse reaction type, horizontal with extraction (one no. controlled extraction) cum condensing type. Emergency stop valve, suitable governor and adequate number of throttle valves of suitable disposition shall be provided on the turbine. Steam Turbines with controlled extraction should be capable for handling variable extraction flow requirement.

Each STG rating and duty conditions

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Sl. No.	Description		Parameters
1.	Generation Capacity, MW (TMCR)	:	40
2.	Steam pressure at ESV inlet, ata	:	85
3.	Steam temperature at ESV inlet, ^{0}C	:	515 °C +/- 5
4.	Generator Voltage, kV	:	11
5.	Extraction Steam Quantity, TPH	:	91
6.	Extraction steam pressure & temperature	:	To be decided during detail engineering
7.	Bleed steam pressure & temperature	:	To be decided during detail engineering

A self-contained oil system for lubrication of turbine bearings and for governing and regulation shall be provided. The oil system shall comprise of two (02) nos. AC motor driven main oil pumps (2X100%), one (01) no. DC motor driven emergency oil pump for lubrication in case of emergency, one (01) no. main oil tank, one (01) no. emergency overhead lube oil tank, 2x100% capacity duplex type lube oil coolers, 2x100% capacity duplex type lube oil filters, one no. oil centrifuge along with necessary piping, valves, fittings, controls for each STG shall be provided. There shall be two oil coolers, each of 100% capacity with changeover valve for changeover of one cooler while the other in operation. MOC of Lube Oil Cooler tubes shall be of SA249 TP316. Two oil filters, each of 100% capacity with changeover valve for cleaning / charging of filter element of one filter while other is in operation shall be provided. The oil filters shall be of use & throw type. One oil purification system of Alfa Laval make of suitable capacity shall be provided for online cleaning of oil. Polishing filter for purifier shall be as per vendor standard. One No. Centrifuge for the STG shall be provided and sized for 1% of normal oil flow through lube oil circuit or 1000LPH whichever is higher. Oil filter changing without pressure drop shall be ensured. One No. Emergency overhead lube oil tank with necessary piping, valves, fittings, controls, coolers, filters, etc. shall also be provided in the lube oil system. Emergency overhead lube oil tank shall be sized for safe coasting down period of the Steam Turbine Generator. Two (02) nos. Jacking Oil Pumps for each turbine shall be considered out of which one shall be with DG back-up. View glass in lube oil vent line shall be considered.

The lube oil piping material shall be as mentioned below:

Supply oil piping from MOT to bearing: Stainless Steel (SS 316)
Return oil piping from bearing to MOT: Stainless Steel (SS 316)
Complete control oil piping: Stainless Steel (SS 316)
Main Oil Tank: Stainless Steel (SS 316)
Emergency Overhead Lube Oil tank and associated piping: Stainless Steel (SS 316)

Labyrinth type packing gland shall be provided between stages of the turbine and ends.

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The glands shall be steam sealed. Steam from gland shall lead to gland steam condenser. Material of construction of tubes of gland steam condenser shall be Welded Stainless steel SA249 TP304.

The turbine shall be provided with electric motor driven/ electro-hydraulic turning gear with provision of hand barring. DG back-up shall also to be considered for turning gear motor.

Governing system shall be as per details mentioned under Control & Instrumentation chapter 06.00 of the TS. Excitation system including AVR shall be as explained in Electrical Chapter 05.00 of the TS.

Two numbers, two stages, twin element steam operated main ejectors with condenser each of 100% duty shall be provided. For start-up, separate starting ejector of 100% capacity shall be provided. Material of construction of tubes for Inter and After Condenser of all the steam ejectors shall be Welded Stainless steel SA249 TP304.

Flexible (Bellow) type exhaust hood shall be provided at the exhaust of each STG.

The turbine shall be equipped with surface type water cooled, twin pass design condenser. The condenser shall be provided with necessary fittings and mountings including motorized vacuum breaker valve and spring-loaded atmospheric relief valve. The condenser shell shall be of carbon steel and welded construction. MOC of condenser shell shall be SA516 GR70. MOC of Condenser tubes shall be of SA249 TP316. Hotwell storage capacity shall be 3 min between NWL and LWL. Hotwell material shall be carbon steel.

The cooling water inlet and outlet connections shall be provided at the fixed end of the condenser. Condenser shall have at least 10% margin for tube plugging. Condenser cooling water inlet and outlet valves shall be motor operated type.

There shall be 2x120 % capacity (1W + 1S) Condensate Extraction Pumps (CEP). Tenderer shall consider frequency corrections (47.5 Hz). The pumps shall preferably be vertical, centrifugal, canister type which shall be capable of delivering condensate from hot well to Deaerator.

Disengagement of the turning gear shall be automatic when the rotor speed exceeds specified limit.

The turbine shall be provided with suitable safety, protection & tripping devices.

All valves which may be subjected to vacuum/ negative pressure shall have suitable gland sealing arrangement / gland sealing with water.

Condenser CW I/L & O/L valve should be Double offset, Rubber seated, Flange Type with

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leakage class as per EN 12266-1 Rate A.

Uncontrolled extraction for HP heater, LP heater and Deaerator are also to be considered.

All piping, valves, fittings, integral piping, drains, vents, insulation work, supports, hangers, saddle, etc., required for the turbine and auxiliaries complete, shall be in the scope of the Tenderer.

Sl. No.	Equipment	Material of Construction	Remarks
1	Surface condenser tube	Welded SS SA 249 TP 316	Cleanliness factor 0.85 and hotwell storage capacity 2 min.
2	Gland steam condenser tube	Welded SS SA 249 TP 304	Fouling factor on air side/ water side : 0.0002 hr ^{0}C m^2/kcal. Cooling medium : condensate from condenser
3	Drain cooler tube	Welded SS SA 249 TP 304	Fouling factor on shell side/ water side: 0.0001/0.0002 hr ^{0}C m^2/kcal
4	LP/HP Heater tube	Welded SS SA 688 TP 304	U-type, horizontal orientation
5	Lube oil cooler tube	Welded SS SA 249 TP 316	Horizontal orientation
6	Air Cooler tube (Generator)	Welded SS SA 249 TP 304	Horizontal orientation

4.1.3. Steam Turbine Driven Turbo Blower

4.1.3.1. Steam Turbine and Auxiliaries

Steam Turbine for turbo blower shall be similar to the STG comprising of surface condenser, ejectors, gland steam condenser, turning gear, condensate extraction pumps, uncontrolled extraction for HP & LP heaters (except controlled process steam extraction and Deaerator extraction), lube as well as control oil system and integral piping with valves, fittings, accessories, etc. complete with all respect unless otherwise specifically mentioned.

Each STG rating and duty conditions

Sl. No.	Description		Parameters
1.	Steam pressure at ESV inlet, ata	:	85
2.	Steam temperature at ESV inlet, ^{0}C	:	515 °C +/- 5
3.	Bleed steam pressure & temperature	:	To be decided during detail engineering

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4.1.3.2. Turbo Blower & Auxiliaries

The turbo-blower shall be multi-stage, single shaft, horizontally split, axial type and without intercooler.

Each Blower rating and duty conditions

Sl. No.	Description		Parameters
1.	Cold Blast Discharge Flow, Nm^3/min	:	5000
2.	Cold Blast Discharge Pressure, ata	:	6.5

The blower shall have high efficiency over the required wide range of operation and suitable for continuous operation under the specified conditions and shall meet the most severe and fluctuating blast requirements normally encountered in the operation of modern furnaces. The blower shall be capable of smooth running with low noise level over its entire operating range and shall be absolutely free from thrust problems, vibrations, etc. The noise level shall not exceed the norms adopted internationally for such type of machines. A liberal factor of safety shall be allowed as regards to duty and mechanical design of the blower so that machine shall be capable of delivering the specified blast requirement. The critical speeds of the blower shall be sufficiently away from the working speed.

The casing shall be horizontal split type to allow easy access to the internal parts. The upper portion of the casing of the blower shall be equipped with necessary lifting lugs. The inlet and discharge branches shall be accommodated in the bottom half of the casing. Suitable arrangement to take care of casing expansion shall also be provided. Design and manufacturing code shall be API 617.

The duty points shall have to be selected is such a way that these should have sufficient margin from anti-surge and choke line.

Blower discharge valve shall be Triple Eccentric type Butterfly valve with zero leakage. The valve shall be provided with continuous duty electric motor. Check Valve (hydraulically assisted, counter weight type) shall be provided at cold blast discharge line of each blower

One (01) no. expansion joint with SS bellow designed for 100% of the rated flow shall be provided at discharge line of each blower.

“Venturi – type” flowmeter shall be installed at cold blast discharge line of each blower. Location of the venturi and blowers discharge temperature measurement systems shall be decided suitably to avoid errors and damage due to turbulent flow zone at blower discharge.

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The blower shall be provided with following controls and regulating devices and fitments:

a) Air Volume Regulator

Air volume control system shall be provided for adjustment of varying blowing rates and also this shall permit a large stable operating range at constant speed. The action of the volume-pressure regulator should not be sudden or with jerk but smooth and fast enough to meet the blast furnace requirement without causing any shock over the entire range of operation. The basic sensing impulse for the regulator shall be taken from the discharge air flow/ discharge pressure measurement. The working of blower shall be either controlled for constant pressure or constant volume. The regulating and control system supplied with the blower shall be such that to provide option of choosing either discharge pressure or air blast quality control.

The pressure and volume control shall be such as to achieve any pressure and volume flow within the ranges specified in this specification.

The blowers shall have state of the art control system including features of constant flow control, constant pressure control, stove filling feed control, surge control, inherent choke control, maximum pressure limit control etc.

b) Anti-surge Control Device

An anti-surge control device shall be provided to protect the blower against mechanical damage and process disturbance. This safety device has to act independently of any other control and shall automatically open the blow-off valve when the load fluctuations in the blast furnace may tend to cause the blower to enter into the surge zone. Two (02) Blow off valves (double port globe/ anti surge) of 100% capacity each shall be actuated automatically by electro-hydraulic actuator. The actually measured surge line and anti-surge control line should have adequate safety margin. The duty points shall be at least 15% away from the anti-surge line. There shall be constant display of current duty point and anti-surge line in flow Vs discharge pressure curve in the monitor. There shall be an alarm if the duty point enters in the margin area i.e. 15% from anti surge line.

Stainless steel blow-off silencer with internal splitters and vent pipe shall be provided. Silencer shall be installed outside blower building and supported by steel structures.

The Turbo Blower shall also be provided with anti-choke controller of suitable type comprising hydraulically actuated choke control valve and associated accessories as per manufacturer's standard.

The location of blow off stack shall be decided based on safety considerations. The release of air into the atmosphere shall be upwards so that no air is sucked inside the filter house. The silencer shall be provided by the Tenderer. It's design, loads, forces &

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moments etc. shall be furnished by the Tenderer during detail engineering to the purchaser for providing supporting structure.

c) Suction Air filters

The suction air filter shall be provided separately for each blower. Each blower shall require two sets of air filters placed on the opposite walls of the inner chamber of the filter room. Atmospheric air shall enter the individual filter room through individual suction air stack/ louver and pass through the filters and enter the turbo blower through suction silencer. The capacity of each filter shall be 60% of the total air flow requirement of each blower and each filter room shall thus have two sets of filters. Filter media should be 100% synthetic & hydrophobic. The filters shall have sufficient reserve capacity which shall be indicated in the tender. The filter house shall have access doors, access stair, explosion and implosion doors. All supports, fixing and anchor bolts, nuts, washers, base frame, platform, ladder, panel, supporting frames structures of the filter element/ panel should be of anti-corrosive material. Each filter set shall be provided with manometer to read the pressure drop across the filter element so that these can be taken out for cleaning. The filter unit shall be of continuous duty and online self-cleaning type with automatic filter elements clean-up system through pulse jet cleaning arrangement. Filter house should be with double stage filtration (including pre-filtration).

20% margin in each suction air filter over maximum flow of each turbo blower to be provided.

The filter classification for pre-filtration shall be F9 of EN779/ ISO 16890-1. The filter classification for second stage filter shall be as per EN 1822:2009/ISO 29463:2017 latest edition.

d) Silencer

Appropriate type of silencers shall be supplied in suction and discharge pipelines. The silencers shall also be provided on safety/ atmospheric exhausts of blow off line from the blower. The expected noise levels from the machine with silencer and also without silencer shall be indicated in the offer. The blower casing including suction pipeline shall be acoustic insulated in addition to thermal insulation so as to contain the noise level within the limits specified in national and international norms.

e) Suction Air Intake

Atmospheric air shall be sucked-in-through a self-supporting steel stack resting on air filter house/ structure. Air intake shall be provided with a weather cowl to prevent the entry of rain water and other extraneous matters. Suction air pipe shall be provided with a suction and damper before entry to the blower. Suction air ducts of steel construction with

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supports shall be provided by Tenderer for each blower. Expansion bellow/ compensator joint inlet shall also be provided by the Tenderer for each blower.

f) Lubrication and Control Oil System

Self-contained oil systems for lubrication of turbine and blower and gear box bearings and also for control regulation shall be supplied for each turbo blower set. The system shall comprise of (i) AC motor driven main oil pump, (ii) AC motor driven auxiliary oil pump of full capacity with atmospheric startup system in the event of oil pressure dropping or in the event of failure of main oil pump, (iii) DC motor driven emergency oil pump. An appropriate automatic interlocking system shall be provided to achieve the operation of various oil pumps in a sequential fashion as desired for the safety and protection of the machine. Oil tanks of adequate capacities with all necessary fittings/ accessories and motor driven vent blowers (oil mist fans) shall be provided. For lube oil system two oil coolers each of the cooler being sized for 115% of maximum requirement with transfer valve for cooler change over during operation shall be supplied. Twin oil filters, each of the filter screens being sized for 110% of maximum requirement with transfer valve for filter change over during operation and pressure loss indicator as well as alarm PDIAH shall be provided for lube oil and control oil system separately along with oil purification system (oil centrifuge) of adequate capacity for on line cleaning of the oil. An emergency lube oil overhead tank shall be provided. Emergency oil system for lubrication oil shall be adequate for both blowers & turbines.

The lubricating oil system shall be designed strictly as per API 614. The total oil system including pipes, valves, fittings, tanks, strainers etc. shall be of stainless steel. Use & throw type filters are to be provided for Lube and Control oil system.

g) Bearings

Suitable bearings with housing and oil forced lubrication for the turbine, gear box and blower shall be provided. A combined journal and tilting and thrust bearing shall be provided to take-up the axial thrust of the blower proper.

h) Emergency Tripping Devices

Adequate facilities shall be provided for emergency tripping of air blower due to surging of blower, low lube oil pressure, excessive vibration, axial displacement etc.

i) Turning Gear

The Turbo Blower shall be provided with Electro Hydraulic / electric motor operated turning gear with manual operation facility. DG back-up for turning gear motor shall also be considered by the Tenderer.

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j) Sole plate / base plate, Anchor bolts etc.

All required sole plates / base plates, fixing and anchor bolts, nuts, washers, base frame, levellig screws, packer plates and shims, bolt box for foundation etc. for blowers, turbine, gear box (if any) and their auxiliaries shall be provided by the Tenderer.

k) Piping, Valves and Fittings

Steam turbine driven blower and auxiliaries shall include all steam, condensate, oil, air, water, vents, drains and cold blast piping complete with valves, fittings, supports insulation as required for the system within the terminating points defined elsewhere in the specification and generally as indicated but not limited to the following:-

i) All pipelines including pipes, fittings, valves, nuts, bolts, gaskets, washers, etc. required for oil system.

ii) Suction air pipeline from suction intake to inlet of blower, blow-off pipelines and cold blast air discharge pipelines from blowers up to the battery limit with pipes, valves, fittings bellow compensators, nuts, bolts, gaskets, washers etc. and supports.

iii) Cooling water supply and return lines with pipes, fittings, valves, nuts, bolts, gaskets, washers etc. from the cooling water supply mains to lube oil coolers and condenser and other auxiliaries of the blower unit and back to return mains.

iv) Drains, vents and other miscellaneous pipelines of all the units of the system. All drain pipelines are to be terminated at the designated trench/drain. All the vent pipelines shall be terminated at outside building 2 m above the highest point of the building roof and direction so as not to damage/ infringe the surrounding building/ structure.

v) Blow off pipelines at the cold blast discharge pipe header shall be complete with blow-off valves, silencers, expansion bellow, compensators, etc. The exhaust lines leading to atmosphere shall suitably be terminated and left in directions such as not to cause any damage to building structures nor face towards building wall.

vi) Steam condensate, steam + air, integral pipe lines in between ESVs and Gland steam condensers (just before Deaerating heater) including supply of pipes, valves, fittings, C&I, supports, insulations etc.

4.1.4. Process & Auxiliary Steam System

PRDS shall be envisaged in parallel to the extraction of STGs as detailed below in order to meet the process steam requirement. Also, PRDS is envisaged to meet the auxiliary/ in-

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house steam requirement of CPP. Each PRDS shall comprise of control valve, by-pass motorized valve (inching type), isolation valve, de-superheating nozzle, safety valve with silencer complete with piping, fittings, accessories, etc.

a) PRDS # 1 (2X50%)

Upstream Steam Pressure & Temperature – 90 ata pr. & 525 °C temp.
Downstream Steam Quantity – 136 TPH (each stream)
Downstream Steam Pressure & Temperature – To be decided by the Tenderer

b) PRDS # 2 (2X50%) for By-Product Plant and CDQ Plant

Upstream Steam Pressure & Temperature – To be decided by the Tenderer
Downstream Steam Quantity – 50 TPH (each stream)
Downstream Steam Pressure & Temperature - 11 to 13 ata pr. & 250 °C to 300 °C temp.

c) PRDS # 3 (2X50%) for RH-OB and EVC

Upstream Steam Pressure & Temperature – To be decided by the Tenderer
Downstream Steam Quantity – 27 TPH (each stream),
Downstream Steam Pressure & Temperature - 16 to 18 ata pr. & 250 °C to 300 °C temp.

d) PRDS # 4 (2X50%) for balance consumers

Upstream Steam Pressure & Temperature – To be decided by the Tenderer
Downstream Steam Quantity – 59 TPH (each stream)
Downstream Steam Pressure & Temperature - 11 to 13 ata pr. & 200 °C to 250 °C temp.

e) Two nos. (1W+1S) PRDS and dual header with interconnection and sectionalizing valves for auxiliary steam requirement for STGs and STBs shall be as per OEM's requirement.

Process steam shall be made available by the Tenderer at the CPP battery limit with following steam parameters:

Line # 1 for By-Product Plant and CDQ Plant: 100 TPH, 11 – 13 ata pr. & 250 °C – 300 °C temp.
Line # 2 for RH-OB - EVC: 54 TPH, 16 – 18 ata pr. & 250 °C – 300 °C temp.
Line # 3 for balance consumers: 118 TPH, 11 – 13 ata pr. & 200 °C – 250 °C temp.

4.1.5. Flexibility Analysis

Thermal flexibility/ stability and stress analysis calculations shall be carried out by the Tenderer to determine the forces, moments, and displacement for the relevant pipeline within the scope of Tenderer. Tenderer shall submit the node point wise load data (force, moment,

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and displacement) for further engineering by the engineering consultant.

4.1.6. Thermal Insulation for Equipment & Pipelines

All hot surfaces including pipes, ducts etc. carrying media above 60 ^{0}C shall be properly insulated. Also the differential temperature shall be maximum 20 deg C. The insulating material shall be chemically inert and remain so in the event of getting saturated with moisture. The design shall ensure satisfactory fixing of the insulation. The outer covering of the thermal insulation shall be finished with aluminium cladding.

The design of insulation material shall conform to following standards or approved equals as applicable:

IS:9842-1994	:	Specification for preformed fibrous pipe insulation.
IS:8183-1993	:	Specification for bonded rockwool
IS:7413-1990	:	Code of practice for application and finishing of thermal insulating material.
IS:737-1991	:	Specification for Al-cladding
IS:3150-1992	:	Specification for stitching wire

4.1.7. Piping, Valves & Fittings

a) Dual headers shall be provided for the Main steam (common header of Boilers), PRDS, Auxiliary PRDS and Feed water system(common header at discharge of Boiler Feed Pumps).

b) The valves shall be cast steel/ forged steel body with trim of ASTM A276 material suitable for the intended design pressure and temperature conditions as per ASME B16.34. The ends shall be butt/ socket welded type. The valve rating required for the application shall be adopted and not as per size.

c) All matching pieces/ flanges for terminal equipment shall be supplied.

d) The line strainers shall be Y-type with cast steel body and 50 mesh SS screen. Necessary blow-off connection with plug shall be provided.

e) On line filter after the tank shall be provided for removing any suspended matter arising while preparing the Hydrazine solution or Phosphate solution which may have suspended solids. The capacity shall be as per the requirement. The filters shall be self-cleaning type and the size shall be less than 50 microns.

f) Each of the HP & LP dosing system shall be provided with one electric hooter to be installed on local control panel. The 'Accept' push button shall operate from the level switch provided on the corresponding tank. The hooter tone for HP & LP system shall be different to enable distinction.

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g) All pipes, valves and fittings shall be made from tested quality materials and hydrostatic tests at shop at 1.5 times the design pressure shall be done.

4.1.8. Boiler Feed Pumps

4.1.8.1. The pumps shall be of horizontal centrifugal type supported in such a manner as to permit free expansion both axially and radially whilst maintaining alignment. The boiler feed pump shall be subjected to reasonable forces and moments from main pipe work. Therefore, the terminal connections of pump shall be designed accordingly.

4.1.8.2. Pump Casing

a) The casing shall be of suitable design to withstand any possible thermal shock and high pressure and constructed of materials specifically selected to prevent erosion and corrosion.

b) There shall be four numbers (2W+1S+1M) Boiler feed pumps common for the two (02) nos. working boilers. Tenderer shall consider frequency corrections (47.5 Hz). The capacity of each pump shall be suitable for 110% MCR of each boiler output including the spray water requirement of the attemperators and desuperheaters. The capacity of the boiler feed pumps shall be decided during detail engineering. All the boiler feed pumps shall be of ring section type. The casing shall have vents and drains with priming connections with valves. Necessary insulation cleats shall be provided in the casing.

c) The clearances between rotating and stationary parts where high pressure differential exists (Wear rings of impellers, balancing device, cylindrical surfaces and seal surfaces) and the gap between impeller periphery and diffuser vanes volute. All these clearances affect pump efficiency as well as pump reliability. The closer the clearances, the higher the efficiency but in most components, reliability is lower i.e. seizure and internal breakage is more possible.

4.1.8.3. Shaft

The shaft shall be of tested forging accurately machined and ground. The material specification and its heat treatment as well as particulars of thermal treatment proposed to minimize distortion during manufacture shall be stated. Shafts should withstand the stresses set up when the pump shall be started quickly. Shaft-size should be so selected that full driver output can be easily transmitted without excessive deflection, vibration, distortion or whip. The total shaft deflection of the BFPs to be supplied by the Tenderer shall be 80 microns.

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4.1.8.4 Impellers

The impellers shall be accurately machined, finished to close tolerance and installed individually on the shaft giving special consideration to prevent recirculation between shaft and impeller.

The first stage of inlet impeller should be specially designed to provide most favourable conditions free from cavitation even during transient/suction condition. Each impeller shall be balanced individually and entire rotor assembly shall be statically and dynamically balanced.

The rotor shall be designed so that its first critical speed in air or water is well above the operating speed. Shaft sleeves of hardened wear resistant material shall be provided at all points of wear. They shall be firmly secured and keyed to the shaft. The material and design shall be such that no internal leakage occurs between shaft and sleeves. The axial thrust of the rotor shall be carried by appropriate type of balancing device and external oil lubricated thrust bearing fitted at the outboard end of the pump with integral journal bearing housing. No axial thrust shall be transferred to the electric motor & hydraulic coupling at any condition of operation.

4.1.8.5. Shaft Seals

Shaft seals shall be of mechanical type. Stuffing box should be so designed that easy replacement of the mechanical seal is possible.

4.1.8.6. Bearings

Each pump shall be equipped with forced oil lubricated babbitt lined sleeve bearings The sleeve bearings shall be horizontally split type. The thrust bearing shall be of sufficient size to carry the maximum unbalanced load in either direction due to any emergency operating condition like the non-operation of the balancing device etc. Temperature sensing elements shall be provided for bearing metal temperature indication and thermometers with alarm contacts shall be provided for bearing oil drain.

4.1.8.7. Lubrication

a) Each pump set shall be provided with a complete pressure lubrication system of sufficient capacity for both pump and drive motor, consisting of oil pump, sump tank, water cooled oil cooler, duplex oil filter, level indicator, sight flow indicator, thermometers, relief valves, Pressure regulators and necessary valves, all interconnected piping and accessories. The oil pump shall be driven by the feed pump shaft and all parts of the system shall be mounted as an integral part of the feed pump assembly. Provision shall be made to ensure continuity of oil supply even on reverse rotation of feed pump.

b) In addition, a standby electric motor driven lubricating pump shall be provided including

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the motor drive and pressure switch. This pump shall come into operation automatically whenever the normal lubricating system pressure drops below a predetermined setting.

c) Required electrical interlock shall be provided for safe and continuous operation of the lubricating oil system, including supply of pressure switches for automatic pump start, trip and alarm interlocks.

d) Provisions of pressure lubrication, if necessary, at the time of coasting down of the feed pump and drive in case of A.C. power failure, shall be also provided.

4.1.8.8. Base Plate

The base plate for each pump shall be of rugged fabricated steel construction reinforced with heavy ribbing. Suitable drip lips shall be provided all around the base plate with necessary tapped drain at the lowest point. Structural dynamic analysis shall be carried out along with seismic analysis of complete base plate and equipment train.

4.1.8.9. Suction & Discharge Nozzles

The pumps shall have top suction and discharge nozzles with raised face flanged ends of appropriate pressure class and provided with necessary reinforcements to withstand the forces and moments transmitted from connected pipes and arrangements to eliminate leakage.

There shall be common inlet and outlet header for boiler feed pumps. The suction nozzle design pressure shall be different from design pressure of casing at discharge side.

4.1.8.10. Strainer

Each boiler feed pump suction pipe shall be provided with permanently installed strainer. Isolating valves shall be provided for each suction strainer. If necessary, an additional strainer may also be temporarily installed on the pump suction nozzle with provision for quick replacement.

4.1.8.11. Coupling

Adequately sized spacer, extension or other approved type flexible couplings shall be used between the pump and the drive. Coupling shall have adequate permanent lubrication arrangement and shall be provided with safety guards.

4.1.8.12. Axial Thrust Balancing Device (Hydraulic)

a) A suitable method of hydraulic thrust balancing shall be supplied. The balancing drum shall be designed to balance pump axial thrust. Drum design shall be relatively long so as to reduce pressure/ liner unit and thus reducing rate of wear.

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b) It is proposed to pass on the balancing chamber leak off connection to the deaerator / BFP suction. A flow measuring arrangement shall be provided in the balancing leak off line to monitor the condition of wear in balancing device. All necessary local instruments including leak off flow indicator with alarm contact, valves and fittings required for safe operation of this system shall be provided.

4.1.8.13. Material of Construction

Each pump shall be constructed with the following materials. Materials given are, however, indicative only. The Tenderer shall supply equivalent or better materials with suitable heat treatment as per the standard of the manufacturer for similar duty.

Part		:	Material
a)	Base plate	:	Structural Steel
b)	Casing	:	Forged Steel
c)	Shaft	:	ASTM-A-276, Type 410
d)	Impeller	:	ASTM-A-296, Grade CA-6NM
e)	Diffusers	:	ASTM-A-296, Grade CA-6NM
f)	Wearing ring	:	ASTM-A-276, Type 420
g)	Balancing drum	:	ASTM-A-276, Type 420
h)	Balancing head	:	ASTM-A-276, Type 420
i)	Shaft sleeves	:	ASTM-A-276, Type 420
j)	Bearings :		
	i) Radial	:	Sleeve Type (Babbit metal)
	ii) Thrust	:	Tilting pad type (suitable material)
k)	Pressure bolting	:	Chrome-Molybdenum steel

Between rubbing faces a minimum difference in hardness of 50 BHN may be maintained.

4.1.8.14. Low Load Protection – Recirculation System

a) A minimum flow recirculation arrangement shall be provided along with each pump. Capacity of the devices shall be adequate such that even under closed condition of the pump discharge valve the temperature rise of the pump and flow induced vibrations are within acceptable limits. However, minimum recirculation flow shall not be less than 25 % of full design flow.

b) For reducing the bypass pressure to a value suitable for feeding the deaerator, each pump shall be provided with suitable multiple stellited orifice plates of 11-13% chrome steel with companion flanges for installation in the recirculation piping and adequately designed for prolonged continuous service. Each recirculation line shall be taken independently to deaerator storage tank. An orifice with a small pressure drop shall be

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fitted in each line near the deaerator to prevent any flashing in the pipeline. The recirculation valve shall be of multiplug type such that pressure reduction takes place in the valve itself.

c) The recirculation system shall also be sized from consideration of minimum flow to be maintained through the pump from high axial thrust consideration.

d) The recirculation control valves shall be designed to open in the event of air or power failure. Signal lights shall be mounted in the local panel/remote control room to indicate open or closed position of the valve.

4.1.8.15. Pump Warming Up Device

The scheme and layout shall include arrangement for keeping the pump warmed up to facilitate quick cutting in of the standby pump. The warm up flow through the standby pump shall be drawn from the discharge header after the isolating valve and returned to the suction header or led to a flash tank after flowing through the standby pump. All valves, pressure reducing devices and instruments required for this shall be provided. By this arrangement differential temperature between top and bottom and differential temperature between pump top and Deaearator water shall be maintained within 10 to 15 ^{0}C at all conditions.

4.1.8.16. Drive Motor

a) The drive motor shall be selected such that a margin of at least 15% is provided over the power required at the rated condition of the pump. It should also be checked that when one pump alone operates with control valve stuck open, the power requirement is lower than the drive power. Detailed calculations for sizing of motors shall be submitted to the Purchaser/ Consultant for approval.

b) Pump shall be equipped with VVVF drive to meet the operating range of capacities specified and required.

c) The drive motor shall also be adequately sized to cover the pump power, coupling and power for connected auxiliaries such as lubricating pump, etc.

4.1.8.17. Instrumentation & Control

a) All local instruments necessary for safe operation of all the equipment shall be supplied and arranged in a local gauge board.

b) One pressure gauge shall be provided at the discharge and suction of each pump. The common suction header shall be provided with one pressure gauge and one temperature gauge. Differential pressure gauge across suction strainer, temperature indicators for drive end/ non-drive end bearing of pump shall be provided.

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c) The gauge board shall also include flow meters, signal lights, relays, etc. required for recirculation system.

d) Vibration measurement for amplitude and velocity.

Details of Control & Instrumentation are indicated in the respective Chapter (06.00) of the TS.

4.1.9. Deaerators

4.1.9.1. Design Requirement

Deaerators shall be capable of operating satisfactorily at boiler MCR loading. The Deaerators shall be designed to meet the feed water requirement of Boilers.

4.1.9.2. Horizontal direct contact spray-cum-tray type single deaerating vessel with a horizontal storage tank shall be provided. Spray type Deaerator like Stork or equivalent is also acceptable. Spring loaded nozzles for spray control shall be provided for guaranteed operation of the Deaerator for the flow range from 100% to 30% without water hammering. The trays shall be provided for final stages of deaerartion and shall be of rigid clamped type.

4.1.9.3. The storage tank shall hold sufficient feed water for about 30 minutes between normal operating level and minimum operating level (low level) at BMCR.

4.1.9.4. The dissolved oxygen content at the discharge from the Deaerator shall not be more than 0.005 cc/litre in the boiler feed water at all loads, upto and including the rated capacity. Deaerator shall also remove even traces of any dissolved gases such as CO_2, likely to be present in the condensate / feed water. The operation of Deaerator shall be stable and free from vibration, water hammer when subjected to pressure decay which may occur at full load trip out condition of the turbines and during the interval required for change over to the alternative steam source.

The Deaerator shell and storage tank may go under vacuum during certain abnormal conditions and Deaerator and storage tank shall be designed accordingly.

4.1.9.5. Suitable ladder, platform and hand railing for access to various parts of the deaerating heater shall be provided. For the storage tank one support leg shall be fixed and other shall be of sliding type to take care of expansion.

4.1.9.6. Materials and Construction

Following materials of construction shall be used for Deaerator :-

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a)	Shell and heads	:	A 516 Gr 70/ A 285 Gr C or equivalent quality.
b)	Spray Nozzles	:	304 Stainless steel
c)	Trays	:	304 Stainless steel
d)	Tray supports	:	304 Stainless steel
e)	Internal bolting	:	304 Stainless steel

f) All metal parts in contact with non-condensable vapour shall be of Type 304 stainless steel.

4.1.9.7. Following minimum connections shall be provided:

a) Perforated pipe connection of suitable size for steam supply/ DM water make up.

b) Connections on the tank for boiler feed pumps/ leak offs/ recirculation lines/ stand by pump for spray water.

c) Drain connection on the storage tank with motorized valve and drain pipe to the basement level.

d) Suitable overflow connections on the storage tank with pneumatic valve and pipe.

4.1.9.8. Instrumentation & Mountings

a) Thermometer pockets and thermometers on the storage tank, deaerating section, condensate inlet, feed water outlet from the Deaerator water storage tank, steam inlet, etc.

b) Pressure gauge and relief valves to conform with the code requirements.

c) Air release valves.

d) Water level gauge / Illuminated two (02) nos.

e) Level switches / Level controllers and other instruments mounted on separate stand pipes with isolating valves and provision for initial filling, vent and drain connection.

4.1.9.9. Condensate Storage Tank

One no. condensate storage tank shall be provided in the CPP. The common condensate header at the outlet of Steam Turbo-blowers as well as the condensate line at the outlet of the STGs shall be connected to the inlet of the condensate storage tank.

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There shall be 3X120% capacity (1W+1S+1M) condensate transfer pumps to supply condensate to the deaerators. DM make-up water required for the CPP shall be connected to the condensate storage tank with a line to common drainage tank. Material of construction of the condensate storage tank shall be SA516 Gr70. Condensate Transfer Pump shall be equipped with mechanical seal.

4.1.10. Piping System and Insulation

4.1.10.1. General

Drawings indicating the layout of pipe work shall be prepared by the Tenderer mainly in line with the approved flow diagrams and equipment layouts and shall be submitted for the Purchaser/ consultant's approval. These drawings shall indicate the position of all hangers, supports, guides, restraints and anchors, all drain and vent connections and the positions of all adjacent pipes. All piping system shall be arranged to allow adequate slope in the direction of flow, except where otherwise approved by the Purchaser/ Consultant. At the point of drainage, drain pockets of ample size and approved construction as per respective codes shall be fitted.

The valve rating required for the application shall be adopted and not as per size.

4.1.10.2. Design of Pipes

Depending upon the applicable pressure, pipe schedule shall be selected. The details and need of stress analysis to be carried out for piping shall be mutually discussed & agreed with the Tenderer during detail engineering stage.

The density and thickness of insulation for various pipes shall be considered by the Tenderer for carrying out the weight analysis of the piping system. The general technical specification for thermal insulation shall be same as indicated in this specification. For pipes, which are subjected to acid pickling and / or hydraulic testing the additional weight of the fluid is to be considered as well.

All piping shall be routed avoiding interference with other pipes considering thermal movement, insulation thickness for both the pipes, hangers, supports, electrical cable trays, ventilation, ducting, structure members and equipment.

All high temperature lines shall be provided with expansion markers with scales at certain hanger locations, as decided by the Purchaser/ Consultant. The Tenderer shall guarantee and prove during trial run, after a few cycles of operation, that the hot and cold movements at the expansion markers are within reasonable limits and also are compatible with the values as may allowable and acceptable to the connected plant and equipment.

The percentage inaccuracy of cold to hot pipe movements (anticipated by the tenderer) from predicted values to actual value shall be indicated with proper reasoning for

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acceptance. If the errors exceed the acceptable limits, necessary adjustments and rectifications shall be carried out by the Tenderer till the above requirement is fulfilled and exhibited by the stress analysis without extra cost to the Purchaser.

Maximum design velocity of fluids through piping shall take into account surge phenomenon, erosion and minimum pressure drop of fluid in lines. The recommended velocities in pipes for various fluids are indicated below:

Recommended Velocities in Pipes

Name of Fluid	Recommended Velocity, m/sec
Main Steam	50 to 65
Auxiliary Steam	20 to 40
Boiler feed water	2.5 to 4
Main Condensate	1.5 to 2.5
Compressed air	10 to 12
Fuel oil	0.5 to 1
Cold Blast Air	20 to 30
Flue Gas	20
Cold Air duct	20
Hot Air duct	18
All water (except mentioned above)	0.6 to 2

Recommended velocities for Fuel Gas Pipelines

(A) Coke-Oven Gas:

Sl. No	Nominal Pipe Dia (mm)	Gas Velocity, m/sec (maximum)	Remarks
1	1000 and above	10	Pipe dia shall be selected as required near the connection with consuming units/ valve station of consuming units.
2	500 to below 1000	5-8	
3	Up-to 450	3-5	

(B) Blast Furnace (BF) Gas and BOF Gas:

Sl. No	Nominal Pipe Dia (mm)	Gas Velocity, m/sec (maximum)	Remarks
1	Above 3000	25	Pipe dia shall be selected as required near the connection with consuming units/ valve station of consuming units.
2	2500 to 3000	22-23	
3	2300 to 2400	20	
4	2000 to 2200	18	
5	1500 to 1900	15	

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6	1000 to 1400	10	
7	500 to below 1000	6-8	
8	Up-to 450	4-6	

(C) Medium Pressure & High Pressure Gases:

Medium	Pressure Range (kgf/cm2 g)	Gas Velocity, m/sec (maximum)	Remark
CBM/ Natural Gas/ LPG/ Propane	Up to 3	8	Pipe dia shall be selected as required near the connection with consuming units/ valve station of consuming units.

Above velocities are for the approximate calculation. Final size shall be determined after pressure drop calculation of the respective pipeline.

Size of pipe, if required shall be increased to meet the pressure requirement at consuming end.

Actual design velocities shall be determined by the Tenderer. However, they shall be conservative and submitted along with the pressure drop calculations, pipe sizing, and pipe thickness selection etc. for approval of the Purchaser / Consultant.

All piping shall be identified by means of an approved colour strips and by adequate lettering, conveniently spaced.

No pipe work shall be laid in trenches carrying electrical cables.

All pipes segments shall be self-draining to have as few drain points as possible. For this dead pocket shall be avoided and all horizontal pipe runs shall be so sloped that throughout the cycle of thermal movements of pipe the slope remains towards the drain point.

Pipes shall not be less than 20 mm bore unless authorized by the Purchaser/ Consultant except that for C&I impulse piping which shall be as per C&I specifications.

The Tenderer shall supply all thermowell stubs and all instrument impulse piping and fittings including the root valves, as required by the flow diagrams. Any additional tapping required during detail engineering for instrumentation along with root valves shall be supplied without any extra cost. Two root valves shall be supplied on all impulse piping where the operating pressure 40 ata and above. The root valves shall be supplied without any extra cost. For more details on C&I piping, refer C&I specification.

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Air release and drain branches shall be provided wherever necessary and arranged so that the drains and air release valves are located for ease operation. Extended spindles shall be provided, if necessary, for remote manual operation.

Drains / vents of water and steam systems with operating pressure 40 ata and above shall be provided with two isolating valves in series. All steam / hot water vents and safety relief valve discharge pipes shall be routed up to building roof tops to be suitably taken out away from working premises. Exhaust to atmosphere shall be protected against infall of rain water.

The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to all valves and other piping accessories required for operation and maintenance. Layout drawing shall indicate valve orientations and availability of access to valves and specialities.

Overhead piping shall have a minimum vertical clearance of 2.0 metres above walkways and working areas and 6 metres above roadways unless otherwise approved by the Purchaser/ Consultant.

All costs for obtaining approval of the Chief Inspector of Boilers for pipes coming under the purview of IBR shall be borne by the Tenderer including final certification. All welding procedures, weld annealing records, shop and field inspection data sheets and all certificates covering piping systems coming under the jurisdiction of Indian Boiler Regulations (IBR) and other applicable codes shall be furnished by the Tenderer to the Purchaser and the Chief Inspector of Boilers in approved forms.

Unless otherwise specifically mentioned, all pipes shall be designed for the maximum pressure and temperatures to be encountered in worst condition of working, including a pump running at shut-off head, a safety / relief valve on related equipment / line blowing at set pressure with full discharge capacity, etc. as applicable.

The piping layout shall be developed by the Tenderer on the basis of approved flow diagrams and equipment layouts as may be finalized for the plant and system supplied. The adequacy of the pipe sizes and all materials shall be ensured considering maximum flow and terminal pressure requirement. The pipe size and pressure drop calculation shall have to be submitted to the Purchaser/ Consultant for getting approval before finalizing the pipe sizes.

4.1.10.3. Condensate Drain Arrangement for Fuel Gases

i) In distribution gas network, distance between two consecutive drain points should be located generally at a distance of 100 meters. However, in no case it shall exceed 150meters.

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ii) Pipes for condensate removal should be of at least 80 mm diameter.

iii) Each low point of gas pipeline shall have individual drain pot/ seal pot. One seal pot never be connected to other low points on same gas pipeline or on different gas pipeline in near-by location.

iv) Minimum height of the water seal in the condensate seal pot shall exceed the maximum working pressure of gas by 500 mm, but this height in no case shall be lower than 2000 mm.

v) Gas condensate/ drains/ drips shall be disposed in the phenolic sewerage drain. This drain shall be connected to the RCC pit inside the CPP area.

4.1.10.4. Purging system of low pressure fuel gas system:

i) Low pressure fuel gas system for such as BFG, COG and BOFG shall be equipped with both Nitrogen and Steam purging system.

ii) The connection of nitrogen and steam pipeline to the gas pipeline, in general shall be done by means of flexible hose which shall be connected only during the period of purging. After completion of purging, hoses shall be disconnected, and isolation valves installed in purging points shall be closed.

iii) Location of purge gas inlet points shall be such that entire section of piping can be purged with minimum dead space.

iv) For purging. Low pressure Nitrogen and low pressure steam shall be used. In case of high pressure availability of steam and nitrogen, pressure reduction shall be done.

v) In low pressure fuel gas lines, Nitrogen and steam purging can be done, in general through the purging points connected on condensate drain line.

vi) For each isolated pipe segment where purging would be done shall have provision to install pressure Gauge (at least 2 Nos) at ground level location so that gas header pressure can be continuously monitored during purging.

vii) COG line purging system shall have drains at suitable location to remove tar/naphthalene during steam purging.

viii) N_2 purging system of gas lines should have remote operable isolation valves.

4.1.10.5. Bleeders/ Vents

i) Bleeders shall be provided on all the gas handling devices and pipelines for purging and venting any section of the gas pipeline.

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ii) The bleeders/ vents of pipelines carrying same or different fluids are not allowed to be combined into one/ common bleeder. There must be individual and dedicated bleeder for each gases/fluids at a single point.

iii) The bleeders shall be taken above the gas pipeline or above roof of the building by at least 4 m, but not lower than 12meters from the ground level. Bleeders on shop roofs shall be located away from roof monitors.

iv) Bleeder/ vents shall be provided for purging / venting any section of the pipeline. Bleeders shall be located generally at all high points in the piping system. Bleeder / vents shall also be provided at downstream / upstream of isolating devices & U-seals.

v) Bleeders shall be located at all high points (i.e. in between two consecutive condensate drip points) in Low Pressure Fuel gas piping system. Bleeder / vents shall also be provided at downstream / upstream of isolating devices & U-seals.

vi) In other gas piping system, vents may be provided at interval of about 200-300m pipe run. However, locations of bleeders shall be analyzed with respect to the location of purging points so that no gas pockets can be formed during purging and venting.

vii) In low pressure fuel gas pipelines vent lines shall have Gate root valve along with DN15 sampling line isolated with CI type plug valve. For other pressurized fuel lines, both root valve and sampling valve shall be of Ball type.

viii) All vents shall discharge at a safe height into atmosphere. The vents shall be above the operating floor / platform for vent valve or roof of the building 4m, but not lower than 8 meters from the ground level.

ix) All vents shall have T piece/cowl with bird screen at the top. For isolation of bleeder/vent pipe flanged gate valve of rising stem type shall be provided. Sampling points (DN15) below isolation valve with lubricated taper plug valve shall be provided in the line to monitor gas samples at the time of purging.

x) Recommended sizes of bleeder / vent pipes corresponding to gas pipe diameter are indicated below:

Recommended Sizes of Bleeder / Vent Pipes

DN (mm)	Bleeder pipe dia. DN (mm)		
	Low Pressure Fuel gas	CBM/ Natural Gas /Propane/ LPG	Other services like Steam, N2
20	-	20	15
25	-	20	15
40	-	25	15

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DN (mm)	Bleeder pipe dia. DN (mm)		
	Low Pressure Fuel gas	CBM/ Natural Gas /Propane/ LPG	Other services like Steam, N2
50	50	50	15
65	50	50	25
80	50	50	25
100	50	50	25
150	50	50	25
200	50	50	50
250	50	50	50
300	50	50	50
400	80	80	50
500	80	80	50
600	80	80	50
700	100		
800	100		
900	100		
1000	150		
1100	150		
1200	150		
1300	150		
1400	150		
1500	200		

4.1.10.6. Material Specification, Size and Rating

Design temperature and material for IBR pipes, valves, fittings, specialities etc. shall be selected as per IBR only. However, as general guide line, the pipe material is indicated below.

Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes and are inside the insulation of high temperature pipes shall have similar materials as the pipes concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

The ratings for various piping, valves, fittings etc. shall be dependent on system design pressure & temperature as per the relevant code. The Tenderer shall select suitable rating of a particular piping class for a piping system and design the piping system accordingly.

Corrosion allowance of 1.5 mm for steam pipe lines and 2.0mm for water pipe lines are to be considered while selecting the pipe thickness for interplant piping.

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Material Specification of Pipes

Service	Design Temperature, ^{0}C	Material
Steam	Below 410 410 to 510 510 to 538	ASTM A106 Gr B ASTM A335P11 ASTM A335P22
Main Steam Header	525 +/-5	ASTM A387 Gr. 22 Cl. 2
Feed water including drains / vents	230 deg C	ASTM A106 Gr. B Seamless
Condensate including drains & vents	As per proposed system	ASTM A106 Gr. B Seamless
Instrument air	As per proposed System	IS : 1239 Part I Medium/ IS : 1978 St 25 seamless – hot dip galvanised.
Service Air	As per proposed system	IS : 1239 Part I Medium
Drinking water	As per proposed system	IS : 1239 Part I Medium, G.I.
All other water	As per proposed system	IS : 1239 Part I Medium/ IS : 3589.
CBM/ Natural Gas/ LPG/ Propane	< 60 ^{0}C	ASTM A106 Gr. B / SA 516 Gr. 70
BFG/ BOFG	< 60 ^{0}C	Up to DN 150 – IS1239 Black DN 200 to DN 750 – 3589 Gr. 330 DN 800 above – 2062 Gr. B
COG	< 60 ^{0}C	Up to DN 600 - ASTM A53 Gr. B Above DN 600 - IS : 2062, Gr.B (Plate shall have with Copper Content 0.25 to 0.35 %)
Cold Blast Pipeline	250 ^{0}C to 300 ^{0}C	SA 516 Gr. 70

4.1.10.7. Fabrication of pipes & Fittings

Except where otherwise specified, all piping shall have butt welded connections with a minimum of flanged joints necessary for maintenance. All high-pressure steam valves and accessories shall have welded connections. Where flanges are adjacent to welded fittings, weld – neck flanges shall be used.

Branches will, in general as per IBR for IBR piping and may be formed by welding. Pipe

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bends and tees shall be truly cylindrical and of uniform section. All welded branches shall be reinforced where needed as per the applicable code/ regulations.

All the pipe bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots and corrugations. A cross - section through any bent portion of the pipe shall be true in diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning the minimum thickness of bend shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per ANSI B31.1/ manufacturer's standard.

Piping shall be fabricated in the shop in the largest practicable sections to minimize the number of field weld joints. The choice of field welds joint location shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas shown on the design and reference drawings.

The ends of pipe and welded fitting shall be bevelled according to details shown in the relevant piping code/ IBR.

Entire fabrication procedure shall be as per applicable code/ IBR.

4.1.10.8. Steam and Feed Water Pipe Work

High pressure piping shall be manufactured from hot finished, seamless steel tubes.

The Tenderer shall make provision for branches for steam purging and chemical cleaning. All such branches are to have flanged connections. Blank flanges shall also be provided.

All branch connections shall be designed with due consideration to both reinforcement and compensation. Where forged steel tees are used, they shall be a similar to the adjacent pipe work. They shall match correctly the bore of adjacent pipe work and shall be proportioned so as to avoid stress risers. The whole of the high-pressure system shall be joined by welding and the use of backing rings shall be avoided as far as possible. However, for main steam piping consumable insert rings shall be used.

All low-pressure steel pipe work shall be joined by means of an approved type of butt-welded joint. Branches shall be welded into pipes in an approved manner. Screwed / socket welded connections may be used for less than 50 mm size if approved by the Purchaser/ Consultant.

Where it is undesirable to use a butt welded joint, in the opinion of the Purchaser/ Consultant, a flanged joint shall be provided. Due attention shall be given to ensuring that studs or bolts can be withdrawn from joints where the pipes are connected to valves, to branches on headers or to tanks.

All normal and performance test stubs and pockets along with root valves wherever

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deemed necessary by the Purchaser/ Consultant shall be provided by the Tenderer without extra cost to the Purchaser.

4.1.10.9. Drain Pipe Work

Drain pipe work shall be generally designed for the design pressure and temperature of the system to be drained. High pressure line drain pipes up to the last isolating valves shall be designed for the same conditions as the main pipes. For the remaining downstream portion design shall be as per relevant standard.

High pressure drains (pressure greater than or equal to 40 ata) shall have two valves in series. The upstream valve shall be hand operated and shall be normally locked open. The downstream valve shall be motor operated. Drain line from lower pressure sources shall have a single motor operated. valve, if required by Purchaser/ Consultant. All other valves shall be used in either closed of fully open position.

High pressure drains shall be provided with temperature indication as applicable of an approved type and shall be located in approved positions. Saturation temperature of the service drained shall be indicated by a red line on the indicator.

Drain pockets of an approved size and construction shall be provided for all steam and air lines.

Drains from water wall bottom headers and economizer bottom shall have one out of two valves with lock close feature.

4.1.10.10. Other Water, Instrument & Service Air Pipe Work

All pipe work shall be fabricated from pipe / tube which conforms to the relevant agreed standard or code. The instrument air piping shall be hot dip galvanized throughout. Drinking water line shall be of G.I. The other pipe work shall be of black carbon steel construction. All branches shall be taken from the top of the mains.

The main header shall have a provision to allow drainage and shall be fitted with drain traps / valves and the necessary isolating and bypass cocks.

4.1.10.11. Design of Pipe Supports, Anchors & Restraints

In general pipe supports, anchors and restraints shall be situated at those points in the building where provision has been made for the loads imposed. The cutting of floor roof beams or the reinforcement in slabs shall not be permitted. The Tenderer shall ensure that the location of hangers and supports shall not increase the force and moment on the equipment beyond their allowable limit.

The Tenderer shall design, fabricate supply all hangers and supports including anchors,

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guides, spring hangers, rollers etc. required for the completeness of the piping system.

The hangers and supports shall be spaced in accordance with standard engineering practice as outlined in applicable codes and standards. Since certain parts of the building may be constructed in reinforced concrete the positions of all pipe supports, anchors & restraints and the loads due to them, shall be determined sufficiently early to allow appropriate provision to be made.

The supporting arrangements shall be capable of supporting the piping systems when full of water during chemical cleaning or hydraulic testing.

All design and fabrication including loading and consideration of allowable stresses shall be in accordance with the relevant piping code. Hangers and supports for systems shall be completely engineered and prefabricated for all piping 50 mm and larger. Sufficient random materials shall be furnished for field support of all lines of smaller diameter.

For pipes of design temperature 100 deg. C or more bottom supports shall be avoided as far as possible and hanger/ spring type supports shall only be used. However, where bottom support cannot be avoided, e.g., for pipes running over racks or trestles, etc. the same shall preferably be provided with suitable shoes along with balls / rollers / rockers to minimize frictional resistance against thermal movements. The materials of shoes as well as the balls / rollers / rockers 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.

Where stress analysis calculations are performed, the location of anchors, guides or restraints shall be designed for the maximum forces and moments encountered. Spring hangers shall be selected to allow the movements determined by the stress analysis.

The Tenderer shall design and provide all supplementary steel required to properly secure and support all pipe supports, guides, restraints, anchors, shock absorbers etc. furnished.

Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

Provisions shall be made for support of piping which may be disconnected during maintenance work.

Supports shall be designed to prevent transfer of excessive loads from support to support or to equipment as the line expands or contracts. Support components shall be attached in places where they shall not damage other construction either during or after installation.

All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being

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required. The construction of spring hanger shall be such that release of the piping load shall not be possible in case of spring failure or misalignment. Suitable steps/ gags shall be provided for the hydrostatic test of the piping.

For pipes having design temperature 100 ^{0}C or more and where rigid rod hangers cannot be used, spring hangers either variable or constant spring may be used provided the load variation on pipe support from cold to hot remains within 20% of the cold setting load. If the vertical movement exceeds 40mm constant load hanger shall be used. However, effects of load variation from cold to hot in pipe support due to spring hanger shall be considered in the stress analysis.

Rigid rod hangers shall not be permitted near equipment terminals.

Hanger schedule shall be submitted for the Purchaser's /Consultant's approval.

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.

Double nuts or locknuts shall be used on hanger rods and bolts in all cases.

Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.

Both constant load and variable spring supports/ hangers 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 turn-buckles for load/ position adjustment shall be provided for all hangers.

Constant load type spring supports / hangers shall be so selected as to permit, for the specified load, an over travel of at least 25 mm or 20% (Whichever is greater) of the specified range of vertical travel or maximum vertical travel (whichever is greater). The initial setting of the hangers/ supports shall be such that half of this 'over-travel' is kept as reserve motion beyond the minimum as well as maximum settings, representing the calculated cold and hot movements of the pipe.

All rigid hangers shall be provided with means for vertical adjustment after erection.

Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves, hanger design shall include provision for shock absorbing devices of approved design. Normally spring type shock absorbers shall be used at locations where variable spring hangers are required. Hydraulic type shock absorbers and vibration control system are not required for piping system.

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Selection of vibration control devices shall be part of the Tenderer's work. If vibration is encountered after the piping system is in operation, appropriate vibration control equipment shall be provided by the Tenderer without any extra cost.

Hanger rods shall be subjected to Tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage and rocking washers shall be provided to permit swing. The parts of hangers which move relative to the pipe during expansion and contraction shall be connected to the pipe clamps or lugs in such a way that these parts lie entirely outside the insulation.

For all hangers the length of suspension shall be so selected that the hanger rod may never make an angle of more than 4 degree 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.

As far as possible all hangers shall be designed to be vertical in the hot condition.

Supports, guides and anchors shall be so designed that excess heat shall not be transmitted to the building steel.

The Tenderer shall prepare each individual hanger sketch showing cold / hot load movements and exact supporting detail.

4.1.10.12. Strength and leakage test for Pipelines

a) Test fluid for BFG/ BOFG, COG, CBM/ Natural Gas, LPG/ Propane, Cold blast, Nitrogen and Compressed air pipeline shall be air and for Steam pipelines, test fluid shall be water.

b) For BFG/ BOFG, COG pipeline, test pressure equivalent to 1.25 times the maximum operating pressure but not less than 0.2 Kgf/cm2 (g) shall be applied using air as per the certified drawings and instructions of Purchaser / Consultant for ascertaining the strength.

c) For cold blast, compressed air, nitrogen, CBM/ Natural Gas & LPG/ Propane line, test pressure shall be 1.25 times the maximum working pressure.

d) For steam service pipelines test pressure shall be 1.5 times the maximum allowable working pressure.

e) For BFG/ BOFG, COG, CBM/ Natural Gas, LPG/ Propane, cold blast, compressed air, nitrogen pipeline, strength test shall be carried out by maintaining the test pressure indicated above for a minimum period of 1/2 hour. For steam pipes, the minimum

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duration shall also be 1/2 hour.

f) During pneumatic leakage test, pressure shall be gradually reduced to 1.1 times the operating pressure to check the leakage by soap solution. Test duration shall be minimum 2 hours. Soap solution shall be applied to the weld surfaces / flanges to check for any leakage. Any defect found shall be rectified after releasing the test pressure and after rectification of defects the test shall be repeated. During pneumatic tests of all gas pipelines pressure and temperature readings shall be taken at the beginning and end of the test. The percentage pressure drop (P) shall be calculated as follows :

P = 100 (1 - P2 / P1 X T1/ T2)

Where P1 and P2 are absolute pressure in the pipe at the beginning and end of test and T1 and T2 are absolute temperature at the beginning and end of the test.

The maximum allowable pressure drop in all gas pipelines shall not exceed 1.0 % per hour for outdoor pipelines during pneumatic test. For pipeline subjected to hydro test, no leakage is permissible

4.1.10.13. Valves & Accessories

i) General requirements - High and low pressure valves

a) All valves shall be of approved make and type and shall have cast/forged steel bodies with covers and glands of appropriate construction. Valves materials and other requirement shall be as per "specification of valves" given below.

b) All IBR valves flanges, accessories etc. shall comply with the requirement of IBR.

c) All valves will, unless otherwise approved, shall have ends prepared for butt-welding and the internal diameter shall be the same as the internal diameter of the pipes to be joined. Where valves are accepted with flanged ends, they shall comply with the requirements of the approved Code of practice for the respective pressure and temperature conditions of the piping system.

d) Material Specification of Valves for steam & other utilities

Component	Design temperature, ^{0}C	Material
A. For high and low pressure steam		
Body	Below 410	ASTM A105/A216 WCB
	410 – 450	ASTM A182 F11/A217 WC6/ A351 Gr CF8
	450 – 538	ASTM A182 F22/A217 WC9
Stem	For all temperature	ASTM A276
Trim	For all temperature	ASTM A276

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e) Material specification of Valves for fuel gas lines

Dimension	Type	Design Std.	Material
For BFG/ BOFG & COG			
DN 15 to 40	Gate valve; Socket End	API 602	Body ASTM A105; SS Trim
DN 50 to 550	Gate valve; Flanged ; Rising stem	API 600	Body A216, Gr. WCB, SS trim
DN 600 and above	Gate valve; Flanged; Rising stem	Manufacturer Std	Body IS-2062, Gr. B, SS trim
DN 15 to 40	Check valve SW – Lift Type #800	BS 5352	Body A105, SS Trim
DN 50 and above	Check Valve Flanged swing check valve/ dual plate #150	BS 1868 / API 594	Body A216, Gr. WCB, SS trim
DN 15 to 40	Globe valve SW / Screwed ; #800	BS 5352	Body A105, SS Trim
DN 50 to 300	Globe valve; Flanged ; Serrated Finish; #150	BS 1873	Body A216, Gr. WCB,, SS trim
DN 350 & above	Butterfly valve WAF Type; #150	BS 5155	Body IS-2062, Gr. B, SS trim
DN 15 / DN 25	Screwed and lubricated, Tapered Plug valve	BS: 5158	Body & PLUG : CI IS 210 FG 200
For CBM/ Natural Gas/ LPG/ Propane			
DN 15 to 40	Ball valve flanged RF Serrated finish #150	BS 5351	Body A216 Gr.WCB SS Trim
DN 50 to 600	Ball valve flanged RF Serrated finish #150	BS 5351	Body A216 Gr.WCB SS Trim
DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A105; SS Trim
DN 50 to 200	Globe valve : Flanged RF Serrated # 150 finish	BS 1873	Body A216 Gr.WCB SS Trim
DN 15 to 40	Check valve SW # 800 Lift type	BS 5352	Body A105; SS Trim
DN 50 to 600	Check valve flanged RF Serrated finish # 150	BS 1868	Body A216 Gr.WCB SS Trim
DN 15 to 40	Gate valve SW # 800	API 602	Body A105 ; SS Trim
DN 50 to 600	Gate valve Flanged RF Serrated Finish # 150	API 600	Body A216 Gr. WCB SS Trim

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f) Material specification of Valves for N_2, Compressed Air lines

Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
DN 15 to 40	Gate valve SW # 800	API 602	Body A105 ; SS Trim
DN 50 & above	Gate valve Flanged RF Serrated Finish # 150	API 600	Body A216 Gr. WCB SS Trim
DN 15 to 40	Ball valve flanged RF Serrated finish #150	BS 5351	Body A216 Gr.WCB SS Trim
DN 50 & above	Ball valve flanged RF Serrated finish #150	BS 5351	Body A216 Gr.WCB SS Trim
DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A105; SS Trim
DN 50 & above	Globe valve : Flanged RF Serrated # 150 finish	BS 1873	Body A216 Gr.WCB SS Trim
DN 15 to 40	Check valve SW # 800 Lift type	BS 5352	Body A105; SS Trim
DN 50 & above	Check valve flanged RF Serrated finish # 150	BS 1868	Body A216 Gr.WCB SS Trim

g) Fabricated Gate Valve Specification

Service: Low Pressure Fuel Gas
Maximum Operating Pressure: 0.2 kg/cm2 (g)
Maximum Operating Temperature: 100 Deg C

1	Size	DN500 & Above
2	Description	Fabricated Double Disc Gate Valve, Electric Operated along-with gear box, hand wheel for manual provision, Rising Stem, Flanged End, Outside shop installation, Orientation – All position
3	Service	Low Pressure Fuel Gas
4	Design Standard	Manufacturer Standard
5	MOC	Body & Bonnet – IS 2062, Gr. B Body Seat Ring - AISI 410/ Cr. Steel Disc – IS 2062, Gr. B with Cr Steel overlay Stem - AISI 410/ Cr. Steel Back Seat - AISI 410/ Cr. Steel Flanges - IS 2062, Gr. B Gland packing - Graphite Gasket – Non-asbestos

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		Gear Unit – Manufacturer Standard Hand Wheel –CS Name Plate- SS
6	Companion Flange	SORF, Serrated finish, Std - As per valve body flange MOC – IS 2062, Gr. B
7	Gasket	Non- Asbestos
8	Fasteners	Bolts/ Studs - ASTM A193 Gr.B7 Nuts - A194 Gr. 2H
9	Inspection	10% radiography on welding
10	Testing	DIN 3230 Part-3 Body Test (Hyd) Pr. - 1.5kg/cm2(g); Result – No leakage Seat Test (Hyd) Pr. - 1.0kg/cm2(g); Result – Leak rate 2 Seal Test (Air) Pr. – 0.4kg/cm2(g); Result – Leak rate 2 Duration – As per DIN 3230
11	Actuator selection	Flameproof and suitable for dusty atmosphere
12	Remarks	1) Working gases contains impurities like dust, tar, napthaetc 2) Manufacturer shall indicate operational time, weight of valve, valve Tag. No.

h) Fabricated Butterfly Shut-Off Valve Specification

Service: Low Pressure Fuel Gas
Maximum Operating Pressure: 0.2 kg/cm2 (g) and Maximum Operating Temperature: 100 Deg C

1	Size	All
2	Description	Fabricated Butterfly Valve, Triple Eccentric Metal Seated Zero Leakage, Electric Operated along-with gear box, hand wheel for manual operation; Flanged End, Outside shop installation
3	Service	Low Pressure Fuel Gas
4	Purpose	Quick Shut-off
3	Design Standard	Manufacturer Standard
5	MOC	Body– IS 2062, Gr. B Body Seat - AISI 410/ Cr. Steel Disc – with Cr Steel overlay Seal – SS alongwith Graphite Shaft - AISI 410/ Cr. Steel Gland packing – Graphite Bearing – SS 316

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		Flanges - IS 2062, Gr. B Gear Unit – Manufacturer Standard Hand Wheel –CS Name Plate- SS
6	Companion Flange	SORF, Serrated finish, Std - As per valve body flange MOC – IS 2062, Gr. B
7	Gasket	Non- Asbestos
8	Fasteners	Bolts/ Studs - ASTM A193 Gr.B7 Nuts - A194 Gr. 2H
9	Inspection	10% radiography on welding
10	Testing	DIN 3230 Part-3 Body Test (Hyd) Pr. - 1.5kg/cm2(g); Result – No leakage Seat Test (Hyd) Pr. - 1.0kg/cm2(g); Result – No leakage Sear Test (Air) Pr. – 0.4kg/cm2(g); Result – No leakage Duration – As per DIN 3230
11	Actuator selection	Flameproof and suitable for dusty atmosphere
12	Remarks	1) Working gases contains impurities like dust, tar, napthaetc 2) Manufacturer shall indicate operational time, weight of valve, valve Tag. No.

i) Specification of Goggle Valve

Service: Low Pressure Fuel Gas
Maximum Operating Pressure: 0.2 kg/cm2 (g) and Maximum Operating Temperature: < 60 ^{0}C

1	Size	DN500 & Above
2	Description	Encased type Goggle Valve, Electro-Hydraulic Operated along-with provision of manual operation, Flanged End, Outside shop installation, Orientation - Vertical on horizontal header
3	Service	Low Pressure Fuel Gas
4	Design Standard	Manufacturer's Standard
5	MOC	Body & Bonnet – IS 2062, Gr. B Body Seat Ring - AISI 410/ Cr. Steel Disc – IS 2062, Gr. B with Cr Steel overlay Compensator, Roller, Drive Shaft - SS Flanges - IS 2062, Gr. B Gasket – Non-asbestos Gear Unit – Manufacturer's Standard

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		Name Plate- SS
6	Companion Flange	SORF, Serrated finish, Std - As per valve body flange MOC – IS 2062, Gr. B
7	Gasket	Non- Asbestos
8	Fasteners	Bolts/ Studs - ASTM A193 Gr.B7 Nuts - A194 Gr. 2H
9	Inspection	10% radiography on welding
10	Testing	Body Test (Air) Pr. – 0.25kg/cm2(g); Result – No leakage Seal Test (Air) Pr. – 0.22kg/cm2(g); Result – No leakage Duration – 30 min for each test
11	Actuator selection	Flameproof and suitable for dusty atmosphere
12	Remarks	1) Working gases contains impurities like dust, tar, naptha etc. 2) Manufacturer shall indicate operational time, weight of valve, valve Tag. No.

Note: Approved equal materials to other international codes shall also be acceptable.

j) All valves shall be tested at the Manufacturer's or Tenderer's works in accordance with the specific requirements of IBR/ the approved Code of Practice. Valves shall be of rising stem or otherwise as approved by the Purchaser/ Consultant and as may be required/ dictated by the operating criteria & access to the value as configured in the piping layout.

k) All low-pressure valves shall be of approved design and manufacture. Where valves are of a similar size and type, they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser/ Consultant's approval.

l) For sizes below 50 mm socket welded low pressure valves may be used. All isolating valves shall be of fullway gate type unless otherwise specified and when in fully open position the bore of the valve shall not be obstructed by any part of the gate. The internal diameter of all valves (except socket welded) at the ends adjacent to the pipe work shall be similar to the internal diameter of the connecting pipe work. All high-pressure steam and feed water isolating valves of 200 mm size and above shall be provided with integral bypass connected to the valve body by means of welded joints.

m) All valves shall have outside screwed (OS &Y), bolted bonnet, the screwed thread on 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.

n) The stops which limit the travel of any valve in the `Open' or `Shut' position shall be arranged exterior to the valve body.

o) Approved access arrangements shall be provided for all valves and particular attention shall be given to this in the case of valves fitted with gearing requiring lubrication at the valve itself.

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p) 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 handwheel is at a height of approximately one meter above the level of the floor or platform from which the valve is to be operated. Where required they shall be provided with head-stocks and pedestals of rigid construction and where gears or bevel 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.

q) The extension linkage shall be so designed as to take care of the thermal movements of the valves body with the pipe on which the valve is installed. The connection of the extension spindle to the valve stem shall be of the same material as that of the valve stem. The floor stands shall have column, nut plate and hand-wheel made of cast iron of a quality not less than Grade-5 of ASTM A-126. Adequate means of easy lubrication shall be provided for valves and operating extension components.

r) 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 on inverted position.

s) 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 convenient position. A separate nipple shall be provided to lubricate each point. The Tenderer shall supply the first fill of oil or grease for these parts. The Tenderer shall supply a suitable manually operated grease gun for the standard type of nipple provided.

t) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

u) All valves of size 65mm NB and above shall be fitted with position 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, an indicator arrangement shall be provided in the floor stand/gearbox for positioning indication in the extended spindle only.

v) Plastic or bakelite valve hand-wheels shall not be accepted.

w) All valves shall be closed by rotating the hand-wheel in a clock-wise 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. Arrow indicating direction of flow shall be marked in the valve body for globe, non-return, butterfly valves etc.

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x) Each valve hand-wheel shall be fitted with a circular nameplate of an approved material indicating in the valve tag number and the function of the valve. The name plates shall incorporate the colour code corresponding to the service of the piping. Valve size, rating, make etc. shall be marked on the valve body.

y) No lugs are required to be provided for the valves and the structural support system should be able to take care of heavy weight of valves.

z) 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.

aa) Eyebolts hall be provided where necessary to facilitate handling heavy valves or parts of valves.

bb) The Tenderer shall supply during the course of the execution, comprehensive GA & cross - section drawing showing the design of valves and test and working pressures and temperatures, rating/ class identification of different parts with material.

ii) Drain Valves

All drain valves shall be of approved type and shall have cast or forged steel bodies with covers and glands of approved construction. Spindles shall be of stainless steel and the materials of internal parts shall be as per standard code of practice and suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Valves shall be designed for continuous operation partially `open' without erosion of the valve seat or faces. Where valve seats are shrouded the design of the shroud shall be such as to prevent foreign matter lodging in the valve seat.

iii) Non –return Valve

a) NRV disc shall be heavy, single piece forged construction for medium & high-pressure valves of Class 600 & above. Normally piston lift type shall be used for high pressure operating conditions and flap type for ordinary conditions.

b) The body seat for swing check valves shall be inclined at such an angle as to minimize clatter.

c) Bodies shall be provided with removable access doors to enable the internal parts to be examined or renewed without removing the valves from the pipe line. The bodies shall be stamped with an arrow to indicate the correct flow direction.

d) Drain arrangement for NRV is not required. If the requirement is to drain the pipe line on both sides of the valves, Tenderer to take care in piping design.

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e) The bodies, doors, hinge pins, and fittings shall comply generally with the requirements of the applicable standard. An alternate material for the hinge pins shall be chromium stainless steel.

f) Valves needing positive closing under any case with a view to the vulnerability of its location, shall be provided with assist closing.

iv) Regulating Valve

a) Regulating valves shall be fitted to the outlet side of bearing, cooler, etc. of equipment supplied with cooling water as specified or subsequently required. They shall be capable of regulating the flow of water through the valve from zero flow to fully open. The valves should be specifically designed for this purpose, the normal type of sluice valve shall not be accepted.

b) The valves shall be fitted with indicators, showing accurately the amount the valve is open. The graduations on the indicator shall be engraved or stamped on.

c) The valves shall be of the outside screw type and the material used in construction shall be for approval by Purchaser/ Consultant, all valves seats and faces shall be readily renewable and be made from materials that are corrosion and wear resistant.

d) The valves shall be supplied with hand-wheels in line with the requirements indicated earlier.

v) Reducing valves (for High pressure & Low-pressure systems)

a) Reducing valves shall be perfectly stable, quiet and vibration less in operation when reducing in any pressure throughout upto the maximum and shall be suitable for continuous use at the operating temperature.

b) Where electrical or hydraulic valve operation is included, the operating mechanism shall be remote from the valve or pipe line and on failure of the operating mechanism the valve shall remain stay-put/full open/full close depending on process condition and then it may be adjusted by hand after disengaging from the actuating mechanism. The entire hydraulic system including pumps, accumulators, pipes, valves, fittings, etc., as required shall be provided and housed in a compact manner.

c) A pressure relief valve shall be provided on the outlet side of each reducing valve, capable of exhausting to atmosphere the maximum discharge of the reducing valve without undue build-up of pressure. The discharge from the relief shall be led to a safe approved position. Pressure gauges and thermometers shall be provided before and after the reducing valve.

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vi) Motor operated valves (For High pressure as well as for Low pressure systems)

a) Motor operated valves shall be fitted with both hand and motor operating gear and where a bypass valve is provided this also shall be provided with both hand and motor operating gear and interlocked to ensure that the bypass valve is opened before the main valve. Each valve gate has reached the `full open' or `full closed' position (with a minimum increase in the torque). The motor shall be placed in such a position relative to the valve that there is no possibility of leakage of liquid, steam or corrosive gas from valve joints on to the motor or control equipment.

b) The hand operating and motor operating mechanism shall be so interlocked that the hand operating mechanism is disconnected before the motor is started. Valves shall be provided with seating control and except where specifically approved by the Purchaser/ Consultant for small valves, a slipping clutch or other torque limiting device shall be incorporated in the motor drive. The operation of opening or closing the valve shall be controlled by means of push buttons labelled respectively `Open' & `Stop'. The control shall be so arranged that the motor can be stopped with the valve in any position by means of `stop' push button and after having been stopped can be restarted either direction by the `open' or `close' push buttons.

c) Necessary positioning indicators for valves closely connected with the operation of main units and need continuous and repeated monitoring shall be provided in plant control room/control pulpits.

d) Following valves also shall be motor operated:

- Main Steam line valves including bypass
- All BFP suction and discharge lines
- Upstream valves of all control valves
- Bypass valves of all control valves for steam lines. These valves shall be inching type.
- Main steam line drain and vent lines – out of two isolation valves one valve shall be motorized.
- Main isolation valve for soot blowing system
- In integral bypass line of HP steam valves (pressure greater than or equal to 40 ata) two valves in series to be provided, and out of these one shall be motorized.
- Double isolation valves shall be provided for the SH outlet header drain and SH vent and out of two isolation valves one valve shall be motorized.
- High pressure lines greater than or equal to 40 ata shall have double isolation valves.

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vii) Safety Valves

a) Safety valves shall be of the direct spring-loaded type and shall have a tight, positive and precision closing.

b) All safety valves shall be provided with a manual lifting lever and gag for hydro test.

c) Valves used for steam, air and any other compressive fluid shall be of pop type.

d) Safety valves shall be so constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10 percent above the set blow-off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the pressure. However, the valves coming under the purview of IBR shall be strictly as per the regulation of IBR.

e) Relieving capacity of the safety valves shall be as per the applicable codes and standards and shall be subject to the approval of the Purchaser/Consultant.

f) 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. Safety valve discharge piping shall be provided with drip tray, shock absorber, silencer etc.

g) Noise level for safety valves shall be between 110dB to 115dB.

4.1.10.14. Steam Traps & Strainers

a) The steam traps shall be inverted bucket or thermodynamic type complete with integral or separate strainers.

b) Traps shall have cast/ forged carbon steel body with stainless steel internals of renewable type. Trap bodies and cover shall be of cast or forged steel and shall be suitable for operation at the maximum working pressure and temperature of steam piping to which they are connected.

c) All Y-Type strainers wherever provided with steam traps or otherwise, shall have cast/ forged carbon steel body with stainless steel screen of not more than 20 mesh size. Screen open area shall be at least three (3) times the pipe internal cross-sectional area. The strainers shall have a screwed blow-off connection with a removable plug.

d) All traps and strainers shall have socket weld ends as ANSI B16.11 for size NB 50 mm and smaller and butt weld ends as per B16.25 for size NB 65 mm and above.

e) Drain traps shall be provided with strainers, inlet and discharge valves and bypasses and test cocks and where discharging to a closed header, shall also be provided with discharge non-return valves.

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f) Strainers shall be permanently mounted on the suction side of all pumps, on the Auxiliary steam lines to air ejectors, gland sealing system, etc. strainer internals shall be easily removable type.

g) The Tenderer shall provide temporary strainers on the inlet side of all major pieces of equipment where permanent strainers are not provided. Strainers that slip between flanges or their equivalent shall be provided. The strainers shall remain in place until their removable is approved by the Purchaser/ Consultants.

4.1.10.15. Desuperheaters

A desuperheater shall be designed for the design conditions of the piping on its upstream side and shall also take care of its severe condition of working. As far as possible, the desuperheaters shall be mounted on a vertical line to avoid the problem of water accumulation in it. However, if the inside diameter of the desuperheater is the same as that of the pipe on which it is mounted and if the pipe is provided with drain pocket and trap station, the desuperheater may be installed horizontally.

4.1.10.16. Refractory, Insulation & Cladding

a) Tenderer shall design and furnish all boiler refractories, insulating and other materials (like wire netting, cladding sheets, fastening materials like clips, wires etc.) required for the entire boiler, its integral piping and other piping within Tenderer's scope of work, including stiffeners, supports, insulation, lugs etc.

b) The complete setting shall be tight as evidenced by test showing that no more than one per cent drop in CO_2 occurs between the upper part of the furnace and the heater inlet.

c) The maximum ambient temperature at site may be taken as 48 ^{0}C. The thermal insulation shall be provided as necessary for the outer surfaces of different equipment, ducting, integral piping, valves etc., to conserve thermal energy and also to maintain outside surface temperature of the materials within 60 ^{0}C for safety of operating personnel. The Tenderer shall optimize insulation thickness based on economic analysis. Wind Velocity shall be considered as 1m/s for design of insulation.

d) All covering necessary to protect insulation from the weather, shall be supplied.

e) Suitable refractory bricks, in-situ castings shall be provided for the inside surfaces of furnace as per the proven experience of the Tenderer.

f) Light resin bonded mineral wool mattresses (IS 8183) of density not less than 100 kg/m3 up to temperature 400 deg C & 150 kg/m3 above 400 deg C / pre formed pipe section (IS 9842)/ Calcium Silicate (BS 3958 Part II) shall be used for insulation of pipe lines.

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g) Hexagonal wire netting shall be provided for securing insulation materials. Wire nettings shall be of galvanized steel of at least 1.0 mm dia and shall have aperture of 10 to 13 mm in case of calcium silicate and 20 mm in case of resin bonded machine made and machine stitched slag wool.

h) The lightly resin bonded slag wool mattresses shall be machine made and machine stitched & soft and flexible for being easily rolled on surfaces to be insulated. They shall not settle down when subjected to prolonged vibration.

i) Binding wire to be used for the application of the insulation shall be galvanized steel wire conforming to IS-280 and of thickness 1.0 mm to 1.6 mm.

j) The stitching wire shall be 0.7 mm diameter copper wire conforming to IS-4412 (latest revision).

k) The metallic jacket over the insulation shall be galvanized steel sheet conforming to IS-277 (latest revision)/ Aluminium sheet and thickness shall be 22 SWG.

l) The inside surface of GI jackets shall be provided with coal tar epoxy protective coating of 8-10 Mills total dry film thickness.

m) All other materials e.g. required insulation supports, washers/ screws etc. shall be of standard design.

n) Asbestos is not allowed for insulation purposes.

o) The Tenderer shall submit with his proposal a detailed application procedure for insulation including pertinent technical data for Purchaser/Consultant's review and use for application of insulation.

p) The Tenderer shall submit the insulation thickness adopted for various equipment/piping with calculation.

q) Necessary castable refractory material shall be applied in all the areas requiring skin casing.

r) Insulation thickness above 60 mm shall be in two (2) layers and above 120 mm shall be in three (03) layers.

s) Necessary seals, fixing materials, expansion joints, door lining etc. to complete the setting and insulations shall be furnished.

t) Access doors shall be provided with fire bricks.

u) Insulation shall be complete with internally situated sheet iron casing; multilayer mat

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insulation with external profile sheet metal covering in 22-gauge Aluminium.

v) Insulation openings provided for all instruments in the piping/vessels shall be provided with special sheet metal cladding.

w) Table for Insulation thickness:

Pipe size (outside dia)	Insulation thickness in mm for various temperature ranges					
Pipe size (outside dia)	100^0C and below	Between 101 and 200^0C	Between 201 and 300^0C	Between 301 and 400^0C	Between 401 and 500^0C	Above 500^0C
Upto DN 50mm	25	50	50	75	100	100
DN 65 to DN 100mm	25	50	75	100	125	125
DN 125 & DN 150mm	50	75	75	100	125	150
DN 200 mm	50	75	75	125	125	150
DN 250 mm	50	75	100	125	150	150
DN 300 mm	50	75	100	125	150	150

**** End of Clauses ****

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4.2. WATER SUPPLY SYSTEM

4.2.1. Scope of Work

The scope of work shall include design, engineering , fabrication, manufactures, inspection/testing at manufacturer's works , assembly & supply, unloading, storage at site, erection, construction/laying, testing, commissioning, & performance guarantee tests etc of plant & equipment and piping etc. of complete water supply facilities along with electrics, instrumentation & control, telecommunication, AC&VS, material handling & hoisting equipment etc as specified and required for complete water supply system comprising of circulating cooling water system with cooling tower, make-up water, DM water, Water conditioning, water supply for AC&VS, water treatment i.e. ETP & Recycle Plant, dewatering system, drinking water & water based fire-fighting systems as specified in this chapter as well as various chapters of Water System Annexure (WSA) complete in all respect on discrete turnkey basis.

Erection work for entire plant & equipment are included in the scope of work of the tenderer. However, Civil and Structural works shall be under separate package. Tenderer shall submit assignment drawing & load data for preparation of detailed civil & structural drawing by Purchaser/ Consultant.

The scope of work shall include the following activities.

i) Supply of all technical literature, drawings & documents, general arrangement drawings, assembly & sub assembly drawings of all the plant & equipment, operation & maintenance manuals, manufacturing drawings, etc as elaborated in relevant chapters.

ii) Submission of all design calculations, data sheets, general arrangement, cross sectional drawings for various equipment, pipeline sizing calculation and calculation for sizing of various sub systems and integrated systems for approval of Purchaser/ Consultant and finalizing the same as per approval of Purchaser/ Consultant as elaborated in relevant chapters.

iii) Water system shall in general comprise of the following facilities: -

a) Cooling water system
b) Water conditioning facilities for cooling water system
c) Water supply system for air conditioning & ventilation.
d) Make up water system
e) Drinking water system
f) Water based fire fighting system
g) DM Water plant
h) Water treatment facilities & water reclaiming facilities as required for the proposed plant & equipment
i) Dewatering system
j) Interplant pipelines
k) Other miscellaneous water systems.

iv) Supply of commissioning spares & consumables is in scope of Tenderer till handing over. List shall be submitted during engineering.

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v) List of two years operation and maintenance spares (Tenderer shall submit an exhaustive list with itemized price for the same).

vi) Supply of special tools, tackles for construction, erection operation and repair & maintenance of the plant & equipment.

vii) All necessary connections for hook up with Purchaser's system at battery limits.

viii) Supply of erection, testing & commissioning materials.

ix) Network flushing fluids, chemicals & consumables.

x) First fill of oils, lubricants, filter media, resins, chemicals reagents and other consumables. Tenderer shall be responsible for supply of all the consumables for startup and commissioning and till the plant is handed over to purchaser.

xi) All Resins, chemicals, reagents, conditioning/dosing chemicals etc for the entire water facilities shall be supplied three (03) months before commissioning.

xii) Supply of chemicals for chemical conditioning till the plant is handed over to purchaser.

xiii) Supply of chemicals during commissioning (eco-friendly) and three months chemical requirement post commissioning for the water system with storage facility.

xiv) Participation in design conference with the Purchaser & Consultant as and when called for.

xv) Pipeline structural stockades, bridges, R.C.C pedestals for overhead pipelines. Civil design for thrust block shall be provided by successful tenderer.

xvi) Pipeline supports, thrust blocks/ anchor blocks, etc.

xvii) Inspection and performance testing of individual equipment and system.

xviii) Make Up, Drinking & Fire Fighting water pipeline network from battery limit to entire plant complex shall be under bidder's scope.

xix) Provision of branch tap of suitable size with an isolation valve shall be provided on return header to quick drain the water directly to pond.

xx) DM water pipe lines – CPVC pipes for SBA, SAC, MB. SS pipes for DM water transfer piping. CS for PSF and ACF. CPVC for chemical.

xxi) Supply of Online silica analyzer & grab sample facility shall be provided.

xxii) CT Fan blade MOC shall be FRP. MOC of drive shaft shall be Carbon Fibre.

xxiii) Water supply system/ systems shall be complete in all respects and any equipment or material not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant shall be deemed to be included under the scope of work of the Tenderer.

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xxiv) The Bidder shall plan to utilize/ reuse/ recycle the wastewater generated i.e blow down, back washed water, water from neutralization pit after pH correction etc. from the unit with necessary treatment etc. as required. Thickener/Clarifier, Sludge treatment, dewatering facilities & R.O. plant in line with TS/WSA for treatment of all discharges/blow down & effluents from various recirculation systems shall be provided by the Tenderer. RO reject sump of capacity 2hrs & pump of required capacity & head to be finalized during engineering shall be provided by the Tenderer. In the total system, no water shall be allowed to be let to storm water drain. The Tenderer shall furnish the details of such scheme. The treated water from treatment plant is to be reused in the CPP Complex and reject water shall be pumped at battery limit. Battery limit shall be defined separately.

xxv) The control of the water-cooling system shall be done from centralized control room of the technological shop with all process and safety interlocks. Running, fault signals shall be made available in the main control room with redundant DDCMIS from main control room. However, provision of operation of each drive shall be made from local control station also for the purpose of maintenance only with all safety interlocks intact.

4.2.2. Specification and Description of Work

4.2.2.1. Cooling Water System

i) For cooling of plant and equipment there shall be a separate Cooling Water Re-circulation System with pump, cooling towers and piping network for the following:

a) Steam Turbine Generators
b) Auxiliary Machine Cooling Units
c) Steam Turbine Driven Turbo Blower

ii) Cooling water pipe header shall be provided from the Pumphouse up to TBS & STG building for each circulation system as per WSA. Each header shall be provided with suitable number of valves for isolating and maintenance purpose.

iii) Tenderer may provide a common pump house to house all groups of pumps for the Condenser cooling, STG, Turbo Blower, auxiliary machine cooling systems based on the system requirement. Separate group of pumps and separate piping shall be provided for each system/sub-system to enable flexibility in operation.

iv) Hot water sump, pumps to pump return hot water to cooling tower may also be considered for the return hot water from various consumers in case the residual head is not adequate to reach the cooling tower top. Losses on account of evaporation and leakages and blow down shall be compensated by addition of make up water in the cold sump.

v) Necessary chemical dosing system shall be provided to inhibit bacterial & fungal growth, scale formation and corrosion of pipeline.

4.2.2.2. Industrial Water Distribution System

i) Industrial water shall be supplied as make-up water to the Captive Power Plant for Industrial & cooling needs at only one point for the entire needs at battery limit as specified.

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ii) The Water loss in the various processes in evaporation, process/ system, minor leakages etc. shall be replenished by a separate common make-up water system to be provided by the Tenderer.

iii) Industrial water distribution system shall include extension of pipelines from the battery limit with an isolation valve, magnetic flow meter and motorized valve, along with pumps (if required), valves, valve pits, sumps etc., to the circulation system as well as process needs.

iv) Online booster shall not be accepted. A makeup water sump with pumps and piping (pump house and sump are to be provided by the Tenderer of capacity 2 hrs), if required, shall be provided.

v) The Tenderer shall provide necessary treatment facility, wherever required, to make the Industrial Make-up water suitable for cooling and other purposes. Also Generation of boiler feed water is in the scope of the Tenderer. Performance guarantee parameter for complete water system shall be ascertained by the Tenderer in line with WSA.

4.2.2.3. Water supply system for air conditioning & ventilation

i) The entire piping network for water supply for air-conditioning and ventilation and other Systems/ Sub-systems is in the scope of the Tenderer.

ii) It shall consist of pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc.

iii) The details and specification of pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc. as specified for cooling water system is applicable for this system also.

iv) Industrial water for the system shall be provided by the Tenderer from the Industrial water network to be provided by the Tenderer within their area. No separate connection at battery limit shall be provided for this purpose.

4.2.2.4. Water Conditioning Systems

i) To prevent the circulation water system from corrosion and scale formation and to bring the make up water to the condition suitable for the cooling water requirement in the Captive Power Plant there shall be a water conditioning facility as per system requirement and inline with the details given in WSA.

ii) It shall consist of dosing tanks, pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc. as specified for cooling water system is applicable for this system also as per WSA. Electro chlorination plant for generation of sodium hypochlorite shall be provided by the Tenderer as per WSA.

iii) Each chemical solution storage tanks shall have a capacity to meet the requirement for 8 hrs period considering dosage of 50ppm at 10% concentration for polymer, 25ppm at 10% concentration for lime and 1ppm at 0.5% concentration for polyelectrolyte as applicable.

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iv) These pumps may be housed in the same pump-house for cooling water system or separately.

v) The Tenderer shall furnish the details of chemical dosing proposed for the system during engg.

vi) The Tenderer shall include in the scope of supply chemicals during commissioning (eco-friendly) and three months chemical requirement post commissioning for the chemical conditioning system with storage facility.

4.2.2.5. Drinking Water System

i) The drinking water shall be made available at one point at battery limit as specified. The Tenderer shall extend the pipeline from battery limit with an isolation valve and pressure gauge up to various drinking water consumers with the following: -

- PVC tank shall be provided on each building
- The ring main shall be of DN80 with branch line of DN50.
- Set of drinking water points shall provided in each building.
- Water coolers, water purifiers etc are in the scope of the Tenderer
- List of consumers shall be provided during engg. stage.
- One tap off point to be left on the building column for STG & TB area.

ii) Tenderer shall provide separate sump and drinking water pumps along with piping and electrics etc. to meet the requirement.

iii) The details and specification of pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc. for cooling water system is applicable for this system also.

4.2.2.6. Water Based Fire-Fighting System

To cater to the needs of water-based fire-fighting system, a firewater-piping network shall be planned with provision of yard hydrants and internal hydrants at regular intervals. The proposed network shall be connected with the existing network at the battery limits with an isolation gate valve at two points to make ring main.

The following shall be considered for designing the fire water network: -

I.	Category at hazard	-	ordinary (as par TAC)
II.	Yard hydrants	-	at 45 m intervals
III.	Internal hydrants	-	at 30 m intervals
IV.	Min pressure at remotest hydrant	-	3.5 kg/cm2

2 nos. of 30 m long hose shall be provided along with fittings for each yard hydrant.

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2 nos. of 15 m long hose shall be provided along with fittings for each internal hydrant. Hose (IS636 Type B with SS coupling and hose box and nozzle) shall be provided along with fittings for each hydrant.

Yard hydrant for fuel handling/storage areas shall be at every 45m interval. Internal hydrant points shall also be provided at every 30m interval in all the floors / working areas/storages/ yard of all the premises/bays including conveyor galleries, junction houses and cable basements / galleries / cellars / tunnels, STG & TB area etc. Hydrant piping network shall be provided in ring main. Each hydrant point shall be provided with hoses, hose boxes and other accessories as per TAC & TS/WSA

The water-based fire fighting system shall be designed, supplied & erected inline with the stipulations under various clauses of WSA.

4.2.2.7. DM Water Plant

Fully automatic PLC controlled three-Streams (2W+1S) DM Water Plant each of tentative capacity 175 m^3/hr. (design capacity of each shall be finalized during engineering based on process needs), shall be provided with requisite controls & instruments. The detailed design parameters of the DM Plant & effluent treatment shall be as per WSA. Pipe for DM Water shall be of stainless steel only. Morpholine dosing system shall be provided.

The treated effluent of the DM Plant shall be suitably reused in the System/ Process after proper treatment. The prevailing pollution control acts shall be binding for selection, erection and operation of these units.

The Tenderer shall supply chemicals for operation during commissioning and three months chemicals requirement post commissioning (after plant handover) with storage facility for the rated output of the DM water Plant.

Design criteria for DM Plant & effluent treatment which comprises of Clarified water storage tank (2 hrs capacity), ACF (backwashing once in 24hrs & at least 75% free board for pressure filters), Acid & Alkali storage & handling, Cation Exchanger (free board 100%), Degasser & tank, Anion Exchanger, MB Exchanger, Resin & its regeneration, DM Water storage tank, blower, pump, neutralization pit, piping & valve etc shall comply WSA. Tank shall be rubber lined.

OBR based PG test to be ensured for DM Plant. Dedicated silica analyzer with online & grab sample facility should be provided in DM Plant

All the required facilities for DM Plant shall be based on 2W+1S stream.

Penalty clause shall be as per WSA for all the equipments considered for the process requirement.

4.2.2.8. Pump House

There shall be a pump-house to locate all the pumps, valves, internal piping, DM water Plant, MCC room, material handling facility, air conditioning & ventilation facilities, illumination &

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instrumentation, etc. However, the Tenderer may provide separate building for DM water Plant. Capacity of handling facility shall be in line with WSA.

Pump house shall be provided with modern office room with standard furniture of reputed make & office, toilet facilities with drinking water provision and fire fighting as per TAC norms.

The sump/suction chamber shall have two compartments with provisions to divert the entire flow the cooling tower/ settling tank to either of the compartment when one of the compartments is under repair/maintenance. Sluice gates shall be provided for isolation of the compartments

Operation of all the pumps, motorized valve shall be carried out centrally from main control room. Running, fault signals shall be made available in the main control room. However, provision of operation of each drive shall be made from local control station also for the purpose of maintenance only with all safety interlocks intact.

Other aspects of pump house shall be as per Water System Annexure (WSA).

4.2.2.9. Pump Sets

i) Separate group of pumps and pipeline headers shall be provided for cooling of various equipments.

ii) Total no. of standby pumps for a particular group shall be as per WSA.

iii) Pump sets for STGs, STBs & Auxiliary cooling system shall be Vertical Turbine type along with their auxiliary equipment suitable for the required duty conditions and shall be designed and manufactured for continuous duty at full load. Pump sets with motor rating more than 300KW shall be provided with less than 1000rpm.

iv) The motor capacity shall have a margin over its BHP absorbed at the pump shaft at duty point and margin shall be 25% for motors of rating upto 15kW, 20% for motors of rating 18.5kW to 160kW and 15% for motors of rating 200kW and above. The above margin shall be addition to temperature de rating.

v) The material of construction of various pumps may be selected superior to that mentioned in WSA to suit the liquid characteristics.

vi) All the pump sets and drainage pumps shall be operated with PLC on auto mode. M.O.C of casing/bowl: - 2.5% Ni Cr.

vii) Sump pump for bailing out water from each chamber of vertical pumps to be provided.

viii) For other requirement, reference may be made to WSA.

4.2.2.10. Cooling Tower

i) RCC Cooling tower shall be provided by Tenderer for cooling of hot water. WBT for Cooling Tower shall be 29ºC.

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ii) Control and operation of the cooling towers shall be done from PLC of water system and main control room of respective shops. CT fans shall be operated with PLC on auto mode.

iii) Number of cells in each group of cooling tower shall be selected in such a manner that when one cell is taken out for maintenance, the remaining cells shall be able to handle the entire hydraulic & thermal load. The capacity of the CT basin and PH Sump each shall be designed for minimum 10 minutes circulating water quantity.

iv) The cooling tower shall be equipped with under slung cranes with CT & LT with complete parking shed. Height of the lift shall be adequate to lift/place material from the fan deck to back to ground. Crane and structural members shall be suitably treated/ Galvanized for corrosion protection.

v) CT Fan blade MOC shall be FRP. MOC of drive shaft shall be Carbon Fiber composite .Fan hub shall be MS galvanized with GRP cover as per WSA /TS. For other requirement, reference may be made to WSA.

vi) Fine and coarse screen of SS material shall be provided in the forebay for arresting contamination in the circulating water.

4.2.2.11. Valves

i) Adequate number of isolation valves with stainless steel internals should be provided in the pipeline network for isolation of pipe sections and equipment, control of pressure, flow & level of fluids, venting, draining, pressure relief etc. (working pressure = 16 kg/cm^2)

ii) Cast steel Valves shall be provided in line with WSA.

iii) For other requirement, reference may be made to WSA.

4.2.2.12. Side Stream Filtration

Side Stream filtration for 10% of the circulation volume is to be provided. Cold water from the CT shall be pumped to filtration plant. Pressure filters shall be provided for this purpose. Number of working Pressure sand filter of total capacity 10% of circulation volume + 1 no. Standby/ reserve PSF +1 Number of PSF in backwash. The operating platform and frontal piping area shall be covered with structural shed. Backwash water overhead tank and wastewater collection tank shall be provided for back washing of the filters. Treated water shall be sent back to cooling towers by residual pressure. Surface loading of Side Stream filter shall be 10 m^3/hr/m^2 & corrosion allowances shall be minimum 2mm as per WSA.

For details, refer to design criteria laid in WSA.

4.2.2.13. Pipes, Fittings & Pipe Supports

i) The pipe work & fittings shall be designed, manufactured, assembled and tested as per the latest standards, codes and recommendations of the Bureau of Indian Standards / ANSI/ ASTM/ AWWA/ any international standards. Pipe work shall be complete in all respects including all accessories essential for proper installation, operation and maintenance, even

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though such items are not specifically mentioned in the specification. Pipe thickness shall be as per WSA.

ii) MS pipeline from DN 15 to DN 150 shall generally conform to IS: 1239 (Part-I), Heavy class & pipe above DN 150 shall conform to IS: 3589-2001 as specified in WSA. MS fittings of size 200 and above shall be fabricated ones. Pipe thickness shall be as per WSA.

iii) GI pipes as per IS: 1239 (part-I)-2004 heavy class shall be used up to size DN 150 mm and all GI fittings up to size 150mm as per IS:1239 (part-II)-1992 shall be used. Pipe thickness shall be as per WSA.

iv) DM water pipe lines - SS pipes for SBA, SAC, MB & DM water transfer piping, CS for PSF & ACF and CPVC for chemical.

v) Anti corrosive protection of the MS underground pipeline shall be done as per IS: 15337-2003. The thickness of tape shall be 3mm up to pipe diameter DN300mm and 4mm for pipe diameter of DN350mm and above.

vi) Pipe may be laid in tunnels considering space constraint. Each pipe tunnel shall be provided with at least a monorail and hoist for erection and maintenance purposes. Minimum height of the tunnel shall be 3.0m and suitable walkway aisles of 1.2m minimum width shall be provided for each tunnel

vii) Ring header with requisite number of motorized isolation valve shall be provided in pump house for each circuit. Motorized butterfly double eccentric valve shall be provided at the end segment of the ring header.

viii) The Tenderer shall supply all the pipes, fittings, pipe supports, flanges, gaskets etc.

ix) The velocity in the pipe shall be as per WSA.

x) For other requirement, reference may be made to various clauses of WSA.

4.2.2.14. Interplant Pipelines

Industrial water for make-up water supply and general plant usage shall be met through the proposed pipeline to be laid from the tapping point to these units.

Drinking water network and fire water network shall be provided to various consumption points in the proposed industrial premises.

Pipelines shall be laid in tunnels as far possible. Wherever it is not possible, pipelines shall be laid over ground on the structural trestle. Fire water, Industrial makeup water & drinking water shall be laid underground. Pipe lines in the tunnels shall be suitably ventilated & illuminated.

4.2.3. Erection, Testing and Commissioning

i) The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the drawings, specifications, Instructions etc. duly approved by the Employer. Erection shall be carried out in the presence of and /or as per the instructions of site

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engineer /supervisory personnel deputed by the Tenderer. Highly skilled workmen shall carry out the erection.

ii) The Tenderer shall supply all required manpower, tools and related equipment, all hoisting equipment, all necessary scaffoldings, all necessary transporting equipment, consumables. Construction and erection materials, petrol, diesel oil, Kerosene, solvents, sealing compound, tapes, brazing and soldering materials, welding and brazing gases, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand/emery paper etc. as required for the satisfactory completion of work.

iii) After erection, all equipment having moving part, subject to pressures or voltages shall be given trial operation. The trial operation shall consist of 24 hours of continuous operation. All modifications and rectifications required during the trial operation or required for proper operation shall be done at his own cost by the Tenderer as accepted by the Employer.

iv) Rotating equipment shall be checked for proper direction of rotation and shaft alignment. Equipment subject to pressures shall be carefully examined for leakage. All equipment, such as pressure taps, temperature measurement connections, flow measurement devices etc. shall be provided by the Tenderer.

v) Erection, testing & commissioning of various equipments and piping etc shall be done also in line with details given in various chapters of WSA.

vi) The Tenderer shall make his own arrangement for handling the equipment and pipelines at the stores and transporting it to the site for installation.

vii) Tenderer shall provide special tools and tackles and necessary manpower for construction, erection, commissioning, operation and repair/maintenance of the plant and equipment.

viii) Adequate segmentation and interconnections shall be provided in the distribution networks to afford maximum flexibility of operation and maintenance.

ix) All materials required for fabrication, construction, testing and inspection shall be supplied by the Tenderer.

4.2.4. Painting

All Plant, equipment, valves, piping etc. shall be painted as per the specification given in WSA.

4.2.5. Preferred Makes

For makes of equipment refer Chapter 14.

**** End of Clauses ****

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WATER SYSTEM ANNEXURE

1. General Water System

Please refer **Project Specific document** for the information.

1.1. Source of Water

1.1.1. The source of water for the project is given in **Project Specific Specification.** Please refer the same.

1.2. Analysis of Water

1.2.1. The analysis of water sourced is given in **Project Specific Specification.** Please refer the same.

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2. Design Criteria for Pump House

2.1. Pump House

The layout of the various equipment inside the pump house shall be designed keeping in view the safety of the personnel, accessibility of equipment and space for maintenance.

The Pump house shall be of civil construction with with brick wall and RCC column, beams & roof, closed on all sides and shall be provided with minimum two entries. One of the entries shall be provided with rolling shutters. For the pump houses having length more than 30m, minimum three entries shall be provided with one rolling shutter, one door adjacent to the rolling shutter and third door at other end. However, multiple doors shall be provided based on technical requirement during engineering. Space provision for maintenance of equipments shall be provided inside pump house. Handling facilities shall be provided in such a way that loading/unloading of equipments can be done on the vehicle parked outside the rolling shutter. Each pump house shall be provided with modern office room with standard furniture of preferred make, and toilet facilities, water purification, water cooler (cap-40 litres) with drinking water points. Office room shall comprises of at least two tables, two reclining chairs, four meeting chairs, two file cabinets, one set of computer with printer facility, necessary illumination and air conditioner. Each technological shops, offices, ECR, and other manned / unmanned buildings shall be provided with drinking water point. One PVC/HDPE OHT of capacity minimum 1000 litre shall be provided at each drinking water point. OHT (PVC/HDPE) shall be provided with drinking water connection, drain pipe and overflow pipe along with suitable valves. Overflow and drain shall be connected to nearest storm water drain. The pump house shall be provided with fire fighting system as per IS: 13039, IS 3844& IS 15325. The pump houses shall in general be above ground unless specified otherwise.

Each pump shall have independent suction. The delivery line of each pump shall be connected to the main header.

Minimum clear gap between equipment to equipment, pipe to wall, equipment to wall and valves to wall should be kept as per ease of maintenance and operation and shall be decided during detailed engineering but shall not be less than 600mm.

In each pump houses maintenance space of minimum 3m shall be provided. However, maintenance space may be suitably increased based on pump house size.

Clear walkway of width 2.0 m shall be provided on one side of the pump house with clear marked approach to all the pump set, motors, valves, filters etc. All operating platforms/maintenance platforms shall be of minimum width 1.0 m.

Structural platform with ladder shall be provided so that the valves can be easily accessible for operation and maintenance.

The electrics of the pump house shall be designed as per the specification given in the relevant chapter.

The pump house shall be provided with necessary illumination facilities. The details of illuminations have been given in the relevant chapter of electrical GTS.

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The capacity of the hoisting and handling equipment shall be selected in such a manner that it is able to handle the single heaviest load. Cranes/monorails with electric hoist shall be provided as indicated in the relevant chapter.

The pump house shall be provided with suitable ventilation, electrics, illumination, instrumentation, telecommunication, office room, control room (if required), with furniture, wall clock and hoisting and handling equipment. The control room and office room shall be air-conditioned.

The pump house shall be provided with adequate drainage facilities with necessary side slope, channels, etc. leading to drainage sump of suitable capacity. Minimum two drainage pumps (one working and one standby) type - submersible / vertical non-clog type centrifugal pumps, of suitable capacity shall be provided to drain out the leakage/seepage water in pump houses, technological shops and electrical buildings. However, in substation / cable tunnels only submersible pump shall be provided. The drainage pumps shall operate automatically based on water levels in the sump. In case of drainage pumps and other special type of vertical pumps, the pumps shall include the electric motor suitable or vertical mounting, motor stool, base plate with accessories and fixing bolts, flexible coupling, shaft enclosing pipe column assembly, bearings, lubrication gaskets and washers pressure gauges, strainer at suction side etc. The characteristics of the prime mover shall be same as described under the main pumps. If the length of the pump house is more than 50m, drainage sump with pumps shall be provided at both end of pump house.

The pump house apart from pump set shall also comprise plate heat exchangers (PHE), Auto backwash filters and simplex / duplex filters. Alternatively, PHE, Auto backwash filters, simplex / duplex filters may be provided on first floor of the pump house with design criteria same as of the pump house.

All pump houses and sumps shall be provided with RCC staircase upto roof/terrace at one end and cage ladder at other end. All pump houses having length more than 50m shall be provided with RCC staircase from two sides upto terrace/roof. All sumps shall be provided with hand railings of 1.2 m height and pump houses with parapet of 1.2 m height.

2.2. Sump/Tank

The sump/tank/suction chamber shall be designed as per the standard of Hydraulic Institute. Sump model tests shall be conducted, if necessary (refer HIS). Sump model test shall be carried out through government-approved institutions like CWPRS Pune, / IISc Bangalore/ IIT Roorkee/ IIT Bombay. The sump having soft/DM water shall be epoxy painted from inside. The sump/suction chamber shall have two compartments for each group of pump with provisions to divert the entire flow from the cooling tower/ settling tank to either of the compartments when one of the compartments is under repair/maintenance. Common suction chamber shall be provided so as to have independent suction for pumps. Sluice gates shall be provided for isolation of the compartments with common chamber. Sluice gates shall be provided for isolation of the compartments. The sluice gates shall be selected for velocity less than 0.5 m/s (refer standard). The suction chambers / sump shall be provided with drain and overflow connections leading to the nearest storm water drain. The minimum capacity of the sump shall be of 10 minutes of the working pumping capacity. However, single compartment may be accepted in case of single group of pump (single water circuit) is envisaged. All tanks/sumps/reservoir (for fire water) shall be RCC covered with suitable provisions for man & equipment entry. Suitable pit for enabling complete drainage.

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The makeup water shall be drawn into the sump through motorized/pneumatic valve, which shall open/close depending upon the level in the sump. The scheme of make-up water supply shall ensure maintenance of normal water level in the sump and prevent wastage through overflow. Level switch shall be provided in the sump, which will actuate motor/pneumatic operated valve on make-up water line to the sump in order to maintain water level within a desired range. A bypass make-up water line shall also be provided into the sump.

The pump house sump shall be provided with low level / very low level / high level / very high alarm and the pumps shall be provided with dry running protection.

2.3. Pump & Piping inside Pump house

Total no. of pumps for a particular group shall be selected in the following manners.

Total no. of working pumps for a particular group	Minimum no. of reserve pumps for each group
1 pump	1*
2 to 3	2
More than 3 but less than 6	3

* In case of slurry pump minimum 2 nos. of standby pump sets will be provided.

In case of drainage pumps, there will be one reserve pump for one working pump.

All the cold water and hot water pumps shall be of horizontal, centrifugal type side suction & side delivery type (HSC) and shall have flooded suction. If HSC/ SSSD pump model is not available with preferred vendors, ESTD pumps/vertical centrifugal pumps may be accepted (case to case). The design criteria of pump house and sump mentioned in this specification is also applicable for vertical centrifugal pumps.

For VT pump application stipulation of hydraulic institute shall be followed.

Open circuit

In pump suction: Gate valve (upto size DN 300) and Butterfly valve beyond DN 300 followed by rubber expansion joint (REJ) shall be provided.

In Pump delivery line: REJ followed by Dual Plate check valve (DPCV) followed by motorised/pneumatic butterfly valve followed by manual butterfly valve.
Recirculation line with control valve shall be provided, if required.

Closed circuit

In pump suction: Gate valve (upto size DN 300) and Butterfly valve beyond DN 300 followed by rubber expansion joint (REJ) shall be provided.

In Pump delivery line: REJ followed by Dual Plate check valve (DPCV) followed by motorised/pneumatic butterfly valve followed by manual butterfly valve.

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For closed circuit, all valves DN 300 and above shall be gear operated.

Ring main concept shall be adopted for the circuit having more than 01 (one) Working pumps. Suitable Segmentation valves shall be provided on the ring main.

Each pump shall be provided with local indication of pressure on suction side and local indication and signalling of pressure on delivery side.

Each header shall be provided with local indication, recording and signalling of flow, pressure and temperature, which shall be depicted on the panel of the control room.

All the valves of diameter 350 mm and above or the valves of any size which requires remote control operation shall be electrically / pneumatically operated. Electrically operated valves shall be provided with limit switches as a safety measure. Electrically operated valves shall have provision for manual operation also. All Manual valves of sizes DN150 to DN 300 shall be gear operated. All valves of sizes up to DN 100 shall be manual operated. Valves for fire fighting system shall be manual/gear operated only.

Rubber Expansion joints shall be provided near the pumps on both suction and delivery lines (i.e. size same as suction/delivery valve size).

The pipe network and valves within the pump house shall be adequately supported so as to avoid undue stress on the pumps.

2.4. Pump House Operation Philosophy

All the controls for the open circuit, recirculation system and cooling tower shall be provided and the control panel shall depict the working condition of various units.

The following interlocks shall be provided, as applicable, in the operation of all the pumps, such that for the starting of any of the pumps:

- The level of the liquid in the pump house basin is higher than the low level.
- Healthiness of the instruments shall be checked.

All the pumps shall be tripped when the low-low level is reached. Provision of automatic switch over of pump shall be provided in case of low pressure sensing at pump delivery line.

Wherever gravity drainage of premises is not feasible, suitable drainage pit shall be provided for collection of drain and stray effluents. Minimum two Vertical / submersible non clog type drainage pumps of adequate capacity shall be provided in the drainage pit for automatic operation based on the drainage pit water level. The level control equipment for automatic operation shall consist of the following:

a) level indication,
b) low level to stop the pump(s),
c) high level to start the first pump,
d) high-high level to start the second pump,
e) high-high-high level for alarm annunciation.

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2.5. Velocity in Pipes

The following flow velocities shall be maintained for the pump suction and delivery branches and water pipeline headers / branch headers and distribution network.

The following velocity criteria are not applicable for fire fighting system. The same shall be guided by IS: 13039, IS 3844 & IS 15325.

Open circuit

Pipe Diameter	Suction side (m/s)	Delivery side (m/s)
Upto DN 150	0.6 – 1.0	0.9 - 1.5
DN 200 to DN 450	0.8 – 1.2	1.2 - 1.5
DN 500 - DN 1200	1.0 – 1.2	1.5 – 2.2
Above DN 1200	1.5 – 2.0	2.2 – 2.5

2.6. Suitable chemical and chloride / biocide dosing facilities shall be provided in the suction chambers of the pump houses so as to prevent biological growth, scale/ corrosion in any of the circulating water system. The facilities shall consist of chemical storage tanks of suitable storage time, dosing pumps (metering type) one working and one reserve. The dosing system shall be complete in all respects with tanks, pumps, valves, supports, agitators and necessary pipe-work. 30 days chemical storage space shall be provided near the pump house in separate building.

2.7. Hoisting & Handling Equipment

The type of lifting device shall be selected based on amount of load to be lifted, height of lift and frequency of operation and the layout of the equipment to be lifted. In general, height of lift is 6 m and more, electrically operated handling equipment shall be provided.

1	Manual hoist with chain pulley block of capacity 1 t	for load from 15 kgs upto 200 kg
2	Electric hoist of capacity 2 t	for load more than 200 kg & upto 1.5 t
3	U/S Crane/ Single Girder EOT Crane of capacity 3t to 5t	for load more than 1.5 t up to 3.5t
4	U/S crane or DG EOT Crane above 5t	for load more than 3.5 t

All the Underslung cranes shall be provided with C type maintenance platform at one end of pump house. Regular RCC/ Structural Staircase shall be provided to reach the C type platform.

For detail specification of hoisting facilities, please refer the relevant clauses of Material Handling & hoisting General Specification write up.

2.8. Overhead Tank / Emergency Overhead Tanks

Make-up water and drinking water overhead tank will be provided at a suitable height for supply of make-up water and drinking water to different consumers for specific units as per details mentioned in the Technical specification.

Emergency overhead tanks will be provided each at a suitable staging height for supply of

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emergency water to critical consumers for a short duration (min. 30 minutes) in the event of interruption in normal cooling water supply. The overhead tanks may be single/multi-compartment type as per requirement, each compartment serving emergency water requirements of individual consumer. The filling of emergency water tanks for loss of water under normal operation and supply of cooling water from the tanks under emergency conditions will be under automatic control. Overhead tanks will be provided with overflow, drain, level transmitters, PRVs and air vent connections.

Overhead tank shall be of RCC construction, epoxy painted from inside (food grade in case of drinking water compartment) and shall be provided with overflow, drain and air vent connections. OH Tanks / EOHT will be provided with stair case (width 1.0 m) upto the top of the tank. There will be a walkable platform all around tanks with hand railings. Level of water in overhead tank will be transmitted to PLC system of respective cooling water system / pump house. OHT shall be provided with suitable lightning arrestor and aviation light.

One ground/underground tank of effective capacity 1.2 times the EOHT capacity shall be provided for collection of return emergency water. A separate group of pumps of adequate capacity (1W motor driven + 1S diesel driven) shall be provided for pumping back the emergency water collected in the underground tank to the overhead tank in 30 minutes. These pumps shall also be used for re-circulating the EOHT water through ground storage sump. Diesel engine operated emergency pumps will operate in conjunction with emergency overhead tanks for supplying emergency cooling water. Capacity of the diesel pumps will match the emergency water flow from the EOHT and shall not be less than normal cooling water flow.

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3. Design Criteria for Pipe Work

Pipe work is intended to convey fluids such as different qualities of water and industrial effluents.

The pipe work shall be designed, manufactured, assembled and tested as per the latest standards, codes and recommendations of the Bureau of Indian Standards, ANSI, ASTM, AWWA, or other equivalent international standards. Pipe work shall be complete in all respects including all accessories essential for proper installation, operation and maintenance.

Piping system shall be designed with high degree of reliability so that the systems perform the duty of fluid handling without any failure under all conditions of plant operation.

Piping layout must follow good engineering practice. Proper attention shall be given to obtain full functional requirement of the piping system with a layout, which provides sufficient clearance for other equipment and operating personnel, easy access for operation and maintenance, convenient supporting points and neat appearance.

Complete design of piping system shall be subject to approval by the Owner/ Consultant. The design shall take into account the effect of internal/external pressure, thermal expansion, self-weight of piping, support reactions, surge and water hammer, earthquake and wind effects at site, corrosion and erosion etc. and any other effects dictated by good engineering practices.

Water Hammer study Surge for cross-country pipeline and calculation of surge protection measures shall be arranged to be carried out by CWPRS Pune/ IISC Bangalore/ IITs / NITs.

MOC of pipe lines to be used for various services shall be as listed below:

1. Cooling / Circulation water (Industrial Quality) –Carbon steel (CS)
2. Waste water / Industrial effluent (with Chloride & hardness levels less than 100 ppm) – CS
3. Waste water / Industrial effluent (with Chloride & hardness levels more than 100 ppm or TDS level more than 1000 ppm) – CPVC/HDPE
4. Chemical pipe lines – CPVC/HDPE
5. Soft water pipe lines – softener frontal piping– SS & In other area – CS pipes
6. DM water pipe lines – SS pipes for SBA, SAC, MB & DM water transfer piping, CS for PSF & ACF and for chemical – as per above
7. Cross country piping – CMDI pipes/CS/GRP (based on application and pressure rating)
8. Make-up water distribution piping – CS pipes
9. Drinking water piping (interplant) – GI pipes upto DN 150 & CS above DN 150.
10. Slurry piping (abrasive) – CS pipes inner lined with abrasive resistant material.
11. Slurry piping (non-abrasive) – CS pipes with higher thickness.
12. Slurry launder – MS launder lined with 30 mm thick basalt tiles
13. Scale flume – RCC flume lined with 30 mm thick Basalt tiles.
14. Fire water (hydrant system) – CS pipes

As far as possible, Pipelines shall be laid over ground on the structural trestle. Wherever pipe lines are laid on trestle, maintenance/working platform with cage ladder in trestles shall be provided for maintenance of valves or any other equipment other than pipe is provided in the piping over trestles. Wherever it is not possible, it will be laid underground. Pipelines for

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Firewater, Industrial Makeup water & Drinking water may be laid underground.

As far as possible all the pipelines shall be laid together along the piping corridor. The piping corridor shall be parallel to and by the side of roads.

The pipe network shall be provided with air release valves at high points and drain valves at the lower points. Isolation valve (gate/ball valve) shall be provided at upstream of the air release valve for maintenance purpose.

Pipeline passing under or through equipment foundations or walls of buildings or any other inaccessible structure shall be provided with steel encasing pipes for easy insertion and removal.

All the gravity network shall be provided with slope of self-cleaning velocities with suitable manholes.

Continuous welding MS pipes shall be used in water services. However, flanged pipe at regular intervals & at bends shall be used for slurry (cast basalt pipe) and other corrosive fluid services.

Except where otherwise specified, all piping shall have butt-welded connections with a minimum of flanged joints for connections to equipment. Branches shall in general, be formed by welding.

Provision shall be made for branches for cleaning and flushing of pipelines wherever necessary.

Manholes shall be provided in the gravity pipe networks and the distance between two manholes shall be 30-50 m depending upon the pipe size.

Wherever over-ground pipelines are crossing roads and railway tracks, they shall be laid on pipe bridges to provide the necessary clearance for the traffic movement (refer relevant GS for layout and transportation)

Walkable platforms of min. width 1.0 m with necessary handrails shall be provided by the side of launder, scale flumes and open gravity network.

Pipe supports shall be capable of supporting the pipelines under all conditions of operation.

All the buried pipelines shall be laid as far as possible at a depth of about 1200 mm, below finished ground level (i.e. the top of the pipelines shall be 1.2 m below the finished ground level).

Isolation /control valves, drain valves, air release valve provided on the buried pipe network shall be housed in suitably sized covered valve pit and the valve pits shall be of self-draining type (means the water accumulation in the valve pit shall not occur). The pit shall be drained either through gravity or by means of pumping.

Wherever the buried pipelines are crossing the roads and tracks, they shall be suitably encased with mild steel pipes or reinforced concrete casing pipes (NP4 grade) and the

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different sizes of the encasing pipes shall be as appended:

Encased pipe diameter	Encasing pipe (For Flanged pipe) size (mm)	Encasing pipe (for welded pipe) size (mm)
Upto 100	300	250
150	400	300
200	500	400
300	600	400
350	600	500
400	700	600
500	800	700
600	900	800
700	1000	900
800	1100	1000
900	1200	1100
1000	1400	1200

In case a number of pipes are crossing road or track, these pipes shall be laid in a reinforced concrete culvert having easy access.

Mechanical cleaning and anticorrosive protection of underground MS pipelines shall conform to IS: 10221 – 1982. The anticorrosive protection of pipelines shall consist of the following activities in sequence.

i) Application of one coat of coal tar primer
ii) Application of one coat of coal tar enamel
iii) One wrap of fiber glass tissue
iv) Application of one coat of coal tar enamel
v) One layer of fiberglass tissue impregnated in coal tar enamel.
vi) Application of the final coat of a water-resistant white wash.

Alternatively Coal tar based anticorrosion tape as per IS: 15337 – 2003 shall be provided for protection of underground mild steel pipelines. The thickness of tapes shall be 3 mm upto pipe diameter DN 300 mm and 4 mm above pipe diameter of DN 300 mm.

3.1. Laying Buried Pipelines

All buried pipelines shall be laid with earth cover sufficient to avoid damage from pressure of vibration caused by the surface traffic. Minimum earth covering over the pipe shall be 1200 mm from the finished ground levels. For laying of buried pipelines earth work in excavation, back filling and acceptance of trenches etc. shall be as per IS: 5822, IS:3114 and IS: 12288.

The trench shall be so dug that the pipeline can be laid to the required alignment and at the required depth; proper levelling of the excavated surfaces is an essential requirement.

In case stones, boulders etc. are found at the bottom of the trench which cannot be removed completely, the bottom shall be levelled by sand layer for a minimum thickness of 150 mm.

If the depth of excavation is more, proper protection for sidewalls shall be provided till the pipe levelling is completed.

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The entire pipe trenches bottom shall be covered with local sand bed of 50 mm thick layer.

After laying the pipelines, 150 mm thick layer of local sand shall be provided over the sand bed.

Precautions shall be taken at all the times to prevent damage to the coating and wrapping in the pipe lines and appurtenances as applicable by workmen or trespassers during laying or at any other time. Pipe handling slung and any blocking used in handling or storing the pipes must be well padded to avoid damage to pipe and its coating.

After laying a pipeline on skids it shall be thoroughly cleaned, inspected and for any damage to the protective coating, satisfactory repair work shall be performed while the pipe is suspended above the trench.

Before laying the pipelines, the Owner shall examine the trenches and after his approval only the pipes can be laid.

After the pipes are erected and tested, the back filling of the trenches shall be done with loose soil free from stones, bricks and metallic pieces, in layers and shall be well rammed and compacted.

Where the pipelines cannot be laid overhead on stockades and are crossing roads and tracks at too many points in a given area, the pipeline may be laid in walk-able tunnels.

Pipelines in tunnels shall be provided with isolating valves, air release valves and drain valves, which are easily accessible for operation and maintenance.

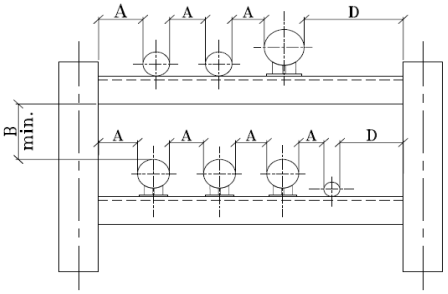
Pipelines in tunnels shall be suitably ventilated and illuminated. There shall be minimum two entries for the tunnel. Each tunnel shall be provided with at-least two vertical centrifugal, non-clog type drainage pumps/submersible pumps (one working and one standby) in a drainage pit and these pumps shall operate automatically based on the liquid levels. Tunnel shall be provided with saucer drain at one side with slope towards the drainage pit. Each tunnel shall be provided with at least a monorail and hoist for erection and maintenance purposes. Minimum height of the tunnel shall be of 3.0 m and suitable walkway of 1.2m minimum width shall be provided for each tunnel.

Spacing of Pipes in U/G Tunnels & Trenches/ OH Structural Trestles

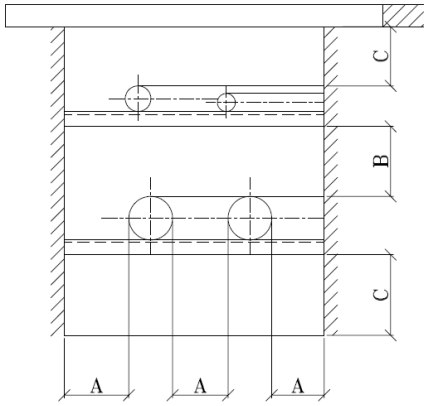
Pipes on O/H structural trestle.

For O/H trestle, 1m clear walkway with hand railings to be provided. If the width of the trestle is more than 6m, 1m walkway to be provided on both sides of the trestle. For pipe DN 350 & above, Saddle support to be provided. Cleat support can be provided inside pump house. For pipe less than DN 350 U-clamp support to be provided.

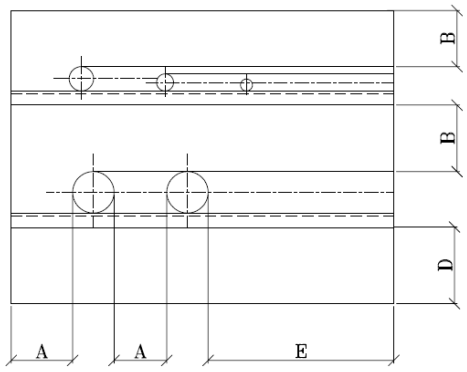
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The typical cross-section of tunnel/trench showing pipe arrangement is as indicated below:



PIPE IN TRENCH



PIPE IN TUNNEL

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Sl. No.	Nominal dia (mm)	Spacing (mm)				
		A	B	C	D	E
1.	50	150	300	100	150	800
2.	65	150	300	100	150	800
3.	80	150	300	100	150	800
4.	100	150	300	100	150	800
5.	125	150	300	100	150	800
6.	150	150	300	100	150	800
7.	200	300	300	100	300	800
8.	250	300	350	100	300	800
9.	300	300	400	100	300	800
10.	350	300	450	100	300	900
11.	400	350	500	100	300	900
12.	450	350	550	100	300	1000
13.	500	350	600	100	300	1000
14.	600	350	700	100	300	1200
15.	700	350	800	100	300	1200
16.	800	400	900	100	500	1500
17.	900	400	1000	100	500	1500
18.	1000	400	1100	100	500	1500

Pipelines within the shop buildings shall be laid overhead supported form the building columns/side walls/cranes girder etc. wherever this is not possible, the pipelines shall be laid either in tunnel or in pipe trenches (covered with removable slabs or chequered plates).

Wherever pipelines are crossing form one bay to another parallel bay, they shall be laid in tunnel or supported form the gable end.

3.2. Pipe Specification

A) Pipe Specification (Carbon Steel)

Type	Dia. (mm)	Standard	Material	Thickness	Manufacture
Black pipe	15-50	B36.10/ IS1239 (Part 1)	A106 / Fe 410	Sch 80 / Heavy class	Seamless
Black pipe	65-150	IS1239 (Part 1)	Fe410	Heavy class	ERW
Carbon steel	200-250	IS3589	Fe410	6.35mm	ERW
Carbon steel	300-350	IS3589	Fe410	7.14mm	ERW
Carbon steel	400-450	IS3589	Fe410	7.14mm	ERW
SW	500-900	IS3589:	Fe410	7.92mm	Spiral Welded.

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SW	1000-1200	IS3589	Fe410	8.74mm	Spiral Welded.
SW	Above 1200	IS3589	Fe410	12mm	Spiral Welded.
GI Pipe	15-150	IS1239 (Part 1)	Fe 410	Heavy class	ERW

CS Fittings	**Applicable standards**.
Pipe butt welded fittings **(Class 300)**	ANSI B16.9 ANSI B16.28 Material: ASTM A234 WPB
Forged fittings **(Class 3000)**: - (Socket / Screwed fittings)	ANSI B16.11, thread to ASA B2.1 Material: ASTM A105
Mitre Bend: -	To be fabricated from parent pipe
Nuts & Bolts	ASTM A194 Gr. 2H ASTM A193 Gr B7

B) Pipe Specification (Stainless steel)

Pipe size	**Applicable standards**.
Upto Dia. 50mm.	Dimensions as per ANSI B36.19, Schedule 40, Conforming ASTM A312 TP304
Beyond 65mm and above	Dimensions as per ANSI B36.19, Schedule 20, Conforming ASTM A312 TP304

SS Fittings	**Applicable standards**.
Butt welding fittings **(Class 300)**	As per ANSI – 16.9, ASTM A304 WP304
Socket welding fittings **(Class 3000**	As per ANSI B16.11– A182 F-304
Screwed fittings	As per ANSI B16.11– A182 F-304

C) HDPE Pipes

1. From sizes OD 20 to OD 50 – IS 7328- PE100, PN 16, Plain End, Dimensional Standard IS 4984
2. From Sizes OF 63 to OD 630 - IS 7328- PE100, PN 10, Plain End, Dimensional Standard IS

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4984

3. HDPE fitting shall generally confirm to IS 7328 PE-100, PN 16/PN 10 based on the pipe rating.

D) CPVC pipe & fittings

1. Pipes of size DN 15 to DN 350 – ASTM D1784 – CPVC (23447-B), Sch. 40, Plain end, Dimensional standard – ASTM F441
2. Fittings - ASTM D1784 – CPVC (23447-B), Sch. 80, Socket cemented, Dimensional standard – ASTM F438

3.3. Table for Maximum Span of Supports

Sl. No.	Nominal pipe size (mm)	Maximum span for liquid services (m)
1.	25	2.1
2.	40	2.7
3.	50	3.0
4.	65	3.4
5.	80	4.0
6.	100	4.3
7.	150	5.2
8.	200	5.8
9.	250	6.7
10.	300	7.0
11.	350	7.6
12.	400	8.2
13.	450	8.5
14.	500	9.2
15.	600	9.8
16.	900	12.0
17.	1000	15.0

Note: Vertical pipe work shall be clamped at intervals of 3.5m (approx.) and at the base of each riser. Maximum span at the place of turning shall be 0.7 times of normal span.

Dimensional Performance and End Finishes

Tolerance on outside diameter of the pipe and specified thickness shall conform to the limits laid down in IS: 3589. Finish pipe shall not deviate from straightness by more than 0.2% of the total length.

Pipes to be butt-welded shall be supplied with ends bevelled to an angle as mentioned in IS: 1239 and IS 3589.

Method of Quality Control in Welded Joints

Following steps shall be taken besides controlling quality in general, to make effective control in carrying out welded joints.

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a) Welding procedures shall be prepared in line with IS: 7307 (Part – I) and tests shall be carried out to quality procedures. Number of procedures will depend on variables like positions of welding, thickness range etc. Once a welding procedure is qualified, strict adherence to it shall be made during actual welding.

b) Welders employed shall be qualified as per IS: 7310 (Part – I) after passing necessary tests.

c) Welding consumables shall be of approved type. Such consumables are, however, subject to qualifying initial check tests as per IS: 814.

d) The approved welding procedure shall be followed during actual welding. Besides, the following stages of inspection shall also be carried out:

i) Weld edge preparation before welding, proper fit up, position of welding, cleaning of slag between the passes, proper weld profile etc., shall be checked visually amongst others.

ii) Non-destructive tests of weld of welded joints shall be carried out as per approved procedures/ drawings.

Preparation of Joints

Prepare the edge correctly to the shape, size and dimensions of the vee-grooves as per ANSI B-16.25 unless otherwise specified in drawings/ documents.

The welding surfaces shall be smooth, uniform and free from fins, tears, notches or any other defect which may adversely affect welding and shall be free from loose scale, slag, rust, grease, paint, moisture or any other foreign material. The clean surface shall extend to about 10 mm beyond the welding faces to avoid contamination of the weld metal with foreign material and to avoid unsound weld deposit.

Assembly, Alignment & Welding

The sequence of welding shall be so planned and followed that there shall be a balance of welding about the neutral axis of the fabrication. sufficient number of welders working shall be employed at the same time in diagonal quadrants of the shell using back-step method of welding. The rate of progress of each welder shall be more or less equal and quality uniform.

The general direction of welding shall be towards the free end of the joint, but in a long joint as in shell fabrication, back-step technique shall be used to reduce distortion.

To minimize internal locked up stresses due to welding, the vertical joints for the shell shall be welded and completed to a circular course and then the horizontal circumferential seam welded. However, before the welding of horizontal seam started, the complete circular course shall be aligned and adjusted for their correct axes.

Alternatively, complete each course in all respect on ground and then the pre-assembled course shall be listed and placed in position. In such a sequence and planning, the same principle of balancing of weld about the neutral axis shall be followed and the method of fabrication of each course shall be similar to fabrication of penstock pipes of transmission/ industrial pipelines of bigger diameter.

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Pipe and attachment shall be aligned properly by accurate and permanent methods prior to welding. If tack welds are used, the tack shall be either fused into the first layer or weld or else chipped out.

Tests on welded joints

(a) Visual examination

Conduct visual examination and measurement of external dimensions of the weld for all joints. Before examining the welded joints, areas close to it on both sides of the weld for a width not less that of 20 mm shall be cleared of slag and other impurities. Examination shall be done by magnifying glass which has a magnification power of ten (10) and measuring instrument which has an accuracy of ± 0.1 mm of by weld gauges. Welded joints shall be examined from both sides. After leak test of the pipeline the coating of the joints shall be done. examine the following during the Visual examination: -

i. Check the correctness of shape and size of the welded joints
ii. Incomplete penetration of weld metal
iii. Influx
iv. Burns
v. Under cuts
vi. Un-welded crates
vii. Cracks in welded spots and heat affected zones
viii. Porosity in welds and spot welds
ix. Compression in welded joints as a result of electrode impact while carrying out contact welding
x. Displacement of welded element.

To carry out any or all tests as specified hereinafter to satisfy the Purchaser about the acceptability of the welded joints, as directed by the Purchaser.

(b) Liquid Dye-penetrant Test

Liquid dye-penetrant tests shall be carried out in accordance with IS: 3658 for surface/ sub-surface defects.

(c) Test by Blowing

The surface of the weld shall be covered with soap solution consisting of one (1) litre of water and hundred (100) grams of soap. Compressed air shall be blown from the opposite side at pressure of 4 to 5 kg/cm^2. The distance between the tip of base and the weld shall not be more than 50 mm. Any formation of soap bubble will indicate welding defects. Portable compressor shall be arranged, if necessary, for this purpose.

(d) Hydro-testing

The pipes shall be tested with water for correctness of pressure withstanding. The hydro test pressure for all welded/flanged water carrying pipes shall be 1.5 times of working pressure or 10 kg/cm2, whichever is higher.

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Tolerance

Deviations for assembly of welded joints may be permitted to the following extent:

Sl. No.		Tolerance	
		Manual arc	**Automatic**
a)	Source butt-Joints		
	i) Gap between the ends of plates	+ 2.00 mm - 1.00 mm	± 1.00 mm
	ii) Stepping of one plate over the other	1.00 mm	2.00 mm
b)	Single Vee-groove Joints		
	i) Bevel angle	± 5 deg.	± 5 deg.
	ii) Gap between two	+ 2.00 mm - 1.00 mm	+ 1.00 mm
		Manual arc	**Automatic**
	iii) Stepping of one plate over other	2.00 mm	2.00 mm
c)	Lap Joint		
	i) Overlap	5.00 mm	5.00 mm
	ii) Gap between the surface	2.00 mm	1.00 mm
d)	Tee-filler Joints		
	i) Gap between the edges of the web and the surface of the flange	2.00 mm	2.00 mm

Note: After hydro testing of the pipeline all the joints shall be coated / painted only after rectification of defects if any.

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4. Design Criteria for Pumps

4.1. Horizontal & Vertical Centrifugal Pumps

All the pumps provided in the pump house shall be horizontal centrifugal type with flooded suction. Drainage pumps installed in sump pits shall be horizontal centrifugal type with priming tank arrangement. In the event of space constraints, the use of vertical centrifugal/non-clog submersible pumps may be permitted. Pump type shall be HSC SSSD type only. In case the HSC SSSD pump of required duty parameter are not in the manufacturing range of approved make, ESTD pump can be accepted subject to submission of details.

The horizontal pumps shall be mounted on a common base plate with the motor and shall be directly coupled to the motor thorough a flexible coupling without any gear reducer. In case of slurry pumps V-belt driven to be provided. Fluid coupling for slurry pumps to be provided as per system requirement.

The pumps (horizontal as well as vertical centrifugal) will be designed, manufactured and tested as per IS:1520, IS:5120, IS:9137 or as per international standards acceptable to the Purchaser and will be suitable for the required duty conditions and capacities.

The pumps and their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty at full load.

The centrifugal pumps shall be suitable for a capacity range of 25% to 125% of duty point capacity. However, Pumps having low flow & high head may be suitably reviewed during detailed engg regarding above.

The motor capacity shall have a margin over its BHP absorbed at the pump shaft at duty point and the margin shall be 25% for motors of rating upto 15kW, 20% for motors of rating 18.5kW to 160kW and 15% for motors of rating 200kW and above. The above margin shall be in addition to temperature derating.

All the pumps shall be selected keeping margin of 10% on rated flow or 5% on calculated head. Pump set with motor of 300 kW and above shall be of nominal 1000 rpm or less. The head rise from rated point to shutoff shall be at least 15 % for pumps upto & including 15 KW motor rating and shall be at least 10% for pumps above 15 KW motor rating. In any case, head rise from rated point to shut off shall not exceed 20%.

The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantable without disturbing the suction and delivery pipe connections.

The equipment design shall incorporate provisions for reduction in noise level of Max 85 dB from 1m distance.

The rotating elements of the pumps shall be checked for critical speed in bending as well as in torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating speed in case of stiff shafts.

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All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

The direction of rotation shall be clearly marked either by incorporating it on the casing or by separate metal plate arrow securely fitted to the casing.

- The head – Vs – discharge characteristics of the pump shall be continuously rising form the duty point to the shut off point without any zone of instability. The required duty range for a pump shall be on the stable portion of its head capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge. The power-Vs- discharge characteristics shall be non-overloading type.

- The pump shall be so selected and installed that the available NPSH is not lower than the required NPSH even in the most adverse operating conditions. Impeller diameter shall be selected preferably with in 25%-75% range of the respective family curve.

- Each pump shall be tested as per the standards stipulated elsewhere in this document. The test shall include hydrostatic test, static and dynamic balancing tests, performance tests, material tests and motor routine tests.

- The pump shaft and bearing shall be adequately sized to take the unbalanced forced due to mal-operation. The pump gland shall ensure proper sealing without excessive tightening of the packing. Proper cooling and flushing arrangement for the gland shall be provided wherever required.

- All moving parts of the pump shall be adequately guarded to prevent any injury to operating personnel.

- Pumps shall be designed and installed keeping in view the easy accessibility of its parts for maintenance. All end suction pumps shall be of back-pull-out design and shall be provided with spacer coupling of adequate length.

- Mechanical seals shall be provided at all pumps envisaged for closed loop circuit and DM water application.

- Minimum no. of standby pump shall be provided for each group of pumps and drainage pumps as specified in the design criteria for pump house.

- The suction pipeline shall be laid at a constant down ward slope from pump centre line to the suction chamber. Reducers used in the line shall be eccentric type to keep the top of the suction line straight.

- Each pump shall be provided with adequate safety interlocks including overload and dry running protection.

- All pumps shall be provided with suitable lifting attachments and each pump installation shall have suitable handling facilities.

- The details of pumps should match with the drive motors throughout the working life of these equipments and to meet operational requirement. High-speed motors of 3000

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rpm shall not be used, as for as practicable. However for low flow and high head, rpm of 2900 will be accepted on case to case basis.

- Pumps shall be installed and commissioned as per manufacturer's instructions. A continuous running for 72 hours shall be required before final acceptance is given to the pumping installation.

4.1.1. Shop testing of pumps

- All materials, casting and forging shall be of tested quality.
- Pump casing shall be of robust construction and hydrostatically tested at 200% of the rated pressure or 150 % shut off pressure, whichever is higher. The test pressure shall be maintained for at least 15 minutes.
- The impellers along with any other un-machined rotating parts shall be tested for proper balancing in order to avoid undue vibration during operation.
- Performance tests shall be carried on each centrifugal pump. Performance test shall be made to determine the following.

  a) The discharge against a specified head when running at a specified speed under a specific suction head.

  b) The power absorbed by the pump at the shaft (BHP) under the above-specified conditions.

  c) Efficiency of the pump under the above specified conditions.

  d) Variation of required NPSH with discharge.

- The pump accessories like bearings, couplings etc. shall be subject to shop tests as per manufacturer's standards.
- The materials of construction of various components of all equipment and material covered under the scope of this specification shall be certified by the contractor with regard to their compliance to specifications laid down for them under relevant clauses of applicable standards and /or the manufacturing drawings of the contractor duly approved by the purchaser. Formal material test certificates to the effect shall be issued by the contractor.
- All test results and certificates including material test certificates shall be submitted for approval to the purchaser before dispatch of equipment.

A stainless-steel name plate shall be furnished and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information: -

- Name of Manufacturer
- Model No.
- Purchaser's item no. or tag No.

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- Serial number of pump
- Capacity in cubic meters per hour
- Pumping head in meters of liquid column
- Specific gravity of liquid pumped
- Revolutions per minute
- Pump input power, kW
- Motor rating, kW
- Design code IS/IPSS:

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4.1.2. Material of Construction For Pumps

A) Horizontal Pumps

Sl. No	ITEM	MATERIAL					
		Clear water/ Industrial Water	Soft Water	DM Water	Drinking Water / Fire water	Scale / Slurry Water	Surface Drain Water
a)	Casing	WCB	WCB	CF-8M	WCB	CI FG 260 2.5% NiCI or Chrome alloy BHN above 500	CI FG 260 2.5% NiCI
b)	Impeller	CF8M	CF8M	CF8M	LTB 2 BR/ CF 8M	CA6NM or Chrome alloy BHN above 500	CIFG 260 2%NiCI
c)	Shaft	EN8	EN8	EN8	EN8	EN8	EN8
d)	Shaft sleeve	SS410	SS410	SS410	SS410	Chrome alloy BHN above 500	SS410
e)	Wearing rings	CI IS: 210 FG260	CI IS: 210 FG260	CI IS: 210 FG260	CI IS: 210 FG260	Chrome alloy BHN above 500	CI IS: 210 FG260
f)	Shims & packings	Brass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442
g)	Neck ring	CI FG 260	CI FG 260	CI FG 260	CI FG 260	Chrome alloy BHN above 500	CI FG 260
h)	Lantern ring	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220

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Sl. No	ITEM	MATERIAL					
		Clear water/ Industrial Water	Soft Water	DM Water	Drinking Water / Fire water	Scale / Slurry Water	Surface Drain Water
i)	Gland	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220
j)	Bearing end cover	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220
k)	Bearing Housing	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220
l)	Coupling Pump & motor	CI FG 260	CI FG 260	CI FG 260	CI FG 260	CI FG 260	CI FG 260
m)	'O' rings	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber
n)	Sleeve nuts	SS 410	SS 410	SS 410	SS 410	SS 410	SS 410
o)	Cowl nuts	SS410	SS410	SS410	SS410	SS410	SS410
p)	Base plate	MS Fabricated	MS Fabricated	MS Fabricated	MS Fabricated	MS Fabricated	MS Fabricated

Note:
1. All pumps handling soft / DM water shall be provided with Mech. Seal.
2. MOC for all pumps shall be compatible with the fluid handled.

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B) Vertical Pumps

Sl. No	ITEM	MATERIAL
1	IMPELLER	19-10 Molybdenum Austenitic Stainless Steel AISI-316 or ASTM A296 CF 8M
2	CASING/ BOWL	2.5% Ni CI: IS 210 FG260
3	CASING RING	CAST IRON (IS 210 FG 260)
4	LINE SHAFT	Chromium Steel AISI-410
5	SHAFT SLEEVE	SS – 410
6	GLAND	CAST IRON
7	BASE FRAME	M.S FABRICATED
8	COMPANION FLANGES	M.S
9	COLUMN PIPE & DISCHARGE HEAD	Carbon Steel IS-2062-1992
10	SUCTION STRAINER	MS GALVANISED

4.2. Vertical Turbine Pump

Vertical Turbine Pumps along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and manufactured for continuous duty at full load.

The vertical turbine pump shall be designed, manufactured and tested as per IS: 1710.

The motor rating shall be maximum of the following requirements: -

a. 15% margin over the pump shaft input power at the rated conditions.
b. 5% margin over the maximum pump shaft input power required within its operating range including the shut-off point.

The above margin shall be in addition to temperature derating.
Capacity Vs discharge pressure curve for each pump shall preferably be continuously drooping from the shut-off point to the rated operation point and be suitable for parallel operation. The pumps shall be designed to avoid cavitation at any of the operating points. The characteristic of the pump shall be non-over loading type.

The required duty range for a pump shall be on stable portion of its head-capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge.

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The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment design shall incorporate provisions for reduction in noise level. The head rise from rated point to shutoff shall be at least 10 % for VT pumps.

The rotating elements of the pumps shall be checked for critical speed in bending as well as torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating sped in case of stiff shafts.

The pumps shall be capable of reverse rotation upto 125% of rated speed due to reverse flow of water.

All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

The direction of rotation shall be clearly marked on a separate metal plate arrow securely fitted to the casing.

A stainless-steel name plate shall be furnished and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information: -

- Name of Manufacturer
- Model No.
- Purchaser's item no. or tag No.
- Serial number of pump
- Capacity in cubic meters per hour
- Pumping head in meters of liquid column
- Specific gravity of liquid pumped
- Revolutions per minute
- Pump input power, kW
- Motor rating, kW
- Design code IS/IPSS

4.2.1. Inspection & Testing

The tests to be conducted at shop for various sub-assemblies/ assemblies of equipment shall include, but not limited to the following:

I. Material/ identification tests for all the components of the pump
II. NDT as indicated below:

(a) Impeller:	Dye Penetration Test (DPT)
(b) Shaft:	DPT and Ultrasonic test

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(c) Wearing rings:	DPT
(d) Impeller:	dynamic balancing
(e) Pump assembly:	Visual inspection

III. Hydrostatic test:

Hydrostatic test shall be done for the following components at a minimum pressure of 200% of shut-off head. The test pressure shall be maintained for at least one hour.

(a) Bowl
(b) Suction bell
(c) Discharge head
(d) Column pipe

IV. Performance test:

Performance test shall be conducted on each pump with one of the actual drive motors at the manufacturer's works in presence of Purchaser's representative as per the requirements of the relevant test codes.

Performance tests shall be conducted at rated r.p.m. to cover the entire range of operation of the pumps. These shall at least cover the range from shut-off point upto 1.3 times the rated capacity of pumps. A minimum of 5 readings shall be taken for capacity Vs Head, covering the above range. After performance test, the pump shall be dismantled for inspection of internal components.

Mechanical run test shall be carried on all pumps to demonstrate smooth running of the pumps, measurement of noise levels, vibration, etc. This test shall be carried out at site also and the site test shall be taken for acceptance of the pump. The noise level shall not exceed 85 dB at 1.0 m distance from the pump or as per the latest norm whichever is less.

The pumps shall be tested for vibration at the guarantee points. Vibration limit shall be as per Hydraulic Institute Standard/ API 610.

The following tolerances shall apply for the performance tests: -
i) Rated capacity: +2.5% at rated head
ii) Efficiency at rated capacity: No negative tolerance

Test reports and manufacturer's test certificates shall be submitted to the Purchaser/ Consultant for approval.

The final tests shall be conducted in the presence of the Purchaser's representative. Test certificates for different tests shall be made available to the Purchaser during the inspection. Material test certificates for bought out items shall be obtained from original manufacturer/

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reputed test house. For all bought out items, test certificates as relevant to the items shall be furnished by the Contractor.

All the pumps shall be subject to stage inspection by the Contractor's own inspecting authority. However, Purchaser's Inspector may visit the works from time to time who should have free access to all the places of the manufacturing premises where any part/ parts are under manufacture.

The Contractor's inspecting authority shall have a close surveillance in respect of the quality of job for the design dimensions, tolerances, surface finish, etc.

4.3. List of Spares for Pump sets

In general, the spares to be supplied with pump sets shall include the following. The spares are intended to cover all wearable/damageable delicate items of the plant.

a) Engine Driven Pumps

Diesel Engine Driven Pump HSC				REMARKS
Sl. No	Description	UNIT	QTY	
1	NECK RING (SET)	SETS	1	One set for each pump
2	SHAFT SLEEVE with nut and lock nut(SET)	SETS	1	One set for each pump
3	BEARING NUT WITH LOCK NUT &WASHERS (SET)	SETS	1	One set for each pump
4	MECHANICAL SEAL KIT WITH GLAND PLATE COMPLETE SET	SETS	1	One set for each pump
5	FINISHED BORE Coupling FOR PUMP	SETS	1	One set for each pump
6	FINISHED BORE Coupling FOR ENGINES	SETS	1	One set for each pump
7	Coupling bushes /spider (sets)	SETS	1	One set for each pump
8	Set of O rings	SETS	1	One set for each pump

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9	Impeller	NOS	1	One No. for each group of pump

b) Multi Stage Pumps

Sl.No	Description	UNIT	QTY	REMARKS
1	COMPLETE PUMP SET	SETS	1	One set for each group of pump
2	NECK RING /WEAR RING (SET)	SETS	1	One set for each pump
3	DISTANCE SLEEVE (SET) FOR EACH PUMP	SETS	1	One set for each pump
4	Suction & Delivery Sleeve	sets	2	One set for each pump
5	Shaft sleeve (set)	SETS	1	One set for each pump
6	SET OF KEYS , ALL STAGE IMPELLER AND COUPLING (SET)	SETS	1	One set for each pump
7	COMPLETE MECHANICAL SEAL WITH GLAND PLATE .	SETS	1	One set for each pump
8	Bearing End Cover DE&NDE SET	SETS	1	One set for each pump
9	FINISHED BORE Coupling pumps	NOS	1	One No. for each pump
10	FINISHED BORE Coupling SET motor	NOS	1	One No. for each group of pump
11	Complete O ring SET	SETS	1	One set for each pump
12	Interstage bush for Diffuser& D.W.G.V (set)	SETS	1	One set for each pump
13	CIRCLIP FOR PUMPS (NOS)	NOS	1	One No. for each pump
14	Impeller	NOS	1	One No. for each group of pump

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c) HSC Pumps

Sl.No	ITEM NAME	UNIT	QTY	Remarks
1	COMPLETE ROTATING ASSEMBLY (except top, bottom casing & mechanical seal).	SET	1	one set for each group of pump
2	NECK RING/WEAR RING /casing ring	SET	1	one set for each pump
3	SHAFT SLEEVE with nut and lock nuts	SET	1	one set for each pump
4	BEARING NUT WITH LOCK NUT &WASHER	SET	1	one set for each pump
5	MECHANICAL SEAL KIT WITH GLAND PLATE COMPLETE SET.	SET	1	one set for each pump
6	Bearing End Cover DE&NDE SET	SET	2	2 set for each group of pump
7	FINISHED BORE Coupling for PUMP	Nos.	1	one number for each group of pump
8	FINISHED BORE Coupling for Motor	Nos.	1	one number for each group of pump
9	Pin with Rubber Bushes fasteners, FOR COUPLING SET	SET	1	one set for each pump
10	SETS OF "O" rings for complete set of pump.	SET	1	one set for each pump
11	DE Shield	SET	1	one set for each pump
12	NDE SHIELD	SET	1	one set for each pump
13	Logging ring	SET	1	one set for each pump

d) ESTD Pumps

Sl.No	Description	UNIT	QTY	Remarks
1	COMPLETE SET OF ROTATING ASSEMBLY	SETS	1	One set for each group of pump
2	wear ring/NECK RING /Impeller ring	SETS	1	One set for each group of pump

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3	LANTERN RING	SETS	1	One set for each group of pump
4	SHAFT SLEEVE	SETS	1	One set for each group of pump
5	SET OF KEYS FOR IMPELLER AND COUPLING	SETS	1	One set for each group of pump
6	Impeller lock nut	Nos.	1	One No. for each group of pump
7	Finished bore Coupling SET FOR PUMP	SETS	1	One set for each group of pump
8	Finished bore Coupling SET FOR MOTOR	Nos.	1	One No. for each group of pump
9	SPIDER FOR ESTD &MST PUMP	Nos.	1	One No. for each group of pump
10	O RING FOR CASHING	SETS	1	One set for each group of pump
11	CIRCLIP FOR ESTD PUMPS	Nos.	1	One No. for each group of pump

e) Vertical Pumps

Sl.No	ITEM NAME	UNIT	QTY	REMARKS
1	Pin with Rubber Bushes fasteners, FOR COUPLING SET	SET	1	one set for each group of pump
2	FINISHED BORE Coupling for PUMP	SET	1	one set for each group of pump
3	FINISHED BORE Coupling for Motor	SET	1	one set for each group of pump
4	BEARING With Nut & LOCK NUT &WASHER	SET	1	one set for each group of pump
5	Impeller	Nos.	1	One No. for each group of pump

f) Vertical Turbine Pumps

Sl.No	ITEM NAME	UNIT	QTY	REMARKS

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1	Sleeve	Nos.	1	one set for each pump
2	Adjusting Nut	Nos.	1	one set for each pump
3	Bush Packing Box	Nos.	1	one set for each pump
4	Water deflector	Nos.	1	one set for each pump
5	Column Pipe	Nos.	1	one set for each pump
6	Line Shaft	Nos.	1	one set for each pump
7	Shaft Sleeve	Nos.	1	one set for each pump
8	Impeller seal ring	Nos.	1	one set for each pump
9	Thrust ring	Nos.	1	one set for each pump
10	Thrust ring retainer	Nos.	1	one set for each pump
11	Pump Shaft	Nos.	1	one set for each pump
12	Shaft coupling	Nos.	1	one set for each pump
13	Basket strainer	Nos.	1	one set for each pump

4.4. DIESEL ENGINE FOR PUMPSET

A) General

- The diesel engine shall be complete with all standard accessories, battery sets, battery charger, instruments & control panel, base frame etc. The noise level for diesel engine shall not exceed 105 dBA at 1.0m distance. If required Acoustic enclosure to be provided.

- The diesel engine shall be compression ignition mechanical direct injection type, capable of being started by a battery powered electric starter motor, and shall accept full load within 15 seconds from the receipt of signal to start.

- The diesel engine shall be natural aspirated, super charged or turbo charged and either air or water-cooled. In case of charge air cooling by means of a belt driven fan or of a belt driven auxiliary water pump, there shall be multiple belts such that half the belts

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should be capable of driving the fan or pump.

- The diesel engine shall be capable of operating continuously (24 hours) on full load.
- The engine driven pump set shall be deemed commissioned after running for 03 hours.
- The diesel engine shall be provided with an automatically adjustable governor to control the engine speed with 10% of its 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.
- The diesel engine shall be provided within-in-built tachometer to indicate the speed of the engine in rpm.
- Any manual device fitted to the engine, which could prevent the engine starting, shall return automatically to the normal position.
- Engines after correction for altitude and ambient temperature shall have bare engine horsepower rating of 10% in excess of maximum horse power required to drive the pump at its duty point.
- The coupling between the engine and the pump shall allow each unit to be removed without disturbing the other.
- The diesel engine capacity shall have a margin over its BHP absorbed at the pump shaft at duty point and the margin shall be 20% for engines of rating upto 200 HP and 15% for engines of rating above 200 HP.

B) Cooling System

- The engine shall be cooled by water from the discharge of the pump (takes off prior to the pump discharge valve) direct into the engine cylinder jackets via a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall be terminated at least 150 mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.
- The discharge from the engine shall be collected and drained into the nearest drainage channel.

C) Air Filtration

The air intake system ensures sufficient clean air to the engine. It shall incorporate the

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suction air filter, which shall be of oil bath type to supply clean air to the engine.

D) Exhaust System

The hot exhaust gases shall be let-off with suitable system. All the hot parts located at the working level shall be insulated. The exhaust system shall include:

- Exhaust manifold
- Silencer: The exhaust gas shall be let off through suitable silencer. The total back pressure shall not exceed the engine manufacturer's recommendation. Sufficient length of straight pipe shall be provided after the exhaust silencer to leave the gases at sufficient height 2 m above the roof of the engine room.
- Expansion joint in SS construction to reduce the forces and moment likely to be transmitted on the engine frame.

E) Fuel System

- Fuel for the engine shall be high-speed diesel oil as per IS : 1460 – 1974.
- Fuel tank and fuel feed pipe shall be provided for the engine.
- The fuel tank shall have the capacity sufficient enough to allow the running of the engine at full load for 4 hours.
- The fuel tank shall be of welded steel construction. The tank shall be mounted above the engine fuel pump to give gravity feed. The tank shall be fitted with a level gauge calibrated in liters, filling in and cleaning hand holes, drain cocks, self supporting from and connection to the engine fuel oil system.
- Valves in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and they shall be located in open position. Plastic tubing shall not be used.
- A duplex filter to suitable capacity shall be provided for the fuel feed pipe between the fuel tank and fuel pump.
- Suitable sludge and sediment trap shall be provided for the fuel feeding system.
- The fuel tanks shall be supplied with hand pump for tapping the fuel tank from oil barrel.

F) Lubricating System

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The lubrication system shall be self-contained with the following equipment.

- Sump: To store sufficient lube oil for circulation, suitable sump shall be located in the engine.
- Pump: Suitable pump for forced lubrication.
- Filter
- Lubricating oil cooler
- Interconnecting piping & tubes in seamless construction.

G) Starting System

The engine shall be capable of manual starting by electric starter motor**.** Since the pump driven by the diesel engine is not required to run continuously for long period and the operation will not be frequent, special features shall be built –in the engine to allow it to start within a very short period, even if it has been remained idle for a considerable long period.

The engine shall be designed in such a way that is shall be started by one operator, if necessary, without any preliminary heating of the combustion chamber. All controls/mechanism, which has to be operated in the starting process, will be within easy reach of the operator.

Automatic cranking shall be effected by a battery driven 24V DC motor having high starting torque to have adequate ampere-hour capacity to provide the starting power for the diesel engine. A control panel for starting of the engine through battery to be provided. Engine START/STOP/TEST buttons shall be provided on control panel. The battery capacity shall be adequate for ten (10) Consecutive starts without recharging with a cold engine under full compression.

The battery shall be used exclusively for starting the diesel engine and kept fully charged all the time. Arrangement for both trickle and booster charge shall be provided. However, when the engine starts or is running, provision shall be kept to ensure that the charger is automatically disconnected and the battery is charged by the engine dynamo. At no times it should happen that the battery gets disconnected and is not available to start the engine.

The charger shall give constant D.C output voltage irrespective of incoming voltage variation specified. The charger shall be with fully controlled bridge circuit with diodes.

H) Governing System

The governor shall be fitted with a speed control device, which will control the speed under all conditions of load.

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The governor shall offer the following features:

Engine should be provided with an adjustable governor capable of regulating engine speed within a range of 10% between shut-off and maximum load condition of the pump. The governor shall be set to maintain rated pump speed at maximum pump load. Engine shall be provided with an over-speed shutdown device. It shall be arranged to shut down the engine at a speed approximately 20% above rated engine 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.

The governor shall be capable of operating without external power supply.

I) Foundation Frame

Suitable foundation frame with foundation bolts & nuts shall be provided.

J) Instruments

The equipment shall be provided with necessary instruments to check the working of the engine continuously. The following instruments shall be minimum which will be provided and the same shall be fixed on a common instrumentation panel mounted directly on the engine base frame:

- Lubricating oil temperature indicator.
- Lubricating oil pressure indicator.
- Cooling water inlet temperature indicator.
- Cooling water outlet temperature indicator.
- Speed-cum-hour meter.

The pressure and temperature gauges shall be of reputed make. The following protections annunciation also shall be provided.

a. High cooling water outlet temperature
b. Low lubricating oil pressure

Any other instrument, control and protection equipment required for the safe operation of the engine shall also be provided.

All the pressure gauges, pressure transmitter, pressure switches etc. where viscous fluid enters inside the instruments shall be provided with diaphragm sealed flanged process connection with flanged isolation valves.

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K) Spares & special tools

List of spare & special tools shall be furnished. Further, following mandatory spares shall be included in the scope of supply.

- Two sets of fuel filters, elements & seals
- Two sets of lubricating oil filters, elements & seals
- Two sets of belts (where used)
- Two sets of engine joints, gaskets & hoses
- Two injector nozzles
- Two complete sets of piston rings for each cylinder
- Two inlet valve and two exhaust valves

In addition to the above, the bidder may include any other spare parts and special tools for maintenance/re-erection of the diesel engine/pump.

L) Diesel Engine Tests

Engine will be tested at test bed as per relevant standard as per details given below.

1) Before engine testing following details shall be recorded on engine test report.
   - Engine Sr. No.
   - Engine Model
   - Shop order No.
   - Fuel Pump Sr. No.
   - Ambient Temp and pressure
   - Testing Date
   - Test Bed No.
   - Tester/ Inspector

2) Start the engine and run at idle speed for some time.

3) Raise the load gradually and allow the performance parameter to reach steady state condition. Check power output at full throttle as per specification and adjust if necessary. Note down following parameters on engine test report.

   - Time
   - RPM
   - Torque (N-M)
   - BHP (Calculated)
   - Fuel Pressure
   - Fuel Rate
   - Lube Oil Pressure

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- Lube Oil Temperature
- Water Temperature
- Exhaust Temperature
- High Idle RPM
- Low Idle RPM
- Corresponding Lube Oil Pressure @ High Idle and Low Idle RPM
- Governing %

Above parameters will be recorded at following load and duration.

Full load	-	60 Minutes
10 % Over Load	-	60 Minutes

4) Engine will be tested with standard test bed facilities.

For each of the items being manufactured/supplied, the following test certificates and documents, as applicable, in requisite copies including original shall be submitted to the Inspection Agency. All test certificates shall be endorsed by the manufacturer and the Successful Tenderer with linkage to the project, purchase order and acceptance criteria.

i. Raw materials identification and physical and chemical test certificates for all materials used in manufacture of the equipment/pipe.
ii. Static/dynamic balancing certificate for rotating components/machines.
iii. Pressure test certificates.
iv. Performance tests certificates for all characteristics.

Inspection at manufacturers' works shall not relieve the Successful Tenderer of responsibility for replacing at his own cost any defective part/material and repairing equipment for defective workmanship that may be discovered at site at a later date.

M) Accessories for the diesel engine:

i.	Oil tank:	1 set
ii.	Oil piping:	1 set
iii.	Coupling (flexible coupling connecting the shaft of pump and end engine coupling guard:	1 set
iv.	Coupling guard:	1 Set
v.	Battery:	2 nos. per diesel engine
vi.	Battery charger:	2 nos. per diesel engine
vii.	Cabling:	1 Set
viii.	Instrumentation:	1 Set
ix.	Panel for the engine:	1 Set

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x. Companion flanges (suction and delivery side) of pump along with bolts, nuts, gaskets and washers: 1 Set

xi. Exhaust piping along with common base plate, foundation bolts, nuts and washers: 1 Set

Contractor to provide diesel engine with all standard accessories, battery sets for auto starting, charger for battery, instrument & electrical panels, pressure switches etc. Rated power requirement of the diesel engine shall meet the requirement of clause no.7.4.5.2.3 of TAC manual (latest revision). The engine shall be capable of delivering the rated output continuously; (24 hours operation) shall run steadily at any load within its rated load, as specified in ISO: 3046. Suitable automatic governing system shall be provided. The fuel for the engine shall be high-speed diesel as per IS: 1460-1974. The diesel engine shall conform to Tariff Advisory Committee (TAC) requirements. The details refer to GTS. Exhaust pipe form the engine shall be extended beyond pump house and shall be terminated at 2 m above the roof of the building.

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5. Design Criteria For Cooling Towers

The cooling towers shall be multi-cell mechanical induced draft type (cross flow/counter flow type). The design wet bulb temperature shall be site specific. The approach of cold water to design wet bulb temperature shall be fixed based on the requirements.

The cooling towers shall be located near the re-circulating water pump house with necessary clearance from the adjoining structures and communication facilities.

The number of cells in each cooling tower shall be selected in such a manner that one no. of cell is spare and can be taken out for maintenance.

No. of installed Cell in Cooling Tower
= No. of working Cell (n)+ 1 No. Standby Cell (1)
= n + 1

Each cell shall be designed with 20% hydraulic overloading.

The cooling towers and the accessories shall be designed and constructed in accordance with the latest applications provisions of Indian or International Standards in general and the following in particular.

PTC – 23 "ASME Performance Test Code for "atmospheric water-cooling equipment".

Cooling tower institute of USA, Bulletin, ATP - 105 for "Acceptance Test Procedure"

IS: 401 for "Code of practice for preservation of timer"

The cooling towers design shall provide towers suitable for reliable operation in the climatic conditions prevailing at the site. In addition, the tower design shall include the following features for reliable operation and fog reduction under varying seasonal conditions:

- Large air to water volume ratio
- Highly effective draft eliminator design
- High fan cylinder air exit height
- Ability to function well with the fans operating continuously at design airflow under all operating conditions.
- Capability to adjust to the seasonal variations of circulating water flows.

The towers shall be designed to withstand the wind load and seismic load for the site. The tower layout shall facilitate location of fan drive motor on that side of the cylinder which will be upwind most of the time.

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Noise level at 1 metre from CT fan motor & dewatering pump casing should not exceed 85 dB (A).

The cooling towers shall be complete in all respects and shall broadly conform to the following requirements.

The drift eliminator shall have sufficient mechanical strength to prevent it against bending & falling from its position. Drift eliminator to limit the drift losses to a less than 0.05%.

The cooling tower basin shall be of RCC construction and shall be epoxy painted from inside including connecting channel. The capacity of the basin shall be designed for approximately 10 minutes circulating water quantity. The basin shall have partitions for isolation of any cell of the tower. Each basin chamber shall be provided with a sludge pit with isolating valve complete with extended spindle and headstock. The basin shall be provided with a slope towards one end with a pit from where drain of the basin shall be connected. Drain valve with extended spindle and headstock of suitable size shall be provided which shall be connected to the nearest drain. Each basin chamber shall be provided with an overflow of suitable size. Cold water outlet channel shall be suitably constructed of RCC for each cell of the cooling towers to facilitate the flow of cold water from the cold-water basin to the main collection channel.

One no. double screen shall be provided at the outlet channel of each cell. The screen shall be replaceable type and made of stainless-steel wire mesh in hot dipped galvanized frame. SS wire-mesh screen shall be of 10 gauge and a mesh size of 25 mm. Guides for the screens shall be of C.I as per IS: 210-1993, FG 260.

Each cell of the cooling tower shall be provided with one multi-blade propeller type axial flow fan of adjustable pitch.

Fan decks shall be provided with drainage away from the fan cylinder and shall extend the full width of the cooling tower covering the water distribution system. The fan cylinder shall be of RCC / FRP (as per discretion of client/consultant) construction and shall be of velocity recovery venturi design. GI pipe handrail of one meter height in double rows shall be provided around the fan deck.

The cooling tower of length more than 40 m shall be provided with a stairway located at each end of the tower for access from ground level to the fan deck. For cooling tower of length less than 40m, one end shall be provided with stairway and other end may be provided with cage ladder.

The fan cylinder shall be true to diameter with due allowance of manufacturing tolerances to ensure trouble-free operation. Fans shall be provided with velocity-recovery type fan cylinder. The motors shall be located outside the fan cylinder, away from the hot and humid

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air system. Access door shall be provided in the fan cylinder for inspection and maintenance purposes.

The tower shall be provided with complete water distribution system including piping, flow control valves and distribution nozzles. Header isolating valves for the tower and water distribution valves for each cell shall be provided. A flow control valve from hot water return header to individual cell shall be provided of CI/CS.

One number each pressure gauge and temperature gauge shall be provided on each hot water riser main.

The cooling tower shall be equipped with suitable material handling devices of appropriate capacity for removal and handling of equipment from the fan deck to the ground level. For cooling towers, electric hoist of suitable capacity shall be provided to handle fan, gear-box & motor. Height of lift shall be adequate to lift/place material from the deck to ground and vice versa. For handling of screen, hoist shall be provided with height of lift suitable to lift screen from & to ground.

The fan rotating assembly shall be statically balanced to ensure vibration-free operation. Each fan assembly shall be provided with vibration limit switches to de-energize the motor in the event of excessive vibration.

Cooling tower fan shall be multiple axial flow type, specially designed for low noise level and vibration free operation. The bolts, nuts and other hardware used for fixing the individual blades to the fan hub shall be selected with min. 20% margin over the power required at motor output terminal for the duty conditions.

Cooling tower fan shall be driven through right angle heavy duty, industrial type reduction gear assembly. Reduction gears shall be of oil bath, positive lubricate type, specially designed for service factor of 2 over fan rated brake power.

The enclosure to the gear box shall be totally enclosed and of weather-proof design to prevent ingress of water vapour into the lubricating oil. The gearbox shall be equipped with oil breather vent. Low oil level interlock for alarm shall be provided.

The gearbox oil shall be of non-hygroscopic type. The oil piping external to the gearbox shall be of galvanized steel of seamless construction conforming to IS: 1239 -2004 (Part-I) heavy grade. Connection between gearbox and external oil piping shall be through wire-reinforced flexible hose assembly. The piping shall be provided with adequate number of union fittings to enable dismantling. The gearbox shall have provision of remotely located sight glass for regular surveillance of quality and quantity of lubricating oil.

The drive shaft shall be designed for high safety factor and the drive shaft assembly shall be statically and dynamically balanced.

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The fill and eliminators shall be built and arranged to permit ease of handling and removal from the tower. The fill and eliminator members shall be securely retained in position to prevent excessive sagging or falling out of position. All fill supports shall be of ample size to properly support their respective loads.

Proper illumination facilities for the fan deck and staircases shall be provided apart from area illumination. Cooling tower fan controls shall be located in the main PLC of water system.

Blow down water from the cooling towers shall be treated with RO and reused in the system or used in the circuits where less stringent quality water can be accommodated.

5.1. Materials Of Construction for RCC Cooling Tower

MOC of the RCC or FRP cooling tower shall be as specified below. However, type of Cooling tower (RCC/FRP) shall be as per details in CTS.

Sl No	Component	Material recommended
1.	Basin	R.C.C.
2.	Stairways, cell partition and fan deck	R.C.C.
3.	Fan cylinder	RCC / FRP
4.	Fill	PVC
5.	Support grids	Stainless steel wire mesh
6.	Drift eliminator	PVC/Engg Plastic
7.	Fan blades	FRP
8.	Spray nozzles	Polypropylene
9.	Fan hub	MS Galvanised with GRP cover
10.	Drive shaft and Coupling, Class III	Carbon Fibre Composite
11.	Fasteners and hard wares	SS (AISI 304)
12.	Base frame for motor	MS Galvanised
13.	Yoke assembly for shaft	SS 304 / 316
14.	Fan Stack door	FRP
15.	Refuse Retaining grate	MS HDG
16.	Screen	SS 304 mesh on MS HDG frame

5.2. Material of Construction for FRP Cooling Tower

Sl No	Component	Material recommended
1.	Cooling tower structure, fan deck,	Pultruded FRP

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Sl No	Component	Material recommended
	handrail, distribution deck, splash box, staircase & walkway	
2.	Fan Cylinder	FRP
3.	Fill	PVC/PP
4.	Drift eliminator	PVC
5.	Louvres	PVC / FRP
6.	Cold water basin	RCC
7.	Hot water distribution system	CPVC pipe with polypropylene nozzles
8.	Fan blades	FRP / Cast Aluminium
9.	Fan guard	G.I. wire
10.	Fan hub	HDG Steel / Aluminium
11.	Fan drive shaft	SS- 304
12.	Hard wares / Fasteners	SS.304
13.	All other steel and iron parts except distribution valves and gear cases	HDG Steel

5.3. List of Spare for Cooling Towers

Sl.No	Description	UNIT	QTY
1	Gear Box Assembly, CI FG260 , IS210	Nos.	1
2	Fan Blade assembly, MS HDG STEEL	set	1
3	Drive shaft assembly with fasteners and bushes. (MoC :HUB-ASTM A743 CF8, FASTENERS SS304)	set	1
4	Spray Nozzle, PP/PVC	Nos.	100

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6. Design Criteria for Plate Heat Exchangers

6.1. Equipment Specification

A) The heat exchanger unit shall consist of gasketed plates supported in frame capable of being opened and closed. The frame provides structural support as well as pressure containment for the gasketed plates and consists of frame plate, pressure plate, guide bar & carrying bars, closing studs/nuts and carrying bar supporting columns.

Wherever Plate Heat Exchangers are envisaged, one number Plate Heat Exchanger should be installed in addition to the required number of Plate Heat Exchangers.

No. of installed Heat Exchangers
= No. of working Heat Exchanger (n)+ 1 No. Standby Heat Exchanger (1)
= n + 1

B) The frame shall be designed to permit future installation of 30% additional plates.

C) Each plate heat exchanger shall be designed for full pressure in each stream and having no pressure on other stream.

D) While designing heat exchange area and number of plates, cleanliness factor on account of fouling shall be considered as 20%.

E) Carbon steel components in contact with fluid system shall have a corrosion allowance of min 3mm. All the threaded hardware items like studs and nuts shall be zinc coated.

F) Minimum thickness of stainless-steel plate (heat transfer plate) shall be 0.5 mm.

G) All nozzles shall be located on frame plate.

H) Inspection openings shall be provided on the pressure plates. The openings shall be blanked by providing blind flanges. Ball valves shall be provided on the bottom blind flanges for drain purposes. Handles are to be provided on all the blind flanges.

I) All nozzles on the frame plate and inspection openings on pressure plate shall be provided with stainless steel sheet lining conforming to AISI 316.

J) Pressure plate shall be supported in a roller bearing hanger from the carrying bar. Pressure plate shall move along the carrying bar and shall be guided by the guide bar.

K) The carrying bar shall be welded to the frame plate and carrying bar support column. A stainless-steel tee section shall be welded to the carrying bar to provide mounting member for the plates of the plate pack. A smooth surface shall be provided for roller bearing

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carrying groove for the whole length of the carrying bar. Carrying bar shall be designed to support 1.5 times the weight of the flooded exchanger along with pressure plate, tie rods, nuts and nozzles.

L) Guide bar shall be welded to the frame plate and carrying bar supporting column. It shall be sheathed in stainless steel on the 3 surfaces coming in contact with the plates and is a guide bar only for the plates.

M) Minimum diameter of tie rod shall be 20 mm.

N) Carbon steel boiler quality plates shall be as per SA 515/516 Grade 60.

O) Plates having thickness of 16 to 50 mm shall be examined ultrasonically as per ASTM A 435.

P) The heat exchangers shall be designed, manufactured and tested as per ASME code Section VIII, Div. 1 and shall be suitable for the duty conditions and capacities as required.

Q) The plate heat exchangers along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty.

R) The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantled without disturbing the inlet and outlet pipe connections.

S) By-pass arrangement with isolation valves shall be provided on the heat exchanger for using it during commissioning and subsequent maintenance.

T) No negative tolerance on the “Overall heat transfer coefficient” of the plate heat exchangers shall be permitted.

U) No positive tolerances on the pressure drop in the heat exchangers shall be permitted.

V) Guaranteed overall heat transfer coefficients offered by the successful Tenderer shall hold good if the variation in the flow rates is within + 2O% of the flow rates.

W) Stainless steel nameplate shall be furnished and securely attached by stainless steel pins at an easily accessible point on each plate heat exchanger. The plate shall be stamped with the following minimum information: -

- Purchaser's item no. or tag in 15 mm high letters.
- Serial number of plate heat exchanger

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- Capacity in cubic meters per hour both for primary & secondary sides.
- Temperature ranges for primary & secondary liquids.
- Pressure drop in Primary & Secondary sides
- Design code.

6.2. Inspection & Testing

a) The tests to be conducted at shop for various sub-assemblies/assemblies of equipment shall include, but not limited to the following:

- Material test
- Testing during manufacture/fabrication like dye penetration tests on randomly selected plates, high intensity light check for plates
- Dimensional checking
- Hydrostatic tests
- Ultrasonic test for the plates used for frame and pressure plates.
- Vacuum chamber test linked with helium crack detection test on all the plates to be carried.

b) All the plate heat exchangers shall be subject to stage inspection by the successful tenderer's own inspecting authority. However, Purchaser's Inspector may visit the works from time to time and who shall have free access to all the places of the manufacturing premises where any part/parts are under manufacturing.

c) The successful tenderer's inspecting authority shall keep a close surveillance in respect of the quality of job for the design dimensions, tolerances, surface finish etc.

Before giving call for final inspection, all the documents shall be furnished to the Purchaser. The record of manufacturing details, inspection and tests carried out by the successful tenderer shall be made available to the final Inspecting Authority. However, approval and final inspection at the manufacturing works shall not relieve the successful Tenderer of responsibility of replacing at his cost any defective part/material which may be detected by the purchaser during erection and commissioning or guarantee period.

Hydrostatic test shall be carried out at 1.5 times the design pressure maintaining test pressure for a minimum of 60 minutes. Testing shall be done by pressurising each side separately.

d) The final tests shall be conducted in the presence of the Purchaser's representative. Test certificates for different tests shall be made available to the Purchaser. Material test certificates for bought out items shall be obtained from original manufacturer/reputed test house. For all bought out items, test certificates as relevant to the items shall be furnished by the successful Tenderer before the equipment is offered for final inspection.

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e) Wherever required, all tests shall be done as per relevant Indian Standards. In the absence of the Indian Standard, the equivalent internationally reputed standards shall be followed.

6.3. Painting

a) Surface of the heat exchanger frame work shall be cleaned to near white metal conforming to Sa 2 1/2 of Swedish Std. SIS 055900 or German Std DIN 55928 (Part-4)

b) After surface preparation, the plate heat exchanger shall be painted as per the manufacturer's standard.

6.4. Acceptance Tests

Acceptance tests shall be carried out by the successful Tenderer after commissioning. These tests shall be performed according to code of practice of HEI of USA or other mutually agreed procedure in the presence of Purchaser's representative. All instruments required for the test shall be arranged by the successful Tenderer. In Case during the tests the heat exchanger performance falls short of guarantee figures, the successful Tenderer shall bear all expenses of improving the performance of the heat exchanger and shall carry out another acceptance test at no extra cost. In case the performance is again unsatisfactory, the successful Tenderer shall be liable to replace the subject equipment by new and better equipment at no extra cost without affecting the overall schedule of the commissioning of the Main Plant

6.5. Guarantee

a) All equipment shall be guaranteed for good workmanship, no material defect and the design parameters for a period as per Contract Agreement

b) The Contractor shall stand guarantee that the heat exchanger shall cool the required quantity of primary water with the specified quantity of secondary water to the temperatures stipulated in Contract. The Contractor shall also guarantee the agreed pressure drops across the primary & secondary sides of heat exchanger. In addition, all items of the heat exchanger are to be guaranteed in respect of material and workmanship. Any defects found during warranty period shall be rectified to the complete satisfaction of the purchaser at the Contractor's cost.

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6.6. Spare List

Sl.No	Description	UNIT	QTY	Remarks
1	Plates for heat exchangers	Nos.	20% of total plates	One set for each group of heat exchanger
2	Gaskets	Nos.	10% of total gaskets	One set for each type of heat exchanger

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7. Design Criteria for DM Water Plant

Three- Stream (2W+1S) fully automatic PLC controlled DM water plant of 100% capacity each shall be provided in a civil building with RCC roof with suitable ventilation and US crane/electric hoist with requisite controls & instruments for auto operation of the plant. Necessary effluent treatment shall be provided for the waste water generated from plant. The prevailing pollution control acts shall be binding for selection, erection and operation of these units. All the required facilities for DM Plant shall be based on 2W+1S stream.

The regeneration cycle and back washing cycle shall be at an interval of 20 hours. Water required for internal consumption like regeneration, back washing etc. shall be additional to the capacities indicated above.

The operation of DM Plant shall be designed to run on fully automatic operation basis.

Water from the makeup water system of the plant shall be considered as the source of raw water for DM Plant.

Make-up water shall be fed to pressure sand filter. Filtered water from pressure sand filter shall be pumped into the activated carbon filter for removal of excess chlorine, oil, colour and traces of iron and organic.

Filtered water from activated carbon filter shall flow into cation exchanger where all positive ions shall be removed. The water from the cation exchanger free from positive ions shall flow into the degasser where air shall be blown to remove CO_2. The degassed water shall be stored in a degassed water storage tanks. Three (03) tanks of 100 % capacity each shall be provided.

The degassed water from the degassed water tanks shall be pumped into the anion exchangers where all negative ions shall be removed. The water from the anion exchangers shall flow into the mixed bed for the removal/polishing of the remaining positive and negative ions. The DM water from the mixed bed shall flow into the DM water storage tanks. From the DM water storage tanks, the demineralised water shall be pumped up to the consumer/battery limit.

The effluent discharged during backwashing/ regeneration shall be led to a lined neutralisation pit of two compartments through acid/ alkali proof drain. Necessary chemicals shall be added to neutralise the effluent water.

Hydrochloric acid and sodium hydroxide (lye) shall be used as regenerants. Regeneration system for the cation exchanger, anion exchanger, and mixed bed exchanger shall consist of acid storage tanks, alkali storage tanks, measuring tanks, ejectors, pipes, valves and density indicator.

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Acid/alkali unloading pumps with necessary pipes, hoses and valves from road tanker to storage tank shall be provided.

Resin traps shall be provided on the pipeline at the outlet of each exchanger. Media traps shall be provided on the pipeline at the outlet of each activated carbon filter.

Panic showers, washing facilities and drinking water pipeline connection for laboratory and other units shall be provided.

7.1. Design and Constructional Details

The DM Water Plant shall be complete in all respect. The design and constructional details of various equipment to be provided in DM plant are given below:

7.1.1. Clarified water tank

Make up/ clarified water shall be received by gravity/ under residual head in a RCC water tank having 2 compartments. Each tank shall epoxy painted from inside and have inlet, outlet, overflow, drain connections with necessary level indicators, isolation valves and pipes, etc.

7.1.2. Pressure Filters:

The pressure filters and the connected equipment shall be designed, manufactured and tested as per relevant IS/IPSS or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated.

Process of the backwashing and bringing the filter to the normal stream to be done automatically. Double flanged butterfly valves with rack and pinion type rotary pneumatic actuators shall be provided for this purpose.

The filtration rate shall be 10 $m^3/hr/m^2$.

The design, fabrication, inspection and testing of the pressure filter shall conform to IS: 2825/ /ASME SEC VIII, DIV.1 / International standard.

- At least 60% (of bed depth) free board shall be left over the filtering media. Media traps shall be provided at the outlet of each filter.
- The pressure filters shall have air scouring facility prior to back washing.
- The back washing cycle shall be at an interval of 20 hours
- Pressure filters shall be provided with access manhole of size 600 mm for filling and charging of gravel, sand and for maintenance purposes.
- Maximum pressure loss across the filters should not be more than 5 mWc.

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- Suspended solids content in the filtered water shall not exceed 5 ppm.
- No negative tolerance on the filtering capability of the pressure filters is acceptable.
- Media traps shall be provided at the outlet of each filter.
- Pressure filters shall be of vertical/horizontal type and shall be provided with built in legs with proper supports to the concrete.
- The filter shall be provided with unfiltered water distributors and header lateral type under-drain collecting system.
- The pressure filter vessel shall be internally painted with 3 coats of anti – corrosive paint and shall be coated externally with a protective paint.

Backwash water overhead tank or backwash pumps shall be provided for backwashing of pressure filter. The tank shall be of effective storage capacity suitable for two backwashes and shall be provided on top of the filter house with staging height of 15m. Necessary inlet & outlet piping connections to the proposed backwash water overhead tank and pressure filters along with all valves, fittings, instrumentation, pipe supports etc. shall be provided with compartments and required capacity and staging height for back washing of filters. The complete piping from the backwash water tank to all the filters for supplying the back wash water to be provided. Drain and overflow pipelines with valves for all the back wash tanks to be provided. However, Backwash pumps shall be selected with actual backwash water requirement. Suction for the pumps shall be provided from clarified / filtered water storage tank.

The piping system and control valves shall be provided in front of the vessel for smooth operation. The same shall include contaminated water inlet, filtered water outlet, back wash inlet, waste water outlet, drain, air scouring and air vent drain cock, sampling cocks etc. All valves shall have flanged connections and shall be supplied with matching flanges, nuts, bolts and gaskets.

7.1.3. Activated Carbon Filter:

The activated carbon filters and the connected equipment shall be designed, manufactured and tested as per relevant IS or as per other international standards acceptable to the Purchaser and shall be suitable for the input water quality.

The vessel shall be of vertical / horizontal type and be provided with built in legs. The pressure filter shall be provided with

i. The design of the vessel shall be as per IS: 2825- 1969 (RA 1984) /ASME SEC VIII, DIV.1.
ii. Piping system and control valves in front of the vessel for smooth operation. It shall include raw water inlet, filtered water outlet, back wash water inlet, backwash water outlet, drain connection and air vent.
iii. Built in leg with proper supports to the concrete.

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iv. Sampling points with isolation valves for inlet and outlet connection.
v. Under drain system shall be header lateral type or strainer on plate design. In case of strainer on plate design, access shall be provided below the bed plate. No sub-fill shall be used in case of header lateral design. Minimum bed depth shall be 1200 mm.
vi. Proper distribution system for Raw water inlet and Back washing to avoid channelling and clogging.
vii. Access manholes shall be provided and size shall be of 600 mm dia min.
viii. Carbon traps shall be provided at the outlet of each vessel.
ix. The back washing cycle shall be at an interval of 20 hours
x. The filtration rate shall not exceed 15 $m^3/h/m^2$.
xi. 2 coats of epoxy-based primer and 3 coats of solvent free epoxy-based finishing paint shall be provided inside the vessel. The dry film thickness shall be 200 microns.
xii. At least 75% (of bed depth) freeboard shall be provided to allow expansion of the bed during back washing.
xiii. An initial charge of filter media.

7.1.4. Cation exchanger

The regeneration cycle shall be 20 hrs.

The vessel shall be of vertical / horizontal type and be provided with built in legs. The design of the vessel shall be as per ASME SEC-VIII, DIV.1. The design surface flow rate shall not exceed 40 $m^3/h/m^2$.

The cation exchanger shall be painted outside with protective paint and rubber lined from inside. Sand blasting of the vessel shall be done before rubber lining. The Natural Rubber Lining shall be minimum 4.5mm thick in three layers and shall have a shore hardness of 65 $\pm$ 5 Deg. (scale -A).

The cation-exchanger shall be provided with:

i) Access manholes for filling, changing of resin and also for maintenance purposes and transparent windows for knowing the level of resins.
ii) An internal collecting system for withdrawing the cationic/ softened water. The strainers shall be of good quality polypropylene material. In case of strainer on plate design, access below the bed plate shall be provided.
iii) HCl shall be considered for regeneration of cation exchanger resin.
iv) At least 80% free board shall be provided to allow expansion of the bed during back washing/addition of extra resin.
v) Distributor for distributing acid during regeneration.
vi) The collecting system as well as the distributor shall function in the reverse way during back washing.

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vii) Built in legs with proper supports to the concrete base.
viii) An orifice board for indicating the wash water flow. It shall be fitted in the drain sump.
ix) Stainless steel sampling points of inlet and outlet water.
x) Resin trap at the outlet of each exchanger.
xi) Initial charges of resin.
xii) It shall be on counter-current regeneration system.
xiii) The piping system and control valves in front of the vessel for smooth operation

7.1.5. Degasser

i) The degasser shall be forced draft, counter flow type with polypropylene fill complete with staircase etc.
ii) The degasser shall be fitted over the degassed water tank and it shall be air tight.
iii) It shall be fitted with sprayer at the top for proper spraying of cationic water. An air vent shall be provided at the top for removal of CO2. The inlet distributor shall be of header lateral system. Material of construction for degasser shall be carbon steel as per IS:2062-2011.The degasser shall be lined on the inside surface with natural rubber lining (4.5mm thick) and the outside surface shall be painted with chlorinated rubber paint. The tower hood should be of stainless steel. Air duct from blower to degasser shall be of FRP.
iv) The degasser shall be fitted with connections for blowing air. It shall be complete in all respects. (Blowing rate shall be furnished).
v) Sump level control shall be for dry running protection of degasser pumps.

Degassed water tank

i) The degassed water tank shall be horizontal cylindrical shell type with dished ends. The design code shall be IS: 2825- 1969 (RA 1984) / ASME SECTION -VIII.
ii) Material of construction for degassed water tank shall be carbon steel as per IS:2062-2011. The tank shall be provided on the inside surface with epoxy paint/natural rubber lining (4.5mm thick) and the outside surface shall be painted with 3 coats of chlorinated rubber paint.
iii) It shall be suitable for mounting on concrete supports. It shall be fitted with inlet, outlet, overflow and drain connections with necessary level indicators, valves and pipes. The capacity of tank shall be as per system requirement and approval of Purchaser / Consultant.

7.1.6. Anion exchanger

The regeneration cycle shall be 20 hours.

The design surface flow rate shall not exceed 40 $m^3/h/m^2$.

The vessel shall be of vertical / horizontal type and be provided with built in legs. The design of the vessel shall be as per IS: 2825- 1969 (RA 1984) / ASME SEC-VIII, DIV.1.

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The anion exchanger shall be painted outside with protective paint and rubber lined from inside. Sand blasting of the vessel shall be done before rubber lining. The Natural Rubber Lining shall be minimum 4.5mm thick in three layers and shall have a shore hardness of 65 $\pm$ 5 Deg. (scale-A)

The anion exchanger shall be provided with -

i) Access manholes for filling, changing of resin and also for maintenance purposes and transparent windows for knowing the level of resins.
ii) An internal collecting system for withdrawing the anionic water. The strainers shall be of good quality polypropylene material. In case of strainer on plate design, access below the bed plate shall be provided.
iii) At least 100 % (of bed depth) free board shall be provided.
iv) Distributor for distributing alkali during regeneration.
v) The collecting system as well as the distributor shall function in the reverse way during back washing.
vi) Built in legs with proper supports to the concrete base.
vii) An orifice board for indicating the wash water flow. It shall be fitted in the drain sump.
viii) Stainless steel sampling points of inlet and outlet water.
ix) An initial charge of resin.
x) It shall be on counter-current regeneration system.
xi) The piping system and control valves in front of the vessel for smooth operation.

7.1.7. Mixed bed exchanger

The regeneration cycle shall be minimum 180 hrs.

The vessel shall be of vertical / horizontal type and be provided with built in legs. The design of the vessel shall be as per IS: 2825- 1969 (RA 1984) / ASME SEC-VIII. DIV.1.The design surface flow rate shall not exceed 60 $m^3/h/m^2$.

The M.B. exchanger shall be painted outside with protective paint and rubber lined from inside. Sand blasting of the vessel shall be done before rubber lining. The Natural Rubber Lining shall be minimum 4.5mm thick in three layers and shall have a shore hardness of 65 $\pm$ 5 Deg. (scale-A).

The M.B. exchanger shall be provided with:

i) Access man-holes for filling, changing of resin and also for maintenance purposes and transparent windows for knowing the level of resins.
ii) An internal collecting system for withdrawing the water. The strainers shall be of good quality polypropylene material. In case of strainer on plate design, access below the bed plate shall be provided.

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iii) At least 100% free board shall be provided to allow expansion of the bed during back washing/addition of extra resin.
iv) Distributor for distributing alkali and separate distributor for distributing acid.
v) Proper resin trap at the outlet of each exchanger shall be provided.
vi) The collecting system as well as the distributor shall function in the reverse way during back washing. The resins shall be supported on a layer of graded pebbles.
vii) Built in legs with proper supports to the concrete base
viii) An orifice board for indicating the wash water flow. It shall be fitted in the drain sump.
ix) Stainless steel (SS 316L) sampling points of inlet and outlet water.
x) It shall be on co-current regeneration system.
xi) A separator for separation for resins during regeneration.
xii) Transparent windows at the resin separation and also at resin top level.
xiii) An initial charge of resin for cation and anion resins. The anion resins shall also effectively remove silica.

7.2. ION Exchange Resins

i) Make-up resins to be supplied shall be based on minimum resin attrition loss of three (3) percentage and five (5) percentage per annum for cation and anion respectively.
ii) All resins shall be supplied in manufacturer's original sealed containers. No broken container shall be accepted.
iii) Subsequent top up of resins to all resin beds, if required, before the handover of the plant shall be made up by the Tenderer.

7.3. Regeneration Level, Regenerant Strength and Exchange Capacity

i) Each resin bed shall be regenerated by employing optimum regeneration levels to prevent leakage of ions.
ii) The strength of acid regenerants at the cation bed inlet shall be within 5% W/W.
iii) Alkali regeneration system consisting of solution tanks, ejectors, etc. shall be so designed such that during regeneration, anion resin bed in anion exchanger is regenerated at about 5% (W/W) strength of alkali.
iv) 10% de-rating in exchange capacity of all types of exchangers is mandatory.

7.4. Exchanger Resin Regeneration System

Regeneration system should be so designed that at a time either cation, anion or mixed bed unit of a particular stream is regenerated. Provision for simultaneous regeneration of cation and anion bed units to be kept to minimise the outage due to regeneration of ion-exchange vessels.

a) **Regeneration of Cation Exchanger**

This shall consist of the following equipment

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I.	Acid Unloading Pumps	- 2 Nos. (1 Working + 1 Reserve)
II.	Bulk Acid Storage Tanks (for 30 to 33% acid)	- 2 Nos.
III.	Acid Measuring Tanks.(for 30 to 33% acid)	- 3 Nos.

Total capacity of Bulk Acid Storage Tanks shall be to meet one month's requirement of the DM Plant rounded to road tanker capacity. The Tenderer along with the tender shall submit calculations for acid consumption. The total capacity of acid measuring tanks for cation and mixed bed exchangers shall be for acid required for double regeneration for two (02) working streams. Acid Measuring tank of adequate capacity shall also be provided for neutralisation pit.

Bulk acid storage tanks and Acid measuring tanks shall be constructed of FRP. The tanks shall be provided with all accessories such as level indicator, level switch, vent with breather, fume absorber, drain connections, etc.

IV. Dosing System

- Dosing system shall be ejector type. Pressurised water for the jet ejector of Cation exchanger & mixed bed shall be taken from DM water storage tank through dedicated pumps (1W+1S).
- Suitable sampling connections, flow transmitter and density transmitter shall be provided to determine the flow rate and strength of the acid injected into the exchanger.
- The dilution ratio of the ejector shall be properly selected such that the bed can be effectively regenerated employing water at the available pressure. The ejectors and nozzles shall be suitably designed for acid service and the high velocity of liquid.
- Acid dosing for neutralisation pit shall be through gravity from acid measuring tank.

b) **Regeneration of Anion Exchangers**

These units shall be designed for regeneration with sodium hydroxide and shall consist of the following equipment.

I.	Alkali Unloading Pumps	- 2 Nos. (1 Working + 1 Reserve)
II.	Alkali Storage Tanks (for 40% alkali)	- 2 Nos.
III.	Alkali Measuring Tanks. (for 30% acid)	- 3 Nos.

Total capacity of Bulk Alkali Storage Tanks shall be to meet one month's requirement of the

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DM Plant rounded to road tanker capacity. Calculations for alkali consumption shall be submitted. The total capacity of alkali measuring tanks for anion & mixed bed exchangers shall be for alkali required for double regeneration for two (02) working streams. Alkali Measuring tank of adequate capacity shall also be provided for neutralisation pit.

Bulk alkali storage tanks and Alkali measuring tanks shall be constructed of FRP. The tanks shall be provided with all accessories such as level indicator, level switch, vent with breather, CO_2 absorber, drain connections, etc.

IV. **Dosing System**

- Dosing system shall be ejector type. Pressurised water for the jet ejectors for anion exchanger and mixed bed shall be taken from DM Water regeneration pumps header.
- Suitable sampling connections, flow transmitter and density transmitter shall be provided to determine the flow rate and strength of the alkali injected into the exchanger.
- The dilution ratio of the ejector shall be properly selected such that the bed can be effectively regenerated employing water at the available pressure. The ejectors and nozzles shall be suitably designed for acid service and the high velocity of liquid.
- Alkali dosing for neutralisation pit shall be through gravity from alkali measuring tank.

c) **Regeneration of Mixed Bed Exchanger.**

I. Backwash

The mixed bed resins shall be backwashed to segregate anion and cation resins.

II. Acid Regeneration.

Acid regeneration of cation resins in the mixed bed shall comprise of acid measuring tanks and ejector with all accessories.

Provision shall be made in the design to prevent diffusion of acid to the anion bed during acid regeneration by maintaining suitable downflow of water in the anion resin bed.

III. Alkali Regeneration.

Alkali regeneration of anion resins in the mixed bed shall comprise of alkali measuring tanks and ejector with all accessories.

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Provisions shall also be made to prevent diffusion of alkali to the cation bed during alkali regeneration by maintaining suitable up-flow of water.

IV. Resin Remixing

After regeneration and rinsing of the resins in the mixed bed the two resin beds shall be mixed by blowing compressed air through the resin bed.

7.5. Demineralised Water Storage Tank

Two Nos. DM Water storage tanks each of 12 hrs holding capacity shall be provided. These shall be vertical, cylindrical, shell type atmospheric tanks with flat bottom. MSRL lining of 4.5 mm thickness shall be provided. Externally these shall be painted with 2 coats of epoxy primer and 3 coats of rubberised final paint. These tanks shall be complete with 2 nos 500 mm dia manholes, level measurement system, overflow, air vent, drain, sample connections, CO_2 absorber, staircase, platform, handrails etc. PP ball rings (floating) shall be provided in the DM Water Storage Tank

7.6. Blowers

Refer Clause No. 15.

7.7. Sampling Rack

Sampling rack shall be provided in the laboratory room adjacent to MCC room to facilitate centralised collection of samples. Small diameter stainless steel pipelines shall be provided to convey water upto the sampling rack.

7.8. Neutralisation Pit

The common neutralisation pit shall be of RCC construction lined with acid/ alkali proof lining suitable for holding regeneration effluents generated from two streams of DM Water Plant with 25% margin. This shall have two compartments. A minimum free board of 500 mm shall be provided. Baffles, isolation gates, and hand railing shall be provided. SS Wire mesh shall be provided along with hand railing to prevent small polyethylene bags, etc. from falling into the pit due to wind. 2 Nos. (1 W +1 R) effluent transfer pumps shall be provided. These pumps shall be of SS construction.

7.9. Piping

One complete set of interconnecting piping shall be supplied. This shall cover all interconnections between equipment and pumps and general utility pipe work for services e.g. compressed air, water for regeneration system, drinking water, toilet facilities, panic

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showers etc.

All pipes required to make the unit self-sufficient shall be provided.

All joints shall be flanged with lining brought over the flanged faces. Bolts and nuts shall be of stainless steel for rubber lined pipes. For pipelines having long straight runs, flanges shall be provided at regular intervals and also at bends to facilitate easy dismantling. Sectionalisation shall also be provided.

Piping for acid, alkali, corrosive water shall be CPVC. Proper pipe fittings of readymade type such as bends, reducers, tee, etc. shall be used.

7.10. Valves

Valves in front of vessels/ filters shall be pneumatically operated diaphragm valve. MOC of valves shall be same as of the parent pipe.

All valves shall be arranged in the front of the vessel and at a height suitable for easy manual operation. In case the height of any hand wheel/lever of a valve is more than 1200 mm above the floor, pedestal for operation shall be provided. However, the hand wheels shall be provided within 1200 mm to avoid pedestals.

For other specification of valves, refer relevant chapter of this GS.

7.11. Electric Actuators

Electric actuators of valves shall be integral type complete with electric motor, necessary gear drive, torque limit switches, position limit switches and terminal board.

Micro-switch shall be provided on the valves for disconnecting power supply which will operate when the valve is operated manually.

All motor operated valves shall have de-clutch able manual override along with the position indicators. The motorised valve shall be designed in such a way that it is possible to remove the actuator from the valve without requiring shutdown.

All limit switches shall be dust and water proof. All motors shall be suitable for DOL starting.

Motors shall be capable to start and run-up with the driven mechanism/equipment connected at a minimum of 85% of the rated voltage at the terminals.

All motors shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% of the rated voltage at its terminals.

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Starting torque shall be less than 160% of the rated torque. Starting current shall be less than or equal to six times the rated current.

Four-pole motors shall be used for all general applications unless specific drive requirement calls for.

OBR based PG test shall be provided for DM Plant. Dedicated silica analyser with online & grab sample facility should be provided in DM Plant

7.12. Quality of Input Make-up Water

S.NO.	Parameters	Make-Up Water Parameters Range
1	pH	7.0-8.2
2	TSS (ppm)	1.8 - 8
3	TDS (ppm)	110 - 220
4	Phenol (ppm)	BDL
5	O&G (ppm)	<1
6	Residual chlorine (ppm)	Nil
7	Turbidity (NTU)	1.4 - 7.5
8	Total Hardness (ppm as CaCO3)	80-140
9	P-Alkalinity (ppm as CaCO3)	Nil
10	M-Alkalinity (ppm as CaCO3)	50-90
11	T-Alkalinity (ppm as CaCO3)	50-90
12	Conductivity (micro Siemens/cm)	200 - 425

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S.NO.	Parameters	Make-Up Water Parameters Range
13	Sulphate (ppm)	50-70
14	Fe (ppm)	0.02-0.11
15	Chloride (ppm as Cl)	30-40
16	Colour	No objection

Note: Successful Tenderer shall carryout analysis of input make-up water at his own cost.

7.13. Quality of Treated Water

Sl. No.	Description	Parameters	Values
	DM WATER PLANT		
1.	After activated carbon filter	Turbidity	<2 ppm
2.	After Cation Exchanger	pH	3 -4
		Total Cations	Not greater than 1 ppm as $CaCO_3$
3.	After degasser	Free CO_2	< 5 ppm as CO_2
4.	After anion exchanger	pH	7.5 - 9.0
		TDS	< 2 mg/1
		Conductivity	< 10 micromho/cm at 20 deg C.
		SiO_2	< 0.2 ppm as SiO_2
5.	After mixed bed units	pH	6.8 to 7.2
		TDS	< 0.15 ppm as $CaCO_3$
		Conductivity	< 0.2 micromho/cm at 25^0C
		Silica as SiO_2	< 0.02 ppm
		Fe	< 0.01 ppm
		Hardness	Nil
		Turbidity	Nil

7.14. Tests, Test Certificates and Documents

For each of the items being manufactured, following test certificates and documents, as applicable for each of the equipment, in requisite copies including original shall be submitted to Purchaser/MECON. All test certificates must be endorsed by the

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Manufacturer and Contractor with linkage to project, purchase order and acceptance criteria.

i. Raw materials identification & physical and chemical test certificates for all materials used in manufacture of the equipment (except IS 2062-2011 Gr. A & IS 210-1993, FG-150).
ii. Details of stage wise inspection & rectification records for fabricated items, castings, forgings and machined articles.
iii. Manufacturer's material and performance/ relevant test certificates for all bought-out items.
iv. Non-Destructive Test reports as per respective code.
v. Static/dynamic balancing certificate for rotating components / machines.
vi. Hardness test certificate.
vii. Pressure Test Certificates.
viii. Performance Test Certificates for all characteristics.
ix. Diagnostic features of NC/CNC system and test certificates for electrical items.

7.15 List of Spares, Tools & Tackles to be Supplied for DM Plant

7.15.1. List of Spares

In general, the spares shall include the following as applicable depending upon the equipment offered by the Contractor. The spares are intended to cover all wearable/damageable delicate items of the plant.

01 For all Centrifugal Pumps:

Refer relevant clause for pumps.

02 For one complete set of blowers

Refer relevant clause for Blowers.

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8. Design Criteria for Water Based Fire-Fighting System

8.1. Dedicated firewater pump houses shall be provided with required nos. of electric motor driven pump sets, diesel engine driven pump sets and jockey as per IS: 13039, IS 3844& IS 15325. An independent fire fighting network in ring main covering all the buildings, internal roads and peripheral roads with all associated electric, instrumentation, piping, underslung cranes and hoisting facilities etc. shall be provided in line with the IS Codes. Also a wet riser ring main shall be provided which will cover the complete plant complex.

8.2. Interval between two consecutive hydrants shall conform to IS: 3844. Isolation valve shall be provided at upstream of each yard hydrants on the riser pipe and in case of internal hydrants isolation valve shall be provided for each riser main of the buildings. Section isolation valves shall be provided for ease of maintenance purpose.

8.3. Internal hydrant shall be provided on all the floors of the buildings, Junctions houses, office building, conveyor galleries, other process building etc. as per IS 3844.

8.4. A fire water covered storage reservoir of adequate capacity (Minimum 2 hr requirement or as specified) shall be provided.

8.5. Filling connection to fire water reservoir shall be provided from the proposed make-up water line for the plant complex.

8.6. The detail specification of Fire water pump, diesel engine and hydrants are specified below: -

8.7. Fire Water Pump

i. The centrifugal pumps shall be suitable for discharging not less than 150% of the rated capacity at a head of not less than 65 % of the rated head. The Shut off head shall not exceed 120% of the rated head.

ii. Other specification and details as specified for horizontal centrifugal pumps in this specification shall also be applicable for fire water pump.

iii. The Fire water Pump shall be as per IS: 12469.

8.8. Fire Hydrant and Hose Cabinet

Landing valve/ yard hydrant shall be as per IS: 5290, Type-A.

The hose cabinet shall be fabricated out of fibre-reinforced plastic (thickness 2.5 mm) of size as mentioned in the table below. The top shall have pressed edge slightly projecting outside to prevent water (while cleaning etc.) from entering the cabinet. The cabinet shall

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be fitted with glass-fronted door. The door shall be provided with a knob and a lock with duplicated key on the body of the door with a glass cover. The glass of the key box shall be easily replicable. Suitable hooks, etc, shall be provided in the cabinet to hold the hose reels etc. mentioned above. Suitable wall mounting bracket shall be provided with the cabinet. Fully dimensioned general arrangement drawing indicating materials of construction, relevant specifications, etc shall be provided.

General specification of Hydrants to be provided is given below.

8.9. Specification of Fire Hydrants and Accessories

Sl. No.	IS no.	Description	Quantity
A.	**INTERNAL HYDRANT**		
1.	IS:5290 Type A	Fire hydrant (landing valves) single outlet oblique type of 75mm flanged inlet, 63mm outlet with hand wheel, Instantaneous bronze female coupling at outlet and blank cap. **(Stainless Steel)**	As per IS: 13039, IS 3844
2.	IS:6392 Table-18	MS matching flange DN80 (Slip-on type) with bolts, nuts & gaskets for the above hydrants	-do-
3.	Hose cabinet with glass front (for indoor installation) of size 750mm X 600mm X 250mm to house one number landing valve, 7.5m long hoses (2 Nos.) branch pipe, nozzle and spanner) consisting of the following:		
a	IS:636 Type-3 & IS:903	Reinforced rubberised fabric lined flexible hose of 7.5 m length having 63mm dia, each fitted (as per IS:1648:1961) with instantaneous male Coupling at one end and female Coupling at the other end.	-do-
b	IS:903	One branch pipe **(Stainless Steel)**	-do--
c)	-do-	One 25mm nozzle **(Stainless Steel)**	-do-
d)	-do-	One nozzle spanner **(Stainless Steel)**	-do-
B.	**YARD HYDRANT**		
1.	IS:5290 Type- A	Fire hydrant (landing valves) single outlet oblique type of 75mm flanged inlet, 63mm outlet with hand wheel, Instantaneous bronze female coupling at outlet and blank cap.**(Stainless Steel)**	-do-
2.	IS:6392 Table-18	MS matching flange DN 80 (Slip-on type)with bolts, nuts & gaskets for the above hydrants	-do-
3.	Hose cabinet with glass front (for indoor installation) of size 750mm X 750mm X 250mm to house one number landing valve, 15m long hoses (2		

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Sl. No.	IS no.	Description	Quantity
	Nos.) branch pipe, nozzle and spanner) consisting of the following:		
a)	IS:636 Type-3 & IS:903	Reinforced rubberised fabric lined flexible canvas hose of 15m length having 63mm dia, each fitted (as per IS:1648-1961) with instantaneous male Coupling at one end and female Coupling at the other end including Intermediate coupling for joining 1x15m long hose.	-do-
b)	IS:903	One branch pipe **(Stainless Steel)**	-do-
c)	-do-	One 25mm nozzle **(Stainless Steel)**	-do-
d)	-do-	One nozzle spanner **(Stainless Steel)**	-do-

The details and specification of pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc. as specified above and as mentioned in other clauses of this specification are applicable for this system also.

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9. Design Criteria for Valves

Flow control /isolating valves, drain valves and air release valves wherever necessary, shall be provided for the complete pipe network including cross- country pipeline.

Motor operated valve shall be integral type complete with electric motor, starter, necessary gear drive, position limit switches, torque switches and all accessories as required. The valves shall also have hand wheel for manual operation.

All valves shall be suitable for service conditions i.e. quality of fluid, flow, temperature and pressure under which they are required to operate.

All the valves of diameter DN 450 and above (except for fire-fighting application) shall be electrically/pneumatically operated. All the valves requiring remote control operation shall also be electrically/pneumatically operated. All valves shall be minimum PN 16. The valve size shall be same as the size of pipeline.

Valves shall be provided on pipe network for isolation of pipe section and equipment, control of pressure and flow, venting, draining etc. They shall be suitably located considering ease of operation and maintenance. Unless there is change in flow quantity in the pipeline, the valve size shall be same as the size of pipeline.

All valves shall be provided with hand wheel and position indictor. The face of each hand wheel shall be clearly marked with words “Open” and “Shut” with arrows adjacent to indicate the direction of rotation.

Valves shall be provided with suitable extension spindle and head stock assembly wherever required. In case gears or bevel system are used, these shall be of cast steel housing only.

9.1. Specification for Butterfly Valves

The butterfly valves shall be designed for bidirectional flow and shall be tested at works accordingly.

Sl No.	Description	Material
01	Body	Cast steel ASTM A216 GR WCB
02	Shaft	Stainless Steel AISI 410
03	Disc	SS, CF8M
04	Seat - for metal seated valve	Stainless Steel CF8M
05	Seat - for soft seated valve	Neoprene /EPDM
06	Pressure rating	PN 16

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07	Pressure testing	BS 6755 Part I
08	Manufacturing Standard	BS 5155 / AWWA C-504/API 609/IS 13095
09	Testing standard	API 598
10	Face to Face Dimension	short body BS EN 558 Series 13
11	Flange Drilling standard	BS EN 1092 PN16
12	Test certificate service	For Physical/chemical analysis & metallurgical tests for body parts, Hydro testing
13	External Fasteners	A193 B7/A194 2H
14	End connections	Upto DN 150 - Wafer/lugged/flanged DN 200 & above –Flanged

9.2. Specification for Dual Plate Check Valve (DN50 & above)

1	Type	Dual Plate Zip Check Valve
2	Body	ASTM A 216 Grade WCB
3	Closure Plate	ASTM A 351 Gr. CF8 M/ SS 316
4	Stop Pin	AISI SS 410
5	Hinge pin	AISI SS 410
6	Spring	INCONNEL
7	Retainer	CF8M (SS 316)
8	Body Bearing	AISI SS 316
9	Plate Bearing	AISI SS 316
10	Spring Bearing	AISI SS 316
11	Design Standard	API 594
12	Pressure rating	PN 16
13	Dimensions	As per API 594
14	Testing	As per API 598
15	Special features required	Arrow indicating the flow direction. Embossed name plate giving details of tag No. size, etc.
16	End Connections	Flanged

9.3. Specification for Lift Check Valve (Size up To DN40)

1	Type	Lift Check Valve
2	Body	Forged Carbon Steel, ASTM A 105
3	Cover	Forged Carbon Steel, ASTM A 105
4	Seat ring	SS AISI 410
5	Disc	SS 410
6	Gasket between cover & Body	Spiral wound SS 304 filled with Graphite
7	Cover Bolt	Alloy Steel ASTM A 193 Gr B7

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8	Spring	SS 316
9	Pressure rating	Class 800
10	Manufacturing Standard	API 602
11	Testing Standard	API 598
12	End connection	Screwed ends/socket weld

9.4. Specification for Gate Valve (upto DN 40)

Sl No.	Description	Material
01	Type	Gate valve with rising spindle & bolted Bonnet.
02	Body /Bonnet	Forged Carbon Steel, ASTM A 105
03	Wedge	CS ASTM A216 Gr.WCB + 13% Cr.
04	Stem	AISI 410
05	Gland Bush	AISI 410
06	Gland flange	Forged Carbon Steel, ASTM A 105
07	Stud, Stud Nut, Eye Bolt nut	ASTM 193 Gr.B & 2H
08	Gland Packing	Graphoil
09	Hand wheel	Carbon steel
10	End Connection	Threaded/socket welded
11	Pressure rating	Class 800
12	Manufacturing Standard	API 602/BS 1414
13	Pressure testing	API 598

9.5. Specification for Gate Valve (DN 50 & above)

Sl No.	Description	Material
01	Type	Gate valve with rising spindle & bolted Bonnet.
02	Body /Bonnet	CS ASTM A216 Gr.WCB
03	Wedge	CS ASTM A216 Gr.WCB + 13% Cr.
04	Stem / Disc	AISI 410
05	Gland Bush	AISI 410
06	Gland flange	CS A216 Gr.WCB
07	Stud, Stud Nut, Eye Bolt nut	ASTM 193 Gr.B & 2H
08	Gland Packing	Graphoil

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Sl No.	Description	Material
09	Hand wheel	Carbon steel
10	End Connection	Flanged
11	Pressure rating	PN 16
12	Manufacturing Standard	API 600/BS 1414/IS14846
13	Pressure testing	API 598
14	Face to Face Dimension	ASME B16.10

9.6. Specification for Globe Valve (upto DN 40)

Sl No.	Description	Material
01	Type	Globe valve
02	Body/ Bonnet	Forged Carbon Steel, ASTM A 105
03	Disc	ASTM A351 CF8M
04	Stem	AISI 410
05	Seat	AISI 410
06	Seating surface & rings	AISI 410
07	Hand wheel	Carbon steel
08	Gland, Gland plate, disc spindle nut	AISI 410
09	Gland Packing	25% Carbon filled PTFE rings
10	Pressure rating	Class 800
11	Manufacturing standards	BS 1873/ API 602
12	End connection	Screwed end/Socket welded
13	Pressure Testing	As per BS 6755 Part I/API 598

9.7. Specification for Globe Valve (DN 50 & above)

Sl. No.	Description	Material
1	Type	Globe valve
2	Body & Bonnet	CS ASTM A216 Gr.WCB
3	Wedge	CS ASTM A216 Gr.WCB + 13% Cr.
4	Stem	SS 410
5	Back seat	CS ASTM A216 Gr.WCB + 13% Cr.
6	Hand wheel	Carbon steel
7	Gland, Gland plate disc spindle nut	SS 410
8	Gland Packing	25% Carbon filled PTFE rings
9	Pressure rating	PN = 16

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Sl. No.	Description	Material
10	Manufacturing standard	BS 1873/ API 600
11	Pressure Testing	As per BS 6755 Part I/API 598
12	End connection	Flanged

9.8. Specification for Plug Valves

Sl. No.	Description	Material
1	Type	Two-way/Three way, lubricated type, tapered plug
2	Body, Cover & Gland	ASTM A216 Gr. WCB
3	Plug	ASTM A351 Gr. CF8
4	Fasteners	Black Hexagonal bolt with nut as per IS:1364 Part 1 & 3,1992, class 4.6/4
5	Gland Packing	Non- Asbestos
6	Gaskets	Non- Asbestos
7	End connection	Screwed end up-to DN50, NPT/Flanged end for DN65 & above
8	Pressure rating	PN 16
9	Manufacturing Standard	BS 5353/API 599
10	Testing Standard	API 598 / API 6D

9.9. Specification for Ball Valve (For size DN 15 to DN 40)

Sl No.	Description	Material
01	Type	Two piece, full bore, floating ball
02	Body & Connector	ASTM A105
03	Ball	ASTM A 351, Gr. CF 8M/SS316
04	Seat	PTFE
05	Stem	AISI 316
06	Body Seal	PTFE
07	Gland	ASTM A479 SS
08	Stem Packing	35 % Carbon filled PTFE
09	End Connection	Screwed NPT/Socket end, Socket weld connection with nipple of 100 mm (sch40 seamless pipe) welded on both sides.
10	Fasteners	HT, SS 304 only

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Sl No.	Description	Material
11	Operation	Lever operated
12	Valve Design	BS 5351/API 6D
13	Pressure testing	API 598/EN12266
14	Pressure rating	Class 800
15	Face to Face Dimension	ANSI B 16.10
16	Max. operating temp	100 Deg ^{0}C

9.10. Specification for Ball Valve (For size above DN 40)

Sl No.	Description	Material
01	Type	Three piece, full bore, floating ball
02	Body & Connector	Cast steel ASTM A216 GR WCB
03	Ball	ASTM A 351, Gr. CF 8M/SS316
04	Seat	PTFE
05	Stem	AISI 316
06	Body Seal	PTFE
07	Gland	ASTM A479 SS
08	Stem Packing	35 % Carbon filled PTFE
09	End Connection	Flanged
10	Fasteners	HT, SS 304 only
11	Operation	Lever operated
12	Valve Design	BS 5351/API 6D
13	Pressure testing	API 598/EN12266
14	Pressure rating	PN = 1.6 N/mm^2
15	Face to Face Dimension	ANSI B 16.10
16	Max. operating temp	100 Deg ^{0}C

9.11. Specification for Air Release Valve

1	Type	Air release valves as per IS: 14845-latest standard total tamper proof design (large orifice). Single Air valve- For main pipe size upto DN 100 Double air valve- For main pipe size Above DN 100
2	Body, Cover and Cowl	ASTM A216 Gr. WCB
3	Small orifice Air release	Bronze/ St. Steel (IS 318 GR LTB2/ SS 304)

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	Nipple	
3	Floats small and large	Timber core with vulcanite/ rubber coating/ SS 304 /SS316
4	Seat Ring	Natural rubber IS 638 type B
5	Pressure rating	PN 16
6	Test pressure	As per IS 14845

9.12. Specification for Float Valve

1	Type	Single - beat type with balancing piston
2	Body/Cover/Gland/Piston	Cast iron Gr 260 as per IS 210-1993
3	Seat ring/valve guide	IS 318 Gr 2
4	Pilot valve seat/face cap / spindle	IS 318 Gr 2
5	Links	M.S. cadmium plated
6	Face ring/piston cups	Leather
7	Lever	M.S.
8	Float	Tinned copper
9	Pressure rating	PN = 10
10	End connections	Flanged end, IS: 6392-1971(RA'88) 50 mm and above. Screwed end upto 40 mm. Threading as per IS: 554/BSP Thread.
11	Hydrostatic testing	Body - 15 Kg/cm^2
12	Design Standard	As per manufacturer standards

9.13. Specification for Knife Edge Gate Valves

Sl No.	**Description**	**MOC/ Specification**
1.	Design Standard	MSS SP 81
2.	Type	Bi-directional with rising spindle
3.	Body	ASTM A 351, Gr. CF8M
4.	Gate	ASTM A 240 Type 316
5.	Seat Ring	POLYURETHANE
6.	Packing Gland	BRAIDED PTFE
7.	Yoke	ASTM A 216 Gr. WCB
8.	Stem	ASTM A 276 Type 316
9.	Gasket	Non Asbestos
10.	Pressure rating	PN 16
11.	Position indicator	Aluminium
12.	Valves mounting fasteners	A193/A194 Gr. B7/2H- CS

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	bolts / nuts	

9.14. Specification for Companion Flanges

1	Type	Raised face plate flanges, Slip-on, welded, plate fabricated, machined finish.
2	Dimensional Standard	As per IS-6392, as per valve rating, Table-17/11, drilled off centre, RF. / As per BS EN 1092 PN 16/ ANSI B 16.5 / AWWA C 207 CLASS D
3	Material	C.S as per IS-2062 GR. 250A.
	Note: Valve flanges and matching flanges shall be drilled as per IS: 6392, table 17 for PN 1.6.	

Nominal size of the valve, make, pressure rating shall be cast on the body of the valve.

9.15. Spares

Sl. No	Description	QTY
1	All valves	1% (min one number of each type & size)
2	Nuts, bolts & Gaskets	1% (min one number of each type & size)
3	Gland Packing	Lot

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10. Design Criteria for Filter

10.1. Online Automatic Backwash Filter – Equipment Specification

10.1.1. Mechanism

The online filter shall be of cylindrical body with wedge wire/weave wire element housed in it. For automatic filter, area will be in the ratio of 1:4 (inlet C/S area to screen area). The filter should start the self-cleaning process when the pressure differential across the screen reaches a preset value or predetermined lapse of time. Differential pressure switch with alarm contacts shall be provided for each filter. Cleaning of the filters shall be automatic and the filtering process shall not get hampered during back wash. The filter shall be of 200 micron or less and the same shall be as per technical requirement. Capacity of the online automatic back wash filter shall be same as the rated flow of the circuit. Suitable by-pass arrangement with required isolation valves shall be provided for online automatic back wash filter.

The screens shall be in SS316L material for surface water (rivers, lakes etc) and for sea water the screens shall be of 6MO (254) material grade. Housings shall be in high grade carbon steel with suitable sandblasting and epoxy coating with polyester coating. The filter control shall be carried out by PLC and MCC system. However, functional description / Control write-up, PLC Input / Output list shall be furnished.

Flush drain valve and vent shall be provided for each unit of the main filter. The design of the filter shall be suitable for easy maintenance and replacement of the parts and inspection.

Minimum water for flushing: The water used for flushing shall not exceed 1 to 2% of the rated flow and the filter shall always deliver at the outlet of 98% of the rated flow. No standby filters are envisaged for this application.

The filters shall be having arrangement to do manual flushing with the help of test button on the front of the control panel as well by simulation locally on the filter by closing the small ball valve for 5 sec and re-opening it, thus creating an artificial backflush cycle.

Provision shall be made for collection of backwash water from the strainers and shall be suitably diverted for further treatment.

Valves to be supplied as part of the filters shall conform to the specification laid in this GS.

10.1.2. Valve Actuator

Refer Electrical GTS for the same.

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10.1.2. Surface Preparation and Painting

Blasting with steel balls on the surface to achieve as SA 2.5 quality according to the requirements of the Swedish standard organisation (SIS)

Phosphatization according to the American Federal specification procedure TT-C-490D-Type 1, also included degreasing by immersion of the product in tank containing various chemical solution.

10.2. Simplex / Duplex Strainer - Equipment Specification

Simplex / Duplex basket filters shall be installed on water pipelines to arrest suspended solids in water.

- Strainers/Duplex basket filters shall be of cylindrical MS construction.
- Strainers/Duplex arrangement with built-in valves shall be such that one element will always remain in operation ensuring continuous uninterrupted supply of filtered water from each strainer. It should not be possible to isolate both the strainers simultaneously due to even inadvertent rotation of hand wheels for movement of valve disc during change over from one basket to another. The changeover valves shall have manual drive.
- Basket Filter bodies and internals shall be designed to withstand design pressure with normal surges.
- Pressure equalizing connections for both the chambers shall be provided for smooth changeover.
- Two nos. dial type pressure gauges of size 150 mm dia shall be provided suitably mounted at the inlet and outlet mains of each strainer.
- Differential pressure switch with alarm contacts shall be provided for each unit of the main strainer across inlet and outlet for operation at a differential pressure adjustable within 0-1 kg/cm^2.
- Flush drain valve and vent shall be provided for each unit of the main strainer. The design of the strainer shall be suitable for easy maintenance and replacement of the parts and inspection.
- Each strainer shall be provided with basket opening area (six times of pipe cross section area or bigger) to ensure high flow volumes at low pressure and a long service

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life.

- Flush drain valve and vent shall be provided for each unit of the main filter. The design of the filter shall be suitable for easy maintenance and replacement of the parts and inspection.

- Along with the offer details of the basket filter such as make, general arrangement and cross sectional drawings, operating parameters, materials of construction of various components supported by manufacturer's literature and catalogues shall be furnished.

- Valves to be supplied as part of the filters shall conform to the specification laid in this GS.

10.3. Y – Strainers - Equipment Specification

Y – Strainers of suitable sizes shall be installed at water pipelines to arrest suspended particles.

- The body of the Strainer will be MS fabricated.
- Element will be SS 304
- Screwed for 50 NB and below
- Flanged for 65 NB and above
- Mesh size will be 1 mm
- Test pressure will be 15kg/cm^2.

10.4. Shop Testing

Testing and inspection of equipment and materials shall be carried out at the works of the Contractor or his sub-Contractor during manufacturing and on final product to ensure conformity of the same with acceptable criteria of Technical Specifications, approved drawings, authenticated manufacturing drawings and reference Indian/International standards.

Tests to be conducted at the shop for various assemblies/sub-assemblies of equipment shall include, but not be limited to the following:

- Material test.
- Tests during manufacture/fabrication.
- Dimensional checking.
- Hydraulic test at the shop.
- Performance test.

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10.5. Spares

Self Cleaning Filter				
Sl.No	Description	UNIT	QTY	Remarks
1	Lower Bearing	Nos.	1	One No for each type
2	Hydrualic Seal	set	1	
3	Slotted spring pin	Nos.	1	One number for each type
4	Suction scanner Nozzle	Nos.	1	One number for each type
5	Suction scanner Shaft	Nos.	1	One number for each type
6	Upper Bearing	Nos.	1	One number for each type
7	O Ring Set (External)	Set	1	One complete set for each type
8	O Ring Set (Internal)	Set	1	One complete set for each type

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11. Design Criteria for Stainless Steel Flexible Hoses

Equipment Specification

1.	Type of Hose	Single Stainless-Steel wire braided corrugated flexible hose assembly SS AISI 304, fitted with SS female swivel fittings at both ends (Nut nipple) suitable for connecting pipes. As per BS: 6501 Part-I with type B flexibility. Alternatively cam lock connection can also be offered
2.	Size	As per requirement
3.	Suitable for pipe internal diameter	As per requirement
4.	Test pressure	1.5 times of operating pressure
5.	Operating pressure	As per System requirement
6.	Frequency of bend	Single
7.	Design temperature	Normal : 40 to 50 ^{0} C Maximum : 110^0 C
8.	End connection	Female swivel end on both sides (Nut nipple) suitable for connecting pipes having flanges

Hose specification (for Blast Furnace): These hoses will be used in all interconnections in stack zone area and other areas.

i. flame resistant cover,
ii. SS wire mesh, wire thickness 0.3 mm,
iii. rubber coating,
iv. glass/ ceramic fibre,
v. Heat resistant (upto 230 deg C) rubber core.

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12. Design Criteria for Rubber Expansion Joints

12.1. Equipment Specification

Material specification:

Rubber Expansion Joints shall be made of high-grade abrasive resistant natural rubber compound reinforced with adequate numbers of piles of heavy cotton duck, rayon cord, impregnated within rubber compound and further reinforced with square metal ring embedded in it. The outer exposed surface of rubber expansion joints shall be given a coating of synthetic/neoprene rubber and further painted with chlorinated rubber-based paint. Rubber expansion joints will be suitable for design temperature of 50 ^{0}C and for handling clear water. Rubber expansion joints shall absorb vibration, shock and axial compression of 10 mm, axial elongation of 10 mm and lateral movement of 10 mm.

Control unit:

One set of control unit (stretcher bolt assembly) consisting of 2/3 nos. limit/tie rod (material IS: 3657 Gr. 6.6), Stretcher Bolt, Triangular Plate (material IS:226), Nuts (material IS:1363 Gr. 6.O) Steel Washer and Rubber Washer of durometer hardness of 100deg Centigrade +/- 5 deg Centigrade.

The control unit shall be made suitable to make RE joint and no. of limit/tie rod matched against each.

12.2. Technical Parameters of Rubber Expansion Joint

1.	Test pressure	18 kg/cm2 or as per relevant standards
	Max. Pressure (operating)	12 kg/cm2
	Design pressure	16 kg/cm2
	Burst pressure (Guaranteed	4 times design pressure
	Leak test	18 bar(g), joint shall be kept immersed in water bath to check leak tightness
2.	Length	As per relevant standard
3.	Tie rod	2 tie rods up to DN65 3 tie rods from DN 80 to DN300 4 tie rods above DN350 and above
4.	Material of construction	
	Body	Natural rubber compound
	Cover	Neoprene rubber
	Tie rod	Carbon steel
5.	Design temperature	Normal 40 Deg Centigrade

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6.	End connection	Max 80 Deg. Centigrade (Worst Case) Carbon steel forged loose flanges at both ends, with dimensions as per IS: 6392

12.3. Spares

1. One Number of each diameter to be provided as spare.

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13. Design Criteria for Sluice Gates

13.1. Equipment Specification

SS Sluice gates shall be supplied as per IS: 13349/AWWA C 561. Gearbox arrangement shall be of open type for small size and closed type for sizes above 400 mm size.

Sluice gates are used as a means of flow isolation in channels and on ends of pipes entering wet walls. Sluice gates are used against a wall between two basins or between a pipe and an open channel.

Sluice gates have been usually located when the influent channel enters the wet well and can be operated to isolate the section of the wet wall for subsequent dewatering and maintenance/repairs.

Thimble mounted sluice gates to be provided for size DN 750 and above (MOC shall be as per table given in this chapter).

Sluice gates shall be of rising spindle type. Sluice gates shall be selected in such a way that the velocity through gates shall be in the range of 0.5-0.75 m/s.

All assembly bolts/studs, nuts, anchor, bolts and washers are acceptable in stainless steel construction to AISI: 304/ AISI: 410.

Sealing of single face is acceptable. Accordingly, leakage test shall be performed to ensure committed leakage for seating head only applied for unseating side.

Item Nos. of all the gates shall be punched on the gate (at an easily identifiable place) before dispatch.

Design and constructional requirements

A wrought stainless steel side guide strip having a machined taper face on the underside shall be fixed to the frame on each side by SS studs and extending over the height of the waterway to provide effective guide throughout the travel of the door.

A stopper shall be cast integral immediately below the waterway and central with it to limit the travel of the door and to avoid the chances of overstraining of wedge brackets. The stoppers shall be provided in such a manner that they do not foul with the seat facings on the door.

Guides shall be adequately secured to the main frame by stud bolts and provision shall be made for appropriate longitudinal movement to adjust degree of wedging consistent with sealing properly. There shall be little lateral movement and tongues, keys, shoulders or

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lugs may be provided for the purpose.

The locations of anchor bolts for the gate frames shall be as per the applicable standard. The diameter of anchor bolts shall not be less than 15 mm. The diameter of anchor bolts for larger gates shall be 20 mm minimum.

The lifting mechanism shall consist of a pillar mounted manually operated geared headstock. The pillar shall be provided with a suitable opening with detachable cover to facilitate easy cleaning and greasing of spindle threads.

The height of headstock shall be sufficient to enable an individual to operate the gate comfortably without bending from the waist. For smaller gates, the height of hand wheel from the base of headstock shall not be less than 600 mm. For larger size gates, the height of hand wheel from the base of headstock shall not be less than 750 mm.

The diameter of hand wheel shall not exceed 750 mm but shall be sufficient to enable operation of gate under the maximum operating head by a single person with an effort on the rim of hand wheel, not exceeding 136 Newton-m while crack opening the gate and not exceeding 68 Newton-m during normal opening after the gate is crack opened. The face of the hand wheel shall be clearly marked with the words "OPEN" and "CLOSE" with an arrow to indicate the direction of opening.

The headstock shall be provided with a suitable locking arrangement and gate position indicator.

The lifting rod shall be provided with square threading, length of threaded portion being approximately 250 mm more than the height of gate opening.

The lifting rod shall also be provided with a safety stop nut at the top to prevent the chances of over closing of gate.

The lifting rod shall be provided with sufficient number of rod guide brackets to limit the unsupported length of rod.

There shall be a provision on the gate for preventing free movement of shutter in the frame during transit, storing and handling. This provision shall be painted with red paint so that it can be easily noticed and removed immediately after erecting the gate assembly before an attempt is made to open the gate.

13.2. Data for Design of Sluice Gates

i.	Type of Mounting	Wall mounted type with head stock. Headstock shall have geared handle for operation.

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ii.	Spindle type	Rising Spindle

13.3. Material of Construction

Sl No.	Description	MOC/ Specification
1.	Design and testing Standard	AWWA C561
2.	Type of Mounting	Wall Mounted / Bi-directional with rising spindle
3.	Transit Stops	UHMWPE
4.	Shutter Side Guide	UHMWPE
5.	Gate Frame	SS ASTM A240 Type 316
6.	Shutter	-do-
7.	Side Seal Retainer	-do-
8.	Bottom Seal retainer Flat	-do-
9.	Top Seal Retainer	-do-
10.	Top Wedge	-do-
11.	Stem	SS ASTM A276, Type 316 (Solid)
12.	Fasteners	SS, AISI 304/410
13.	Anchor bolts	SS, AISI 304/410
14.	Bottom Rubber seal	Neoprene ASTM D2000
15.	Side Rubber Seal	UHMWPE (backed with Neoprene ASTM D2000)
16.	Top Rubber Seal	-do-
17.	Hinge Pin & Stem	SS ASTM A276 Type 316
18.	Thrust Nut	Bronze ASTM B865 (CA863) / SS ASTM A276 Type 316
19.	Headstock Pillar	CI IS210 Gr 260
20.	Stem cover with indicating scale	Transparent Polycarbonate tube
21.	Crank Handle	CI IS 210 FG260
22.	Pillar Mounted Bevel Gear Headstock (PBGH-2000)	CI IS210 Gr 260
23.	Stop Nut	CS IS 210 FG260
24.	Stem Coupling	SS ASTM A 276 type 316
25.	Operating Nut / Stem Nut	Leaded Tin Bronze IS318 LTB-2

Note:
Permissible leakage rate will be 1.24 litre / minute / meter of seating perimeter as per AWWA C561 standard.

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14. Design Criteria for Raw Water & Drinking Water Treatment Plant

The Raw Water Treatment Plant is to be provided to meet the makeup water requirements of various circulation systems and drinking water needs.

To install water treatment plant comprising pre-treatment units for settling, clarification and filtration for the influent raw water with a view to obtaining an acceptable quality of make-up water & drinking water. The raw water treatment plant can be designed with conventional treatment system or through Lamella clarifier.

14.1. Raw Water Treatment System

Raw water from raw water pump house shall be passed through cascade aerators. From cascade aerators raw water shall pass through a separate stilling chamber. Raw water from each stilling chamber shall pass through parshall flumes. From each parshall flume raw water shall be passed through flash mixer, Flocculator and settler (Plate clarifier/ tubes settler) with pre-chlorination, dosing of Alum, lime and polyelectrolyte dosing. For polyelectrolyte dosing, selection of polyelectrolyte shall be compatible for ultimate end use of the treated water for drinking water consumption. After clarification, overflow water shall flow to the clarified water sump near the Make-up water pump house. All water retaining / storing RCC structures will be painted with food grade epoxy paint from inside.

The underflow of the clarifiers and the waste wash water from the pressure filter shall be collected in a sludge sump situated near the clariflocculator and shall be pumped to the dewatering system. Suitable agitation shall be provided in the sludge sumps to avoid settling of the sludge. Storage of chemicals and their dosing facilities shall be provided inside the chemical house located besides the clariflocculator.

Provision of slurry storage tanks & slurry transfer system along with piping to be ensured. The capacity of the slurry storage tank shall be adequate for storage of the waste wash water generated from the backwash in conjunction with the underflow sludge discharged from the clarifier during the said period. Two nos. of slurry storage tank shall be provided of suitable capacity and suitable Nos. of slurry transfer pumps will be installed for transporting the slurry to the dewatering system.

Sludge recirculation System from underflow of clarifiers shall be provided in case the consistency of the sludge is not suitable for dewatering system. The recirculation System shall be complete with necessary valves, fitting, etc. as required along with sludge recirculation pumps (1W+2R), for each clarifier.

14.2. Make-Up Water System

Clarified water from the clariflocculator flows to the clarified water sump. The clarified water storage tank shall be provided with a storage capacity 1 hour. Clarified water pumps,

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will feed the clarified water to a pressure filter with sand/dual media for filtration of the clarified water. Filtered water will be received into the makeup water storage tank from where major part of the water will be pumped to the make-up water network of the proposed Plant and another part will be used for back-washing purpose of the pressure filter. The make-up water storage tank shall be provided with a capacity of 2 hour.

Two nos. make-up water Pumps (1W +1S) shall be provided for pumping the filtered water into the make-up piping network or to the overhead tank as per the requirement.

14.3. Drinking Water System

Part of the filtered water will be chlorinated through an online chlorinator and pumped and supplied throughout the plant for drinking purposes. Two nos. drinking water Pumps (1W +1S) shall be provided for pumping the potable water to the drinking water circuit.

14.4. Design Parameters

The design of the treatment plant shall be based on the following considerations:

The maximum TSS after clariflocculator shall not exceed 50 ppm and maximum TSS in the treated make-up water (after pressure filter / gravity sand filter / valve less gravity filter) shall not exceed 5 ppm and the pH of treated make-up water shall be in the range of 7.5 to 8.2. With a view to demonstrate the aforesaid guaranteed performance values, equipment to be selected judiciously and to carry out the process design calculations based on optimum chemical dosing rates for each of the aforesaid conditions and include the most appropriate process scheme.

14.5. Design

The complete system shall be designed following good engineering practices and standards. The detailed scope of design shall include:

i. Development of the pumping and treatment scheme.
ii. Finalisation of equipment layout of the complete treatment plant
iii. Design and routing of pipes, cables, ventilation ducts etc. upto the design limit.
iv. Design of Raw water pump house, Clariflocculators, flash - mixer, sludge pumping system, chemical house.
v. Design of complete electrics, Power distribution, instrumentation, automation, ventilation and material handling facilities.
vi. Civil drawing/Assignment drawing.

Treatment plant shall be designed as per "Manual on Water Supply and Treatment" of CPHEEO (Central Public Health and Environmental Engineering Organisation)

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The Make-up Water Treatment Plant shall be designed for the required output. The treatment plant shall generally consist of the following technological units/equipment/sub-systems:

Sl. No.	DESCRIPTION
001	Raw water inlet pipe line
002	Cascade Aerator
003	Stilling Chamber
004	Flash Mixer
005	Clariflocculators/
006	Chemical storage cum preparation / Dosing area
007	Pressure sand filter / Rapid sand gravity filter / valve less gravity filter complete with piping and control valves, water distributor, under drain collection system, air vents, drain cocks, manholes, sampling points, instruments etc. with initial charge of filtering mass.
008	Filter Air Blower
009	Slurry storage tank agitator mechanisms complete with shaft, paddles,
010	motor, gearbox, base plate, platforms, walkways, handrail etc.
011	Slurry storage tank fittings viz vertical baffles and wear plates.
012	Sludge pump sets (1W+2R) and pumping system
013	Raw water pump house
014	Raw water sump
015	Pump sets
	Raw water pump sets
	Clarified water pump sets
	Make-up water pump sets
	Drinking water pump sets
016	Backwash system for filters
017	Electro Chlorination Plant
018	Alum solution preparation-cum-dosing tanks of MSRL construction with SS-316 dissolving baskets.
019	Alum dosing pumps of suitable capacity, electromechanical type with SS-316 wetted parts
020	Lime preparation-cum-dosing tanks with dissolving baskets.
021	Lime dosing pumps, of suitable capacity, and electro-mechanical type.
022	Polyelectrolyte solution preparation-cum-dosing tanks of MSRL construction.
023	Polyelectrolyte dosing pumps of suitable capacity, electromechanical type with SS-316 wetted parts.
024	Polymer tank agitator with SS wetted parts complete with drive motor &

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Sl. No.	DESCRIPTION
	accessories
025	Lime tank agitators complete with drive motor & accessories.
026	Polyelectrolyte tank agitator with SS wetted parts complete with drive motor & accessories.
027	Gate valves, non-return valves, plug valves and needle valves as required.
028	Clarified water, filtered/make up water, back wash water, waste wash water piping
029	Chemical dosing piping
030	Underflow slurry piping
031	Instrumentation as per T.S.
032	Electrics as per T.S.
033	Structural work as per T.S.

Broad specifications for the major equipment/sub-systems of the proposed Make-up Water Treatment Plant are outlined below:

14.5.1. Pre-treatment

Cascade Aerator

In Cascade Aerator water is allowed to flow downwards after spreading over inclined surface in thin sheets and the turbulence is secured by allowing the water to pass through a series of steps or baffles. The number of steps shall be 4 to 6. Exposure time can be increased by increasing the no. of steps and the area to volume ratio improved by adding baffles to produce turbulence. Head requirements shall be in the range of 0.5 to 3.0m and the space requirement shall be in the range of 0.015 - 0.045 $m^2/m^3/h$. Necessary treatment and cleaning of Cascade Aerator to be provided for removal corrosion and slime deposition.

Stilling Chamber & Flash Mixers and Flocculation Tank

Stilling chambers, (two for each clariflocculator) shall be designed to provide adequate retention time for optimal functioning of the system.

Flash mixer shall be designed to provide adequate mixing time with the coagulant with retention time of 60 sec. Flocculation tank of RCC construction is designed for a retention time of 15 minutes and provided for slow mixing of influent water with PE Solution.

As such suitable piping arrangement on inlet side and outlet side of flash mixers is to be provided along with necessary isolation valves. Pipes leading to Clariflocculators, structural ladders, platforms, hand-railings, etc. shall also be provided. Coagulant preparation and dosing system shall also be provided. The outflow Pipes shall be adequately supported.

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One portable pH meter shall be provided to measure the pH of water before and after flash mixer.

14.5.2. Inclined Plate settler

Inclined plate settlers shall be provided with in-built scrapper mechanism inside the lamella. Each inclined plate settler shall be able to produce the required treated water capacity during normal operation. The plate to shall be designed to ensure the following:

Water moves in the upward direction while the sludge flows in a downwards direction.

The influent water is distributed evenly amongst all the plates causing laminar flow conditions to occur in the settler.

Maximum plate area is utilised for the clarification purposes.

The plates can be removed and cleaned during operation.

The gap between the two plates remains the same throughout the length and width of the plate.

The plates, overflow channels etc. do not bend or deform during operation.

The orifices, through which the clarified water flows to the overflow channel, are suitably sized and spaced for providing equal loading of solids amongst various plates.

The clarified water flows to the clarified water sump through gravity.

The sludge collects in the sludge chamber provided at the bottom of the settler most effectively and do not re suspend in the influent water.

The plates, overflow channel etc. shall be light in weight, strong, rigid and easy to maintain as well as of non-corroding material.

The gap between the two plates shall be suitably selected to provide optimum operation of the unit. The rise rate for the settlers, shall be in the range of 1.25 to 1.5 m/s.

A hopper shaped sludge chamber shall be provided with each settler. The sludge chamber shall be of sufficient storage capacity to allow periodic draining of sludge to the sludge pit.

Suitable baffle arrangement shall be provided to ensure effective separation of the influent water and the settling sludge.

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A telescopic pipe arrangement shall be provided so that the level of sludge in the sludge chamber can be assessed.

To protect the plates, overflow channels etc. from an accidental impact load and direct sun light, the plate settler shall be provided with suitable covers.

Suitable measures for proper cleaning, flushing of the settler and its various components shall be provided.

Suitable platforms, handrails, approach staircases, ladders etc. shall be provided on top of the settler.

14.5.3. RCC Clariflocculators/HRSCC/UHRC

- Clariflocculator/HRSCC complete with all mechanical and electrical accessories shall be designed in such a way that each can handle required quantity of raw water.
- The clarifier should be capable of operating successfully with the rise rate of 2.5 to 4.0 $m^3/m^2/hr$ and adequate surface area for surface loading.
- The clariflocculator/HRSCC shall also contain overflow weir, peripheral launder for collection of clarified water, sludge raking arms with MS scrappers and squeezes attached to the bladder, sludge drainage pipeline with telescopic arrangement, sludge chamber along with necessary instrumentation and protection system
- Walkways with handrails shall be provided along the periphery of the Clariflocculators/HRSCC and on the moving bridge assembly.
- Suitable measures for proper cleaning, flushing of the clariflocculator/HRSCC and its various components shall be provided
- Suitable platforms, handrails, approach staircases/ ladders etc. shall be provided for the clariflocculator/HRSCC

14.5.4. Filter House: Pressure filters / Auto Valve less Gravity filter, Activated carbon filters and accessories shall be installed in a covered structural building or in open space based on requirement and shall be constructed based on general arrangement drawings, foundation details and load data.

Pressure Filters: Refer specification of pressure filter mentioned under chapter 07.

Auto Valve less Gravity Filter

The filters and the connected equipment shall be designed, manufactured and tested as per CPHO manual or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated. In addition following shall be followed.

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The surface loading shall be 1 0 $m^3/hr/m^2$.

Housing shall be fabricated as per IS:2062 Gr. B and designed as per IS 803.

At least 60% of free board shall be left over the filtering media. Media traps shall be provided at the outlet of each filter.

Back wash cycle for each filter shall be once in every 24 hrs with 20 hrs service cycle.

Suspended solids content in the filtered water shall not exceed 5 ppm.

The piping system and control valves shall be provided in front of the vessel for smooth operation. The same shall include contaminated water inlet, filtered water outlet, back wash inlet, waste water outlet, drain and air vent.

Filters shall be provided with access manholes of size 600 mm for filling and charging of gravel, sand and for maintenance purposes. Filter shall be provided with cage ladder to access top and hand railing on the filter top.

Filters shall be of vertical type. The filter shall be provided with unfiltered water distributors and header lateral type under-drain collecting system.

Maximum pressure loss across the filters should not be more than 5 mWC.

- Inspection opening shall be provided to inspect the internals and filtering media.
- The pressure filter vessel shall be internally painted with 3 coats of anti – corrosive paint and shall be coated externally with a protective paint.

Activated Carbon Filter: Refer specification of Activated carbon filter mentioned under chapter 07.

14.5.5. Chemical Storage cum Preparation/ Dosing Area

a) The chemical dosing/ storage system shall be provided considering the following:

- The chemical house shall be of two storied building having minimum two entries. One entry shall be provided with a ramp for truck entry.
- The ground floor shall be used for storage of chemicals and the first floor shall have chemical solution preparation tanks & dosing pumps.
- The chemical storage capacity shall be for a minimum of 30 days consumption of chemicals.
- The process of preparation of chemical solution shall be designed so that it is safe to

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operate.

- Each of the solution tanks shall have a capacity to meet the requirement for a minimum 8 hrs period.
- One weighing machine shall be provided at the ground floor and weighed amount of chemicals shall be transported to the first floor. A pallet box shall be provided for lifting the chemicals. Six pairs of gloves for handling of chemicals along with measuring jars, dissolving trays etc. shall be provided for safe and proper handling and measurement of the chemicals. 1 Ton electric hoist at each floor shall be provided for handling of chemicals.
- The floor and walls (upto 3m height) at both floors shall be provided with acid/alkali resistant tiles.
- Metering pumps with MOC compatible with the respective chemical shall be used for dosing the chemical solutions to the flash mixer.
- Two pumps (one working + one standby) shall be provided dosing chemicals.
- Each of the solution preparation tanks and solution handling tanks shall be provided with agitators with electric drive. Material for agitator shaft and paddles shall be stainless steel (AISI 304).
- The solution preparation and holding tanks shall be interchangeable.
- The valves shall be provided as per requirement and specifications as per the relevant chapter in this specification.
- An operating platform of requisite dimensions shall be provided at an appropriate height to ensure smooth handling of chemical for solution preparation purpose.
- Eye wash & safety shower shall be provided at each floor.
- Effluents from the chemical house shall be discharged into the storm water drainage system only after neutralization.

b) Eye wash & Safety shower

Eye/ face wash and emergency safety showers shall be provided as a combined & integrated unit and shall be designed as per IS: 10592. Drinking water connection shall be provided for shower and washing facility. The eyewash showers shall be made from corrosion resistant materials.

Flooring	:	PCC flooring with acid proof polyvinyl tiles and dyke wall to restrict water flow outside the shower area
Drainage system	:	Proper drainage system shall be provided for quick disposal of used water.

Features:

- Two Types of Showers - one for face protection at lower level & second for full body protection.

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- Both the showers can either be operated simultaneously or singularly as per the requirements.
- Showers are fitted with pull chain for body shower as well as foot-operated for face wash.

Material of construction:

- Pipe - GI heavy grade confirming to IS: 1239 Part-I (heavy)
- A self-closing valve in Gunmetal
- Foot Pedal in MS Galvanised
- Spring in MS Galvanised
- Pull Chain in MS Galvanised
- Showerhead Material - SS 304
- Eyewash Nozzles Material - SS 304
- Eyewash Bowl Material - SS 304

14.5.5. Sludge Removal System

- Sludge from the underflow of clarifier shall be removed either by telescopic valve arrangement or though pumping system.
- Three nos. (1W+ 2S) sludge pumps shall be provided for the each clariflocculators. The capacity and head of the pumps shall be decided based on the sludge characteristics. The sludge pumps shall be of Ni hard, non-clog, centrifugal type.
- Sludge pumping system shall be so designed that the pump, pipe network and valves shall be flushed with industrial water after completing the cycle of pumping.

14.6. Air Blowers

- Two twin lobe/tri-lobe type air blowers (One working and one reserve) complete with accessories and piping shall be provided for air scouring of the filters. The air blowers shall be of oil free type. The blower may be of centrifugal type or rotary based on system requirement.
- The air blowers shall be complete with drive motor, base plate, coupling, coupling guard, bolts, nuts and gaskets, air filter, etc.
- The capacity and pressure of the air blower shall be decided to suit the requirement of the air scouring of filters. The drive motor shall be selected with at least 15 % overload margin over the maximum shaft power requirement.

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Spare for Blowers

Sl.No	Description	UNIT	QTY
1	Bearing	set	1
2	Piston	set	1
3	Spring	set	1
4	Port	set	1
5	Sealing	Set	1 for each model
6	Gasket & O ring	Set	1 for each model

14.7. Chlorine House and Chlorination System

For Electro-Chlorinator refer Cl. No. 20.01

- One chlorine house shall be provided.
- The chlorine house shall consist of two rooms. One room shall be planned for chlorine storage and the other room shall be planned for dosing chlorine gas into the pipeline feeding filtered water to the overhead tank. The chlorine storage room shall have sufficient space to store one month's requirement of chlorine. The chlorine storage room shall also house the safety and supervisory equipment.
- The storage and dosing rooms shall be provided with 2 doors and the doors shall open outwards. The rooms shall be accessible to truck approach and shall be provided with ramps.
- Normally natural ventilation and means for cross ventilation shall permit changes of complete air in the rooms in about 10 to 15 minutes. Ventilators shall be provided at the bottom, one opposite to the other. The rooms shall be vented to upper atmosphere and shall be equipped with positive means of exhaust near the floor level, capable of complete air change within 3 to 4 minutes at the time of emergency. The ventilation system shall consist of a combination of fresh air inlet system and exhaust fans. The air fans shall have dry panel filters for supplying filtered air into the rooms. The supply air fan shall of tube axial type and the exhaust fan shall be of propeller type.
- Chlorine dosing shall be done with a view to maintain 0.5 mg/lit of free residual chlorine at the consumption points.
- The chlorine house and chlorine dosing system shall be designed as per IS - 10553 Parts I & II.
- The following safety and supervisory equipment shall be provided in the storage room.
  - 2 Nos. Gas masks.
  - 1 No. Residual chlorine testing kit.
  - First aid box and eye wash fountain.

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14.8. Sludge Agitators

i. Suitable Nos. of agitator assemblies shall be provided for installation in the open topped slurry storage tanks to ensure the following:

a) To keep the solids in an appropriate degree of suspension
b) To prevent formation of stagnant conditions at any point of the tank
c) To facilitate intermittent batch pumping of the slurry in a predetermined controlled manner without differential accumulation of size fractions within the tank.

ii. The slurry storage tanks will be of RCC construction will be constructed having required storage capacity (24 hrs). The tank will receive the underflow sludge discharged from the clarifier on a continuous basis and shall also receive the waste wash water and rinse water discharged from the Filter on a batch-basis during the back washing period.

iii. The selection of the correct agitator mechanism shall be based on selection of the appropriate propeller diameter and rotational speed to ensure that sufficient axial force is developed to maintain the solids in suspension in the storage tank to suit the aforesaid tank dimensions and the slurry characteristics.

iv. The agitator shall be of axial flow, single MIL (minimum induced loss) propeller type designed for the requisite duty conditions. The propeller shall be specifically designed to minimise the induced losses that are generated by the vortex sheets created by the pressure differentials in the liquid near the propeller trailing edges.

v. Each agitator assembly shall consist of a super structure which shall be mounted on the open topped slurry storage tank and shall support the gear box, motor, V-belt drive, shaft, propeller, etc. The super structure shall be fitted with necessary walkways and handrails also.

vi. Each agitator shall consist of the following major components:

a) **Propeller:** - Keeping in view the height: area ratio of the tank and the anticipated percentage value of solids in the slurry, only one propeller will be used which shall be located at the bottom of the shaft. The propeller blades shall be made of SS and bolted to the flange(s) of the agitator shaft. The propeller assembly shall be balanced within limits, which shall be dictated by the weight and the proposed operating speed. Tenderer shall recommend whether the propeller blades are to be covered with any abrasion resistant rubber.

b) **Propeller shaft:** - The propeller shaft shall be constructed of SS and shall be provided with flanges welded to it at the top, bottom and intermediate positions (as required). The dimensions of the shaft shall be so selected that the running speed does not exceed 50% of the critical speed. Shaft shall be solid in construction.

c) **Drive:** - Gear reducer drive shall be provided to suit to the exact duty requirements for the agitator. Medium sized propellers may be driven by gear boxes with vertical input shaft and vertically mounted motors and larger units will be driven by gear boxes with Horizontal shaft and horizontally mounted motors. The gear box will be

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of multi stage, helical gear variety and the complete gear and shaft assembly shall be housed in a high grade cast iron housing. The gear box shall be driven by a standard motor. The output shaft shall be fitted with a cast steel half coupling to match the propeller shaft

Spare for Agitators

Sl.No	Description	UNIT	QTY	Remarks
1	Oil seal for gear box MoC - Rubber)	set	1	One complete set for each type
2	Oil seal for bearing housing (MoC -Rubber)	set	1	
3	Bushes (Rubber)	set	1	One complete set for each type
4	Bearing for Lantern stool	set	1	One complete set for each type

Dewatering System

14. 9. General

As part of the water treatment plant, fully automated PLC controlled sludge dewatering plant shall be provided for handling the sludge from the unit.
The sludge dewatering plant shall be capable of producing filter cake of low moisture (=<30%) consistently. Suitable mode of filter cake discharge shall be provided under the sludge dewatering plant so that the filter cakes can be conveyed by trucks for final disposal.
The dewatering station shall be PLC controlled and operated from a remote location

Design Criteria

The sludge dewatering plant shall consist of n(Working)+1(Stand-by) of plate & frame type filter presses complete with all ancillary equipment and interconnecting piping.
The dewatering station will be PLC controlled and operated from a control room located in the chemical house / WTP
The filtrate from the dewatering station shall be led back to the thickeners/system

Filter Press

The filter press shall have high hydraulic capacity and shall be designed for dewatering the slurry efficiently with proper handling and disposal facilities for dry cake and 100% removal of filtrate, eliminating all blowback and residual lockup of filtrate.

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The overall operating cycle time for each press shall be not less than1hour.

The filter fabric shall be capable of handling the desired slurry with appropriate weave, breaking strength, air permeability and long durability. The filter cloth shall not warrant any special cleaning. The filtering area shall be optimum.

The material of construction of the components of filter press shall be matching with the duty conditions. The filter press shall be completely assembled on an integral structural base.

Smooth sliding of plates over tie bar shall be ensured by suitable arrangement.

Cam arrangement shall be provided for enabling jerking action on the cake for dislodging it to the conveyor / hopper installed below the press.

The filter press will have high hydraulic capacity and will be designed for dewatering the slurry efficiently with proper handling and disposal facilities for dry cake and maximum removal of filtrate, eliminating all blowback and residual lockup of filtrate.

The material of construction of the components of filter press will be matching with the duty conditions. The filter press will be completely assembled on an integral structural base.

Filter press frame

The filter press structure shall consist of feed head, moving plate, end plate and tie bars. The structure shall be MS fabricated of structural steel. The moving plate shall be mounted on the tie bars by means of rollers.

The filter press frame shall be strong enough to withstand forces of hydraulic cylinder during the operation of press.

Suitable coupling shall be provided for minimizing misalignment between the movable head and ram.

Filters tray shall be shall be constructed in MS with hard rubber lining of 3mm thickness.

Filter plates

Plate shall be rigid in construction for withstanding fluid pressure and hydraulic oil pressure for tightening during operation of press.

Filters plate shall be of the centre feed, four-cornered. Handles shall be provided on the sides of the plates for getting suitable support from tie bars.

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Plate material and filter material shall be selected considering the pressure, temperature and analysis of the influent slurry.

Air manifold

A manifold shall be provided to allow air blowing through the press for removal of residual moisture at the end of the filtration cycle. Individual control valves for each of the corner discharge port shall be provided for the filtrate collection header. A common discharge header shall be provided for collection of filtrate and its conveyance.

After completion of the filtration cycle provision for drying of cake by air compaction shall be provided.

Cloth Wash System

Cloth wash system shall be provided for cleaning of the filter plate cloth. One LDPE/PVC tank of capacity to cater two consecutive cloth wash requirement shall be provided along with 2 Nos. (1W+1S) pumps. The wash water shall be collected and sent to the same location where filtrate of filter press is taken.

Hydraulic closure system

The hydraulic opening and closing system shall include one double acting hydraulic cylinder and one hydraulic power pack. The system shall be designed to automatically compensate for any thermal expansion or contraction of the plate stack as well as maintain the proper clamping force throughout the process cycle.

The hydraulic cylinder shall be capable of producing sufficient clamping pressure.

Controls

Control panel shall be provided at closing end of filter press. The PLC shall have 20% spare IO"s. the software to program PLC shall be provided.

The control panel shall provide either manual control or automatic control selector switch in weatherproof enclosure. The panel shall include necessary starter, control relays, timers. All components shall be prewired to a main numbered terminal strip. The connection sleeve shall be punched.

All solenoids valve shall be provide in separate SS enclosures.

The fuse terminal shall be provided with LED display for all solenoids.

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Discharge mode of dry filter cake

Cake shall be discharged from filter press to truck either through conveying system like belt conveyor or directly through discharge chute below the press.

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15. Design Criteria for Gas Cleaning Plant - Effluent

Treatment Plant

The contaminated water from the respective units/shop (like gas cleaning plant of Blast furnace and BOF GCP) shall be treated in the Effluent Treatment Plant (ETP) comprising primarily the thickener units using polymer as coagulant, polyelectrolyte as flocculent and lime for pH correction. Hydraulics of the system shall be so designed that the clarified water from the thickener will be gravitated to the cooling tower top. The underflow sludge from the thickener shall be pumped to two nos. sludge storage tanks. A separate group of pumps shall be provided for disposal of slurry from the storage tanks.

The slurry pumps along with the facilities for chemical storage and coagulant/ flocculent dosing and pH correction shall be housed in the sludge pump house-cum-chemical house to be located near the thickeners.

15.1. General

Effluent Treatment Plant shall essentially comprise, but not be limited to the following units/facilities:

Sl. No.	Description
1.	Flash mixer complete with mixer blade, shaft, gearbox, motor, base plate, supports, etc.
2.	Thickener complete with raker arm, lifting device, feed well, approach bridge, drive motor gear box, limit switches, common base plate and underflow pumps, etc.
3	Sludge storage tank with agitator mechanism complete with paddle, shaft, motor, gearbox, base plate, platforms, handrails, etc.
4	Complete chemical dosing system
5	Complete dewatering plant with cake disposal system

15.2. Broad Design Guidelines

- **Slurry Launder**

Carbon steel basalt lined (30 mm thk.) slurry launder complete with walkway, hand rails and structural support, shall be provided from the discharge point of Gas Cleaning Plant up to the ETP. The cross-section and the slope with available level constraints shall be so designed as to ensure a self-cleansing velocity (min. 1.5 m/s) to avoid deposition of solids at the launder bottom. The minimum free board shall be 300 mm to avoid spillage of slurry during plant operation.

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- **Flash Mixers (if required)**

  RCC flash mixers with structural ladders, platforms, hand railings, etc. shall be provided to allow 60 seconds mixing time with the dosing chemicals. The outflow channels with walkways of removable chequered plates leading to thickeners shall be provided with gates to control/cut off the supply to thickeners. Local type pH measurements shall be provided before and after the chemical dosing.

- **Thickeners**

  Two number thickeners shall be provided for the system. Each thickener shall have capacity to treat 70% of the total effluent. When one of the thickeners is under shutdown the other one should able to take full load. The thickeners shall be of central drive type. The raker arm mechanism with gear reduction unit shall be provided. In the event of the raker arm getting jammed, audio-visual signals shall be available at the sludge pump house control panel. The raker arm shall be provided with lifting device (electro- mechanical type). Working position of the thickener shall also be depicted in the pump house. After encountering maximum torque limit, the raker arm shall lift automatically by 300 mm and continue to rotate in the lifted position. At the preset torque level, the raker drive motor shall trip.

  Sludge chamber shall be provided with manually operated knife edge gate valves to connect to the pump suction lines. Portable type local pH meter shall be provided to measure the pH of the clarified water.

- **Chemical House and Slurry Pump House**

  (i) Chemical house shall be provided as per guidelines mentioned in Chapter 15.
  (ii) Three slurry pumps (one working and two stand-by) shall be provided for each thickeners. The capacity and head of the pumps shall be decided based on the sludge characteristics. The sludge pumps shall be of non- clog type horizontal centrifugal in Ni-hard construction having minimum hardness of 500 BHN.

  (a) All valves for slurry operations shall be SS knife edge gate valves. Electrically operated valves, if any, shall have local and remote operations.
  (b) The unintentional tripping of the drive motors, jamming of valves, etc. shall be accompanied by visual signal at the pump house control panel.
  (c) Industrial water connections for flushing the pumps, pipe network and valves after completing the cycle of pumping.
  (d) Compressed/Instrument air connection shall be provided in the slurry piping for flushing purpose.

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15.3. Dewatering System

For details, refer relevant clauses of chapter 14.

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16. Design Criteria for Oil Skimmer

Oil skimmer shall be floating continuous tube type with cantilever boom arrangement.

The oil skimmer shall be designed to continuously move the collective tube over the complete width of each compartment of scale pit/secondary settling tank/sumps/tanks.

The oil skimmer shall be designed for 24 hrs. Operation.

The oil skimmer shall be dual tube designed so that it can be used for skimming of two separate compartments simultaneously.

The oil skimmer should consist of MS Vertical Mast, Cantilever Boom with Swivel arrangement suitable for 360^{0} rotation. Cantilever Boom should be fixed to the Vertical Mast on one side and Tube type Oil Skimmer is mounted on the other side.

The oil skimmer main body/ Housing of the Oil skimmer should be made from weather proof aluminium casting.

The oil skimmer tube should be made from Oleophyllic polymer and scrapers should be made from high abrasion resistant ceramic.

Oil scraped from the tube will be gravitated into the container located at ground level near the skimmer thorough a pipe. Containers shall be placed in such a way that it can be handled through fork lift or any other handling equipment. Each oil skimmer shall have independent oil collecting container. Capacity of the container shall be decided based on the source of effluent. However, the same shall be minimum 200 litres.

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17. Design Criteria for Sand Filter

17.1. Following type of filter to be provided based on the type of application:

1. Scale removal system: Pressure sand Filters
2. For circulating water system and treatment unit (Side stream filtration, Make-up water system) : Auto Valve less Gravity Sand filter (AVGF) / Pressure Filters (PSF)

Following accessories (wherever applicable) shall be provided along with pressure filters:

(a) Air blowers common
(b) Frontal piping
(c) Pipe headers
(d) Pneumatic operated Valves
(e) Requisite no. of companion flanges, Gaskets, Bolts, nuts & washers
(f) Foundation bolts
(g) Electrics
(h) Instrumentation
(i) Pipe supports, etc
(j) Initial fills of filter media

Entire piping (headers & branches) is included in the scope of work.

a) For the backwash water from the backwash water over head tanks or back wash pumps
b) For the air pipelines from Blowers to Filters
c) Waste water from the filters to the Waste Water Sump
d) Nitrogen/Instrument Air pipeline to all pneumatic operated valves.
e) Filtered water line from the filters to the Filtered water sump.

All termination points shall be flanged end connection and matching flanges are to be provided. The backwash water to be suitably treated in treatment plant.

17.2. DESIGN CRITERIA:

As mentioned in the relevant clauses no. 7. & 14. for pressure filter and valve less gravity filter respectively.

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18. Design Criteria for Sludge Scrapper Assembly

18.1. The sludge scrapper assembly shall be complete in all respects and shall broadly consist of the following components.

I) Truck assembly
II) Bridge assembly with bridge drive and hoist drive assembly.
III) Oil skimmer and sludge scraper Blade Assembly
IV) Festoon support assembly
V) Control panel.
VI) Cabling

The scrapper machine frame shall be fabricated from rolled steel sections, mounted on steel wheels suitable for rolling on standard rail. Travel mechanism consists of centrally located drive comprising of motor, gear box, brake, float shafts with flexible geared couplings and the wheels. The wetted part shall be painted suitably to restrict the erosion of the frame.

Scrapping blade shall be made up of mild steel plate and shall be suitably fitted to the Scrapper arms. The Scrapper Arms shall be raised or lowered by centrally driven twin drum hoisting mechanism, suitably located on the machine frame and consisting of motor, worm gear boxes, float shafts with flexible geared couplings, brake, rope drums, wire rope and rope pulleys.

Equipment will scrap the sludge/scale from the bottom of tank towards the scale collecting pit /Hopper in its forward motion. On reverse travel Scrapper blade goes up and Skimmer blade comes down to push the floating oil towards the Tube type oil skimmer.

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19. Design Criteria for Chemical Dosing System for Recirculation System

Various types of chemicals need to be dosed in the water recirculation system in order to maintain the quality of water suitable for the application. The various dosing system are listed below:

1. Scale /corrosion inhibitors
2. Anti foulants
3. Biocides
4. Flushing chemicals
5. Passivation chemicals
6. Other chemical dosing system as required for treatments.

Note: Biocide dosing system shall be provided for recirculation system as per the following criteria:

1. One oxidising and one non-oxidising biocide to be used or
2. Two type of non-oxidising biocides shall be used.

Tenderer shall indicate the trade name, composition, appearance, odor, pH optimal, pH after dosage, solubility gravity dosage, feeding dosage, solubility, specific gravity dosage, feeding procedure at feeding points of all chemical.

19.1. Chemicals

All chemicals shall be supplied in liquid form.

A) Scale / Corrosion Inhibitors.

The scale / corrosion inhibitors shall be preferably of Phosphate – Organo phosphonate type.

- Suitable Iron dispersant / anti foulants etc. may be blended in the chemical if required for any particular system.
- The chemicals shall be continuously pumped into the circulating water by metering pumps at the required dosage rate.
- These chemicals shall be supplied in Carboys.

B) Deposit control agents

Deposit control agent shall be used as per system requirement.

C) Corrosion inhibitors

Suitable corrosion inhibitors shall be used for the control of corrosion in open re-circulating cooling water systems. The corrosion inhibitor shall be fed to the re- circulating

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water, wherever found necessary, by means of a metering pump. Corrosion resistant feeding equipment shall be used.

D) Anti-foulants

Suitable anti-foulants shall be applied for the prevention and removal of iron oxide and other metallic oxides in the water re-circulating systems wherever found necessary. The anti-foulants shall have good dispersing properties.

E) Biocides

Suitable biocides (Alternate to Electro-chlorination or ClO2 dosing) shall be provided for the control of bacterial, fungal and algal growth in the re-circulating cooling water systems. The biocides shall have good solubility and dispersing properties to ensure good distribution throughout the system and efficient penetration of the slime masses, to the encountered. Dosing rate and dosing points shall be judiciously selected based on the water analysis and the test to be carried out taking the following factors into consideration:

i. The nature and extent of the anticipated microbiological contamination for the different re-circulating water systems.
ii. The type and volume of systems to be treated.
iii. Quality of the makeup water
iv. The degree of recommended control of microbiological contamination.
v. Retention time in the system.

- The biocides shall be selected considering slug dosage after every 15 days
- The selected biocides shall be effective against all types of micro-organisms including Iron bacteria, Sulphate reducing bacteria, algae and fungi etc.
- These chemicals shall be supplied preferably in carbuoys having sizes suitable for convenient handling.

19.2. Monitoring Chemicals

- All the monitoring chemicals required for monitoring of system variables which control the dosage of chemicals shall be provided.
- The system variables will be measured three times a day i.e. once every shift.
- The list of chemicals along with quantity of monitoring chemicals proposed for the system shall be furnished.
- These chemicals shall be supplied in Kits. Each kit shall have all required chemicals

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and measuring jars and instruments etc. for monitoring the variables. One such kit shall be supplied for each of the pump house.

The dosing chemicals shall preferably have minimum shelf life of one year. The chemicals shall not degrade while storage in an ambient temperature of 50^0 C.

The chemicals shall not inflame when exposed to sunlight / naked flame.

The chemical shall not produce excessive fumes and odour which are harmful to human beings.

The material of carboys and drums shall be chemically non- reactive to the chemical stored in it shall be supplied.

19.3. Dosing System for Scale / Corrosion Inhibitors

A structural platform shall be provided by the Contractor in the pump house for stationing the dosing pumps. This platform shall be constructed at a suitable height so that either 200 lit. Drums or small carbuoys can be stationed below the platform and the dosing pumps shall draw the liquid from the drums / carbuoys and pump it through the pipelines upto the dosing point.

19.4. Dosing Pumps

All chemicals for scale and corrosion inhibition are required to be dosed continuously at a constant rate and shall be dosed by metering pumps.

2 Nos. metering pumps (1 working & 1 standby) shall be provided for each chemical.

The metering pumps shall be electronically controlled electro-magnetically driven with stroke and frequency setting arrangement and shall be complete with lub rings, check valves in suction and delivery, suction tube, foot valve and ant siphon / backpressure valve etc.

Pump flow rate shall be adjustable from zero to 100 percent of the specified rated capacity even while the pump is in operation. The stroke adjuster shall have requisite graduations to indicate the set flow rate and shall be fitted with a locking arrangement so that the preset capacity does not change during pump operation. It shall also have suitable internal stops to prevent its detachment at settings below zero percent and above 100 percent.

Pumps shall be driven by electromagnetic power unit consisting of an epoxy moulded coil. The capacity of pump each chemical shall be decided depending on recommended dosage.

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The MOC of chemical dosing pumps should be non-corrosive and polypropylene based. MOC of chemical dosing tanks shall be HDPE preferably.

19.5. Electro-Chlorination Plant

19.5.1. System Overview

Constant chlorination is safe and efficient fouling control. To prevent Bio fouling in the condenser, PHE, cooling tower and other system components, an onsite generation of sodium Hypochlorite using electric chlorinating system for circulating water system shall be provided.

Large doses of chlorine will kill most marine lives and plant growth, except some that can close their shells, such as muscles and anemones. These survive for very long periods, which are eliminated by intermittent application of large chlorine doses for short duration of time.

19.5.2. Technical Specification

In the Circulation Water chlorinating system, chlorine shall be dosed at the CW system / sump / cooling tower to prevent microbiological growth. The design dosage rate shall be 5 ppm for shock dosing. The dosage rate and duration must be line tuned to ensure a minimum required presence of 0.5 ppm in the entire system and at the consumer end.

The system will be designed such that the operation of the plant can be controlled and monitored from the control room located in the chlorination plant building / control room of the water complex. Starting and stopping of the plant shall be automatic and chlorine flow rate selection will be manual.

The unit should generate active chlorine in the form of neutral sodium hypochlorite, having strength of 5 g/l (5000 ppm), on a continuous basis round the clock. The Hypochlorite generation system shall consist of 2 streams, consisting of the following;

1. 2 set of electrolysers (1w + 1s)
2. 1 transformer rectifier
3. 1 dedicated Electrolyte preparation (dilute brine preparation) system
4. Hypochlorite collection & storage system
5. Hydrogen dilution system
6. Hypochlorite dosing & distribution system to the system.

Residual chlorine test kit:

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A DPD colorimetric type portable test kit shall be provided, to check the free chlorine residual in the chlorinated CW water.

Guarantee

The electrolysers (Cell) coating shall be guaranteed for a life of 10 years from the date of commissioning.

The following Protection interlocks for the electrolysers shall be **provided**:

1. Electrolyser outlet temperature high.
2. Electrolyte flow low.
3. Saturated Brine level low in brine tank.
4. Blower failure.
5. Electrolyser over voltage.
6. Transformer – Rectifier temperature high.

Effluent disposal system.

No water/chemical is to be discharged in the storm water drain.

19.6. Chlorine Dioxide

Chlorine dioxide may be used in cooling water systems for control of Microorganisms at low dosages and is used over a broad pH range having an effective kill rate over the entire spectrum of microorganisms.

Chlorine dioxide is effective at high pH, unaffected by ammonia, and demonstrates significant advantages over chlorine in systems susceptible to high levels of organic contaminants. Chlorine dioxide is a selective oxidizer, it is able to control microorganisms in cooling water at very low dosages.

Chlorine dioxide may also be used for treatment of drinking water.

Chlorine dioxide generation

Chlorine dioxide shall be generated by following three methods viz. by Chlorine Gas method, by Sodium Hypochlorite method and by two chemical methods.

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A. Chlorine Gas method

Chlorine dioxide is generated at site through a chlorine dioxide generator. In the generator unit, chlorine dioxide is generated by a chemical reaction that occurs when a controlled volume of precursor chemical is combined with a water stream containing Chlorine.

Following is the reaction for generation of ClO_2 by Chlorine gas method:

$2NaClO_2 + Cl_2 \rightarrow 2ClO_2 + 2NaCl$

Chlorine Dioxide Generator:
A Chlorinated water line will be fed to the Chlorine dioxide generator. Chlorine dioxide precursor will be dosed into the base of the generator column. Mixing and reaction takes place as the flow passes up through the column. Each chemical and the water should enter the generator column at a specific rate.

Outlet water from Chlorine Dioxide Generator will comprise of Water with Chlorine Dioxide. The dosing point will be the Cooling Tower sump on the circulating pump suction side.

B. Sodium Hypochlorite method

Chlorine dioxide is generated at site through a chlorine dioxide generator. In the generator unit, chlorine dioxide is generated by a chemical reaction that occurs when a controlled volume of precursor chemical is combined with a water stream containing sodium hypochlorite (minimum 12% active) and a Hydrochloric Acid (minimum 32 % active).

Following is the reaction for generation of ClO_2 by Chlorine gas method:

$2NaClO_2 + NaOCl + 2HCl \rightarrow 2ClO_2 + 3NaCl + H_2O$

A Chlorinated water line will be fed to the Chlorine dioxide generator. Sodium Hypochlorite and Hydrochloric acid will be dosed into the water line inside generator and Chlorine dioxide precursor will be dosed into the base of the generator column. Mixing and reaction takes place as the flow passes up through the column. Each chemical and water should enter the generator column at a specific rate.

Outlet water from Chlorine Dioxide Generator will comprise of Water with Chlorine dioxide. The dosing point will be the Cooling Tower sump on the circulating pump suction side.

There are several basic components that make up the generator unit. Each component is supplied as a complete system.

C. Two Chemical Method

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Chlorine dioxide is generated at site through a chlorine dioxide generator. In the generator unit, chlorine dioxide is generated by a chemical reaction that occurs when a controlled volume of precursor chemical is combined with a water stream containing sodium chlorite (solution 25 % w/w) and a Hydrochloric Acid (33 %).

Following is the reaction for generation of ClO_2 by Chlorine gas method:

$5NaClO_2 + 4HCl \rightarrow 4ClO_2 + 5NaCl + 2H_2O$

Chemical Metering Pump:
Positive-displacement metering pumps of appropriate size shall be mounted along with the generator unit. The output capacity of each pump shall be readily adjusted while the pump is running, to meter the desired chemical feed rate.

Flow Rate Indicator / Flow Switch:
A combination flow rate indicator and flow switch shall be installed with the sensor in the water line and the meter and electronics housed in the electrical control box.

Built-in Safety Features
The generator unit shall have built-in safety features. If the water flow through, the generator should inadvertently be shut off, all chemical feed will stop immediately.

Treatment Recommendation
Dosage: The optimum dosage for an oxidative application will be determined using a chlorine dioxide demand run preferably during field trial. However, recommend dosage of Chlorine dioxide at 1 ppm for 2 hours daily, which can be optimized after the practical run at site.

Point of Feed: Chlorine dioxide will be dosed in the cooling tower sump at the suction side of the circulating pumps.

Service program: Bidder to provide for complete application and monitoring of the system.

19.7. Piping

A piping network between the dosing stations and the dosing points shall be provided by the tenderer.

HDPE/CPVC piping shall be used for pumping of the chemicals based on the suitability.

19.8. Monitoring Appratus

All monitoring apparatus like corrosion coupons, slides for bio testing etc. required for

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proper monitoring of each system shall be supplied and installed.

19.9. Reports

Three types of reports shall be furnished.

Test Reports

The test reports shall be furnished at an interval of every 1 month. The report's contents shall cover but not limited to the following items:

a) Predicted performance curves for the system with respect to corrosion rates and scale deposits
b) Actual performance curves
c) The details of variation in the various critical parameters being monitored in each shift for the previous period.
d) The dosage rate maintained during the period and its variation.

Monitoring reports

The monitoring reports shall be submitted every 2 months interval. The monitoring report shall include but not limited to the following:

a) Water loss figures, make-up water quantity for each system.
b) Health report of cooling tower
c) Actual cycle of concentration for various systems
d) Suggestions for improvement in cycle of concentration without affecting the guaranteed performance.
e) Suggestions for reuse of blow down of each system.

Chemical consumption reports

The report shall be furnished to Purchaser on a monthly basis. The report shall include the following:

a) Inventory position of each chemical
b) Ordered quantity
c) Chemical consumption figures for the previous month.

19.10. Control Panel

The control panel will be common for all the Chemical Dosing pumps of one dosing system and shall be suitable for mounting inside the Pump House Bay. The control panel shall be made of 2.5 mm thick CRCA sheet steel with IP-55 enclosure and shall be of floor /

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wall mounted type. The Chemical Dosing Pumps shall work in LOCAL made as per the control philosophy offered by the Tenderer.

The control panel shall consist of the following:

- Incoming MCCB of suitable rating.
- Outgoing feeders for all the Chemical Dosing Pumps consisting of fuses, contractors of minimum 32 Amp rating, thermal overload relays with built in single phasing preventer.
- All the control and protection components like HRC fuses, MCBs, relays, auxiliary contractors, selector switches, step-down control transformer, timers, push buttons, Power and control terminal blocks etc.
- LED indication lamps for incoming power supply ON, individuals Chemical Dosing Pumps ON / OFF / TRIP, etc.

19.11. Flushing of Circulating Water Pipelines

The tenderer shall ensure that the pre-cleaning chemical at the designed rate is being dosed in the flushing water during flushing of the circulating water pipelines.

19.12. Passivation of Circulating Water Pipelines

The tenderer shall ensure that the Chemical quantity in the water during initial filling of circulating water pipelines is as per the designed quantity to ensure proper passivation of the piping network.

19.13. Normal Operation

During normal operation the tenderer shall ensure proper dosage of chemicals inside the circulating water.

19.14. Performance Guarantee

The Complete system shall be designed to achieve the following.

Uniform corrosion rate of 5 mpy maximum for steel components and 0.5 mpy for non ferrous components.

Pitting Corrosion rate of 12 mpy maximum.

Uniform scale deposition rate of less than 3 mpy.

Total Bacterial Count less than 100,000 per ml.

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Sulphate reducing bacteria less than 100 colonies / ml.

Iron Bacteria less than 100 colonies / ml.

In case, the treatment programme provided by the tenderer fails or requires additional chemicals to achieve the guaranteed performance, the tenderer shall supply the necessary additional chemicals and shall undertake suitable measures for the successful execution of the modified programme without any additional cost implication to the Purchaser.

Spare for Dosing pumps

Sl.No	Description	UNIT	QTY	Remarks
1	Suction NRV	No	1	One number for each type of pump
2	Discharge NRV	No	1	One number for each type of pump
3	Pump Circuit Board (PCB)	No	1	One number for each type of pump
4	Diaphragm	No	1	One number for each type of pump

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20. Design Criteria for Surge Tank / Expansion Tank

20.1. Equipment Specification

Vessel shall be designed to meet the operation and performance requirements as furnished in respective Process Data Sheets.

20.2. Codes and Standards

The following codes shall be referred during the fabrication of pressure vessels and tanks.

Boiler and pressure	:	IS: 2825 / ASME SECTION VIII DIV.1
Vessel Code Welding	:	ASME SECTION IX Pipe Flanges
	:	ANSI B 16.5
NACE Standard	:	MR 01-75 (Latest Edition)

And any other Codes / Standards / Specifications mentioned / furnished in the subsequent clauses of this technical specification.

MATERIAL OF CONSTRUCTION

SHELL	SA 516 GR.70
DISH END	SA 516 GR.70
PAD PLATE	SA 516 GR.70
LEG SUPPORT	IS 2062 GR.A/B
FLANGES	SA 105
PIPES/NECK	SA 106 GR. B
FORGINGS	SA 105
MANHOLE FLANGES	SA 105/SA516 GR.70
MANHOLE NECK	SA 516 GR.70
FASTENERS	SA 193 Gr.B7/SA 194 Gr.2H
GASKET	SS SPIRAL WOND GRAPHITE FILLED WITH CS CENTERING KING & WINDING MATERIAL SS 304.

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20.3. Design

- The design / engineering work related to preparation of fabrication drawings, weld joint and weld details, etc. shall be in Contractor's scope of work.
- The capacity and design calculations for thickness of all major components like shell, head, nozzles etc. for approval prior to manufacture/fabrication shall be provided. In case of any alteration in material or thickness, approval shall be obtained from Purchaser's. For CS vessels, the shell or head thickness exclusive of C.A. shall be taken, even if pressure/ load requirements may suggest lower thickness. Non pressure carbon steel parts (e.g. Skirt, lugs, Cleats, etc.) shall have a provision of 3 mm corrosion allowance.
- Minimum thickness of the shell will be 12 mm and that of disc ends will be 14 mm. Full radiography will be carried.
- Plates shall be bent along the direction of plate rolling for forming the cylindrical components of vessel. Plates shall have only positive tolerances on thickness.
- Carbon content of C.S plate shall not exceed 0.25%. One product analysis per heat shall be supplied.
- All vertical & horizontal vessels shall be provided with lifting lugs.
- Reinforcing pads for internal or external structural attachments to vessels shells shall be provided with a ¼". NPT vent hole. External vent holes shall be plugged with a plastic sealant after the vessel has been tested.
- All pressure vessels weld joints of category A and B shall be welded with full penetration and full fusion. Welds shall be as per ASME Code Section VIII Division 1, Table UW-12, NO.1.

Vessel Supports

- The type of supports for vertical vessels shall be as indicated in the specification.

- Access opening in skirt, vent holes and piping opening shall be provided in supporting skirt as per enclosed standard specification.

- Skirt and adjoining vessel shell outside diameter shall be the same.

Nozzles and Man-ways

- When the inside diameters of nozzles are specified, these shall be maintained. When the inside diameters of manways are specified, it shall be considered as a minimum.

- Nozzles, openings and their reinforcements shall be attached to the vessels with complete penetration welds.

- Nozzles upto and including 50mm NB in size shall be stiffened by 2 nos. 40 x 6mm thick flats welded at 900 apart.

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- Nozzle flanges shall be as per ANSI B 16.5 type and rating as specified. Substitution of weld neck type flanges with Slip-on type will not be permitted.

- All manhole covers shall be hinged or provided with a davit along with suitable lifting handle. Bolts, Nuts, Gaskets including spares shall be in Contractor's scope.

- External reinforcing pads shall have a minimum of one vent hole except those pads for nozzles greater than 400 mm NB shall have a minimum of 2 vents and nozzles in excesses of 900mm NB shall have 4 vents. Pads installed by sections shall have at least one vent per section. All vents shall be tapped for future plugging and plug shall have ¼" NPT connection (max).

- Class 300 flanges shall be used as a minimum, unless mentioned otherwise for pressure relief valve connection.

- For heavy wall thickness vessels, integrally reinforced necks are preferred, although long welding neck flanges and built-up construction are permissible.

- Where 125 Ra is specified for flange surface finish, the range for acceptance shall be 63 Ra minimum to 250 Ra maximum. Finishes shall be judged by visual comparison with surface finish roughness standards conforming to ANSI B46.1. Where flange surface finish is not specified, it is the responsibility of the contractor for the gasket specified. Fabricator shall ensure suitable protection of flange faces, threaded connection, and machined surfaces, during transit.

- Lap joint flanges are not permitted in severe cyclic service. An example for sever cyclic service is defined in paragraph 300.2 of ANSI / ASME B 31.3 piping code.

- All flanges intended for use with spiral wound metal gaskets shall be designed using the manufacturer's minimum gasket seating stress or the ASME Code value, whichever is greater.

- special consideration for the prevention of over stressing the flange or bolts during gasket seating, when class 300 and lower flanges are used with spiral wound metal gaskets shall be given.

- Nozzle and manways shall not be located in tray down comers.

- All opening shall be cut off flush with the inside on the shell and the inside edge shall be rounded.

- Threaded fittings of tapped holes are not permitted.

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- Internals like distributor piping, deflector, vortex breaker, tray support rings, demisters etc. are in Contractor's scope, including bolting and spares. Details of demister such as make, make type etc. shall be subject to MECON / Purchaser's approval during detailed engineering.

- Externals like manhole davit, pipe davit, insulation supports, Pipe supports, stiffening rings, fire proofing supports, name plate, etc. are in Contractor's scope, unless mentioned otherwise.

- Sizes of nozzles for safety valve shall be indicated during approval of G.A drawings by MECON / Purchaser. Contractor's scope shall include supply of nozzles with flanges, etc.

- Nozzle orientation shall be subject to MECON / Purchaser's approval during detail engineering.

20.4. Materials

- All materials used in the vessels shall be new and of the type and grade specified in the specifications / drawings. All plates shall be supplied in normalized condition.

- Materials of construction of vent stack and seat drum shall be selected as per the requirement of NACE, MR-01-75.

- Each plate or forging shall be legibly stamped or stenciled showing grade number and plate or forging number. When metal stamping is done it shall preferably be on the long edge of each component as it leaves the mill. Metal stamping on rolled surfaces shall be done with a "low stress" stamp.

- Internal support rings shall be of the same material as the shell in killed steel vessels unless otherwise mentioned, except in lined portions of vessels where they shall be alloy corresponding to the lining. They shall be continuously welded on the top and stitch welded on the bottom when carbon steel and continuously both sides when alloy.

- Plates from 16 to 50mm shall be ultrasonically tested as per SA 435 and above 50mm as per SA 578 for an Acceptance Level-1.

- All bought out items by fabricator shall meet the relevant inspection requirements and test certificates.

20.5. Fabrication

- Vessels heads may be deep torispherical or 2:1 semi-ellipsoidal. Plate thickness

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selected for vessel heads shall include due allowance for thinning during the forming operations.

- Dished ends in vessels upto 2.0m shall be made in one piece. When a formed head is made from more than one plate, it shall have a crown plate having diameter greater than that of the reinforcing pad of any nozzle located at the centre of the head. The central part of cordial seam blank shall be at least 50mm or 3 times plate thickness away from the beginning of knuckle curvature. The inside and outside surfaces shall be MP/DP examined for detection of cracks.

- Fabricator shall check for possible fouling / clash or attachments with each other and with weld seams. Such fouling shall be resolved in consultation with the Purchaser.

- Skirt and other attachment welds shall have complete fusion for the full length of the weld, and shall be free from undercut, overlap, or abrupt ridges or valleys. All internal attachment welds shall be continuous, unless otherwise mentioned.

- Edges shall be prepared after cutting, machining or grinding to eliminate defective material or discoloration. All welding edges of above 25mm thickness and the welding edges of dish ends of all thickness shall be checked by MP/DP examination for detection or cracks, bruntations or segregations.

- Drawings and instruction for fabrication and installation or tray and mesh blanket supports attached to the vessel shall be furnished by the appropriate supplier of the vessels internals. The vessel attachments shall be installed in accordance with the instructions, and specifications, by the vessel manufacturer. It is the responsibility of the vessel manufacturer to supply, or cause to be supplied, all materials required for the fabrication of the vessel attachments for the support of internals.

- Insulation supporting lugs / rings / pins / studs at a pitch of 300 mm over vessel surfaces shall be provided wherever applicable.

20.6. Welding

a) All welding shall be done by a metal arc process. Only approved WPS, and qualified welders shall be engaged.

b) Covered welding electrodes for non-alloy welding shall be in accordance with specifications AWS A5. 1, ASME SFA-5.1.

c) Bare electrodes shall be in accordance with the following: -

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WELDING PROCESS	ELECTRODE
Submerged Arc Welding	AWS A 5.17, ASME SFA-5.17
Inert Gas Welding	AWS A 5.18, ASME SFA-5.18
Flux-cored Arc Welding	AWS A 5.20, ASME SFA-5.20

- Deposited weld metal mechanical properties shall conform to the ASTM requirements for the base metal.

- Backing up strips, if used, shall be removed.

- Circumferential welds shall be so located that visual inspection can be made with all internal equipment in place.

- Seams in supporting skirts shall be made with full penetration butt welds. Connections between skirts and vessel heads shall be made with a smooth flat faced weld, unless otherwise shown. The width of the weld shall be at least equal to the skirt thickness, and its height shall be twice its width.

- All welding directly to the vessel shall be completed prior to final treatment.

- All welded joints for vent stack & seal drum shall be 100% radiographed. As a minimum requirement all other pressure vessels shall be spot radiographed (minimum 10%). Each spot radiograph shall be a minimum of six inches (152 mm) in length and in accordance with the ASME code. All welds to be covered by nozzle reinforcing pads and at least one weld intersection shall be radiographed. Non-radiographable welds shall be examined by magnetic particle or dye penetrant as a acceptable alternative.

- For vessel shell thickness 2 inch (50 mm) and greater, 100% ultrasonic examination is required in accordance with the ASME code, after final post weld heat treatment.

20.7. Heat Treatment

- Vent stack & seal drum shall be stress relieved after welding to meet the required hardness etc. as per the NACE stipulations.

- For carbon steel formed components, including dished ends, stress relieving shall be performed as per ASME Section VIII Div. 1, (UCS – 79).

- In addition, cold formed carbon steel heads and knuckles shall be stress relieved when their thickness is 16 mm or greater. Hot formed heads shall also be normalised in case they are formed at temperatures below the normalizing range. Hot formed dished ends or similar parts, which have not been uniformly heated in the normalizing range in the

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final stages of manufacture shall be normalized.

- Vessels in caustic service, amine or sour gas service shall be stress relieved.

- Flange facings must be protected against oxidation during heat treatment.

20.8. Painting

Vessels shall be cleaned by sand blasting prior to painting to Sa 2 ½ grade.

All uninsulated carbon steel surfaces shall be given two coats of epoxy zinc chromate primer (P-5) with min. DFT of 35 microns per coat followed by two coats of acrylic polyurethane finish coat (F-2) with min. DFT of 30 microns per coat.

- For insulated carbon steel surfaces, (i.e. Test storage tank) two shop coats of red oxide zinc chromate primer (P-1) with min. DFT of 35 microns per coat shall be given.

- Earthing lugs shall only be cleaned by wire brush and not to be painted.

- Sand blasting is not required for internal surfaces of vessels. Only wire brush cleaning is required for the same. However, wherever internal surface painting has been specified, i.e. in Test storage tank, sand blasting will be required.

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21. Reuse/Recycle of CT BD & Waste Water

To minimize make up water consumption and to achieve zero discharge, the process waste water, Neutralised effluent from DM/Soft water plant and ETP, cooling tower blowdown water and other liquid waste generated in the plant shall be recycled and reused in the system after necessary treatment as required.

The reject from the RO plant shall be taken to the crystallizer based Zero Liquid discharge Plant.

21.1. CT BD Treatment

The CT Blowdown treatment plant shall have following stages of treatment scheme for satisfying the norms of treated water quality.

PRIMARY TREATMENT (Equalization tank, Flash Mixer, Solid Contact Clarifier Reactor)
TERTIAIRY TREATMENT (Multi Grade Filter)
ADVANCED MEMBRNAE TECHNOLOGY (Cross Flow Filtration, Reverse Osmosis).

21.1.1. Primary Treatment

Equalization Tank

Effluent generated from the various sources shall be collected into Equalization tank having retention time about 2 hours or as per system requirement where suitable chemicals shall be dosed to equalize the effluent. One tank in MSRL construction with agitator and two dosing pumps shall be provided for dosing the chemicals. Waste water from the tank shall be pumped by means of pumps to the pre-treatment units i.e. HRSCC/Flash mixer to remove the suspended matter.

Flash Mixer

RCC Flash mixer shall be designed to provide adequate mixing time with the coagulant with retention time of 120 sec with following facilities indicated below.

i. Inlet/ outlet connecting arrangement of flash mixers.

ii. One no. agitator shall be provided for each flash mixer chamber. The agitator shall be vertical mounted type. A common base plate / frame shall be provided for the complete agitator unit.

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iii. The material of construction for the wetted parts including Agitator shaft, impeller etc. shall be Stainless Steel while for non wetted parts it shall be MS (Epoxy). The agitator shall be mounted on the foundation integral with the top slab of the flash mixer.

iv. Flash mixer shall be provided with platforms, hand railings etc and openings for entry in to the chamber with rungs. Drain pipe & valve of suitable size upto the common drain pit shall be provided.

v. Outlet pipes leading to HRSCC shall be provided.

vi. The flash mixer shall be internally painted with an anti corrosive epoxy paint.

High Rate Solid Contact Clarifier (HRSCC)

HRSCC shall be capable of operating successfully with the rise rate of 2.5 to 4.0 m3/m2/hr and adequate surface area for surface loading. The clarifier shall have inbuilt mechanism for flash mixing, flocculation and clarification within the unit. (Flash Mixing can be provided as a separate unit prior to HRSCC instead of inbuilt flash mixing mechanism). The clarifier should have inbuilt provision for sludge recirculation. The central drive assembly should be mounted on a fix bridge. The equipment shall be complete with all required components including accessories and conforms to the following specifications:

- Side walls of the clarifier are of RCC.
- Components like scrappers, platforms, handrails, ladders shall be MSEP.
- Rotating parts like gear boxes, drive shafts, electrical motors shall be as per Indian Standards
- Walkways with handrails shall be provided along the periphery of the HRSCC and on the moving bridge assembly.
- Suitable platforms, handrails, approach staircases/ ladders etc. shall be provided for the clarifier
- Necessary telescopic sludge disposal system shall be provided.

The sludge generated from HRSCC will be collected in sludge sump and will be pumped to sludge dewatering system.

Overflow from the clarifier shall be collected into the Clarified water tank.

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In case, oil & grease levels are high and cannot be minimized in HRSCC, DAF may be provided as alternate to HRSCC. For details refer, relevant General Specification chapter for environmental system.

21.1.2. Tertiary Treatment Multi Grade Filter (MGF - ACF)

For details of pressure filter and ACF, please refer relevant clauses of Chapter 07.

Dewatering System

For details of dewatering system, please refer relevant clauses of Chapter 15.

21.1.3. Advanced Membrane Technology

Ultra-Filtration System

Membrane filtration (Ultra-filtration) module has been used widely for the removal of colloidal matters like silica, suspended solids & pre-treatment to reverse osmosis system. It also helps in removing COD, BOD large extent due to separation of solids.

The pre-treated filtered water will be passed through basket type strainer & then through the ultra-filtration skid. Suitable stand-by skids shall be provided as per system requirement. The ultra-filtration system shall be automatically operated. Ultra-fitration membranes shall be made up of PES/PVDF material and shall be designed with low flux not exceeding 35 GFD (60 lmh).

UF system shall be complete with all auxiliary including CEB and CIP system. The back wash of the UF system shall be through separate group of pumps. The UF treated water shall be used for backwashing purpose. The back wash waste water shall be collected in the back wash collection tank (same as MGF back wash waste water collection) and further transferred to Equalization tank/HRSCC.

- The process scheme should incorporate hollow fibre Ultra-filtration followed by Reverse Osmosis.
- The Ultra-filtration membrane should be operated on dead end mode/cross flow mode.
- The ultra-filtration membrane should be from reputed manufacturer as per preferred makes.

This system will have the facility of automatic valves provided on the backwash & reject line to facilitate on-line backwashing. This function shall be controlled and monitored by PLC operation.

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Reverse Osmosis System

The treatment system shall comprise RO of latest technology. Suitable stand-by skids shall be provided as per system requirement. The RO system shall be sized to produce the rated output and quality for the entire life of the membrane. As such, initial operating pressure at any temperature shall be maintained at a minimum value to keep the membrane compaction rate within the design value. High pressure pumps shall be selected to permit inlet pressure adjustments to be made to compensate for membrane compaction and temperature variations.

Pre-treated water after adjustment of pH and chemical conditioning shall be pumped by high pressure pumps (one working and one standby pump) into reverse osmosis train. The permeate from pressure tubes of R.O. blocks shall be combined and shall flow to the degasify column.

Measurement and transmission of conductivity, Silt density index (permanently installed and to be directly connected to PLC for data monitoring.) However, measurement will not be continuous type. As per process requirement, measurement shall be taken (manual feeding of silt density reading in plant PLC is not acceptable), pH, ORP, turbidity and temperature shall be provided after Cartridge filter to automatically and consistently monitor the parameters of RO feed water. Suitable arrangements shall be provided to drain the feed water in case any of the parameters do not meet the feed condition to RO.

Provision shall be made for flushing of the system automatically after each shutdown so as to prevent the precipitation of sparingly soluble materials on the membrane surface during periods of shutdown.

Carbon dioxide is removed in the degasify column by means of two air blowers (one working and one standby). pH of the degasified permeate will then be suitably corrected.

Dosing of Antiscalant in the RO Feed is to be done to make sure that the Feed Water Scaling tendency on the Membranes in controlled within the limits. The system comprises of dosing pumps and solution tank.

Micron Cartridge Filter (MCF) to be provided which removes fine colloidal suspended impurities, which have escaped from upstream units. The unit can reject fine solids upto 5 μ, which if carried over can clog the RO membrane. The unit shall be fitted with special type of cartridge, which is having more dirt holding capacity compared to other standard type of cartridges. Each RO skid shall have individual MCF.

For the development of High pressure required for RO System Vertical Multistage Centrifugal Pump may be provided.

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The RO system shall comprise of R.O. membranes housed in FRP Pressure Vessels. All interconnecting low-pressure shall be Extra Strong u-PVC and high pressure shall be Stainless Steel – SS304. Necessary instrumentation to be provided to monitor the operation of the system.

Dedicated Chemical Cleaning System comprising of a Chemical preparation tank, a Centrifugal Pump in SS Construction and a cartridge filter unit shall be provided.

The Reverse osmosis system should be built for a suitable low flux not exceeding 10 GFD (17 lmh). The membranes used should be of reputed make of low fouling type.

Automation Philosophy

The Cross flow Filtration system will have automatic operation. Necessary tripping facilities shall be provided through PLC for safe operation of the system. When the system trips, there will be visual display in the panel and also annunciation to this effect.

The R.O system will be manually operated. Since cleaning to the membrane system requires intermittently, manual operation system provided for cleaning of both filtration as well as RO Systems.

Equipment Specification

The proposed reverse osmosis plant shall be housed in a RCC/Structural building. The building shall house basket filter, UF skids, cartridge filters, high-pressure pumps, RO modules, various chemical dosing facilities, degassed water pumps, chemical cleaning and flushing facilities, and control panel. The degasser tower, degasser blower and degasified permeate tank shall be planned outside the RO plant building. The building shall be provided suitable material handling and ventilation facilities. Provision for storage of all chemicals for meeting at least 15 days requirement shall be kept.

High Pressure Pumps

VFD driven RO high pressure pumps shall be provided. Two pumps (1W+1S) shall be provided for each RO train. MOC of the pumps shall be SS and shall be selected to suit the high pressure requirement.

R.O. Trains (Blocks)

The R.O. train shall be installed having capacity to meet the required through-put. RO train shall be equipped with valves, piping work, flushing and cleaning connections, instrumentation and control console. R.O. train shall be an integrated assembly of high strength fiber glass reinforced epoxy thermally cured pressure tubes housing the R.O.

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membrane elements, feed, product and concentrate piping, all mounted on a high-strength steel structure.

RO train shall receive high pressure feed water through a pressure control valve which will be preset to a specific operating pressure to maintain design permeate flow rate. Necessary protection device shall be provided against potential start-up surge pressures. High pressure alarm system shall be provided to prevent excess pressure on the feed side.

UF & RO Membrane Cleaning System

Membrane cleaning system shall be provided in the UF & RO plant by chemical recirculation when the pressure drop across the system exceeds the preset value. The cleaning system shall comprise chemical solution tank, chemical recirculation pump and cartridge filter. The chemical solution tank shall be provided with motorized stirrer to prepare chemical solution.

Following parameters to be achieved in the water quality before feeding it to RO Membranes:

a) Silt Density Index (SDI) at the inlet to RO membrane shall be less than 5.
b) Oil & Grease at the inlet to RO membrane shall be below detectable limit.
c) BOD & COD levels shall be permissible for the selected membrane.

21.2. Zero Liquid Discharge Plant

21.2.1. Process Design Basis

The reject from RO plant shall be fed to the Zero Liquid discharge Plant.

The reject streams TDS may not be more than 6000 ppm. This needs to be concentrated to almost 60,000 or more using membrane based concentration step.

The rejected with high TDS shall be fed to the evaporator system. Buffer volume of minimum three days reject quantity for storing the RO reject shall be provided in case the evaporator system is not in operation.

21.2.2. Process Description

The system being shall be based on Mechanical Vapor compression (MVR) / Thermal Vapour Recompression (TVR) principle. The system shall be fully integrated automated system incorporating vapor compression unit centrifuge. The high purity distillate produced in the system shall be used as process makeup water. The evaporation system shall be sized

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for concentrating R.O. rejects and shall have the required normal water evaporation capacity.

The reject from the waste streams shall be collected in separate wastewater tanks. The wastewater shall then be pumped at constant rate for preheating by exchanging heat with the outgoing distillate. The most cost-effective heat exchanger for this service shall be provided. The preheated reject shall flow into the flash tank. The slurry then shall be pumped into the multi effect evaporators. Number of effect shall be decided based on the feed characteristic during engineering stage. The evaporated vapor shall flow through the mist eliminator in flash Tank to the suction of the Mechanical / Thermo Vapor Compressor. The compressed vapor shall flow to the heating side of the evaporator. As it condenses, it shall transfer the latent heat of vaporization back to the liquid film on the tube side. Condensed water vapor shall be pumped out of the system as distillate after transferring heat in the forced Circulation Heat Exchanger. The concentrated slurry after evaporator shall be either taken into a thickener and underflow of the thickener shall be fed to centrifuge/crystallizer or can be directly fed to crystallizer/centrifuge for solid separation. This slurry is fed to the centrifuge/crystallizer which shall separate out the salt crystals.

The salt generated from the ZLD system shall be properly filled in polypropylene bags and stored at a dedicated space. The space shall be suitable to store minimum three day salt generation.

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22.00 Painting Scheme

This specification covers the materials, tools, facilities and quality requirements for surface preparation and painting of equipments covered under this specification.

This is only general guideline of the paining scheme to be followed. However, in case a specific painting procedure is stipulated for any equipment, then these general guidelines shall be superceded. Any special case which may arise from time to time shall be dealt with merit of each case.

The term painting referred herein covers rust preventive, fungus/insects preventive and decorative coating along with surface protection. The complete paint system for any item includes the following basic activities:

a) Proper surface preparation
b) Application of primer coats
c) Application of intermediate coats
d) Application of finished coats
e) Final paint

All the above coats shall be of quality paint products and of preferred make. The scope of work shall also include supply of paint materials as per specification described herein.

If the contractor desires to adopt alternative paint system for any specific item for an improvement or equivalent to the system specified here-in or as per recommendations of paint manufacturer, may do so subject to purchaser's approval in advance.

Painting Scheme:

Legend

SP - Surface preparation quality as per SIS standard
2P1- Two (2) coats of Primer paint type P1
1I1 - One (1) coats of Intermediate paint type I1
2F1 - Two (2) c oats of Finish paint type F1
DFT - Dry Film Thickness in microns developed
CRT- Clean and Retouch

Sl. No.	Description	Painting Scheme		Total DFT
		At Shop	At Site	
1	**Pipe / Duct work (Overground)**			

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1.1	Non – insulated (temperature up to 80^0C) - Indoor - Outdoor	 SP – St2/ St3 2P1 SP – St2 / St3 2P1 + 1I1	 CRT 2F1 CRT 2F1	 130 205
2	Static equipment like storage tanks, vessels, heat exchangers, etc. - Indoor - Outdoor	 SP – Sa 2.5 2P2/2P3 SP – Sa 2.5 2P2/2P3+1I2/1I3	 CRT 2F5/2F6 CRT 2F5/2F6	 170/240 240/320
	Rotary/moving equipment and machineries like blowers, pumps, gear boxes, etc. - Indoor - Outdoor	 SP – Sa 2.5 2P3/2P4 SP-Sa 2.5 2P3 + 1I3/1I4	 CRT 2F6/2F7 CRT 2F6/2F7	 240/140 320/340

Surface Preparation

Surface preparation required for paint application shall be such as to clean the surface thoroughly of any material which will be conducive to premature failure of the paint substrates.

The entire surface shall be cleaned of loose substance and foreign materials such as dirt, rust, scale, oil, grease, welding flux etc. in order that the prime coat is rigidly anchored to the virgin metal surface. The surface preparation shall confirm to pictorial representation of

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surface quality grade of Swedish standards Institution SIS-055900 or equivalent such as SSPC-VIS-1.67 or DIN55928 (part 4) of BS 4232 or IS 1477 (Part 1).

Surface Preparation Grade

Sl. No.	Surface Preparation	Swedish Std SIS 055900	DIN Std. Din 55928 (Part 4)
1	Blast cleaning to white metal Removal of all visible rusts, mill-scales, paint and foreign matters.	Sa 3	Sa 3
2	Blast cleaning to near white metal: 95% of any section of surface area is free from all rusts, mill-scales and visible residues.	Sa 2.5	Sa 2.5
3	Blast cleaning to commercial quality: At least 2/3 of any section of the surface area is free from all rusts, mill-scales and visible residues.	Sa 2	Sa 2
4	Brush-off blast cleaning: Removal of all loose mill-scales, rust and foreign matters etc.	Sa 1	Sa 1
5	Power tool cleaning: Very thorough scrapping and wire brushing to remove loose mill-scale, rust and foreign matters to have pronounced metallic shine.	St 3	St 3
6	Hand tool cleaning: Removal by hand brushing of loose mill-scale, loose rust and foreign matters.	St 2	St 2

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Paint Material

Primer Paint

Primer Paint product shall be applied only on dry and clean surfaces.

1. **Primer Paint – P1 (Phenolic– Alkyd Based)**

A single pack air drying phenolic modified alkyd composition with zinc phosphate as a primer paint conforming generally to IS:2074.

Air drying time - About 60 minutes (touch dry)

- Overnight (hard dry) Dry film thickness

(DFT)/Coat - 40 microns (min) Temperature resistance

- Upto 100^0C dry heat

2. Primer Paint – P2 (Chlororubber Based)

A single pack air drying high build chlorinated rubber based zinc phosphate primer.

Percent chlororubber - 20 to 22 (% Chlorine above 65% in chlororubber)

Air drying time - About 15 minutes (touch dry)
- Overnight (hard dry)

DFT/ Coat - 50 microns (min)

Temperature resistance - Up to 65^0 C dry heat

3. Primer Paint – P3 (PVC Copolymer Alkyd Based)

Polyvinyl chloride (PVC) - Alkyd zinc phosphate – redoxide based primer

Ratio : PVC copolymer + alkyd resin (1:1)

Pigments : Zinc phosphate & Fillers

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Air drying time	-	24 hours
DFT/Coat	-	80 microns
Temperature resistance	-	Upto 80^0C dry heat

4. Primer Paint – P4 (Epoxy Based)

A two pack air drying Epoxy polyamide resin based red oxide - zinc phosphate primer.

Epoxy content (% wt.)	-	15 to 18
Air drying time	-	About 30 minutes (touch dry) - overnight (hard dry)
DFT/Coat	-	30 microns (min)
Temperature resistance	-	Upto 120^0C dry heat

Intermediate Paint

These paints shall be applied over primer coats as an intermediate layer to provide weather proof seal of primer coats.

1. Intermediate Paint – I1 (Phenolic alkyd based)

A single pack high build phenolic based paint with micaceous iron oxide (M10).

Air Drying Time	-	4 to 6 hours (touch dry) - 2 days (hard dry)
DFT / Coat	-	75 microns (min)
Temperature resistance	-	Upto 100 deg C dry heat
Compatible with	-	Primer P1

2. Intermediate Paint - I2 (Chlororubber based)

A single pack air drying high build chloro based paint with MIO.

Air Drying Time	-	15 minutes (touch dry) - 24 hours (hard dry)
DFT/Coat	-	70 microns (min)
Temperature resistance	-	Upto 65 deg C dry heat

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Compatible with - Primer P2, P3 & P4

3. Intermediate Paint - I3 (PVC – Alkyd Based)

PVC Coploymer	- Resin 1:1
Pigments	- Micaceous iron oxide (MIO)
DFT/ Coat	- 80 microns (min)
Temperature resistance	- Upto 80 deg C dry heat
Compatible with	- Primer P2 & P3

4. Intermediate paint - I4

A two pack air drying high build epoxy resin based paint with MIO. Air drying

time	- 6 to 8 hours (touch dry)
	- 7 days (full cure)
DFT/coat	- 100 m icrons
Temperature resistance	- Upto 180^0C dry heat
Compatible with	- Primer P4 & P5

Finish Paint

Finish paint costs shall be applied over primer coats and intermediate coats after proper cleaning and touch up primed surface.

1Finish Paint – F1

A single pack air drying high gloss phenolic alkyd modified synthetic enamel p aint suitably pigmented.

Air drying time	- 3 to 4 hours (touch dry)
	- 24 hours (hard dry)
DFT/Coat	- 25 microns (min)
Temperature resistance	- Upto 100^0C dry heat
Compatible with	- Primer P1Intermediate I1
Colour	- Generally all shades

2. Finish Paint – F5

Asingle pack air drying plasticized chlororubber paint suitably pigmented.

Air drying time	- 30 minutes (touch dry)
	- 24 hours (hard dry)

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DFT/Coat - 35 microns (min)

Temperature resistance - Upto 65^0C dry heat

Compatible with - Primer P2 & P3, Intermediate I2 & I3

Colour - Nearly all shades except few.

3. Finish Paint – F6

A PVC– Copolymer alkyd based enamel.

Density - 1.17 U±U 0.05

Total solids (1 wt) - 55 U±U 2

DFT/Coat - 40 microns

Compatible with - P2 and P3

4. Finish Paint – F7

A two pack air drying epoxy polyamide enamel suitably pigmented.

Air drying time - 2 to 3 hours (touch dry)
- 7 days (full cure)

DFT/Coat - 40 microns (min)

Temperature resistance - Up to 130^0C dry heat

Compatible with - Primer P4 & P5,

Colour - Generally all shades.

Interm
ediate

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Colour Code

The colour codes are mentioned for all the items including pipe work. Shades of finish coat of paint applied over respective item indicated below are tentative and subject to alteration as per Purchaser's request or due to compatible paint system adopted. The service for which colour code/bands are not specified are to be mutually agreed for by the Purchaser & the Contractor.

Sl. No.	Items Painted	Colour	Colour No. of
1.	**Equipment and Machinery**		
a	General indoor equipment	Light grey	63
b	General outdoor equipment	Dark admiralty	63
c	Crane bridges, trolleys, hooks etc. and other mobile equipment	Base : Lemon yellow Stripes : Black (100 mm	35 5
d	Furnaces	Aluminium	
e	Tanks	Base : Same as for general equipment Strips : Same shade as for piping around the tnk at half the tank	
f	Fire-fighting equipment	Signal red	53

Pipe work

Colours shall be as given below. The base colour shall be applied throughout entire length except on surfaces of materials such as asbestos, aluminium, brass, bronze, galvanized steel, stainless steel and other corrosion resistant alloys and rubber / synthetic polymers. In such cases identification colour bands of at least 500mm width shall be provided near each branch, valve and at distances not exceeding 10m either as local colour coatings or coloured adhesive type of suitable material or label attached to the pipe work. Additional identification bands superimposed over the base colour shall be provided near each branch, valve and at distance not exceeding 10m. The bands shall be atleast 25mm wide except in care of double bands where the first band shall be about 100mm wide. Direction of flow shall be clearly marked on the pipelines at intervals not exceeding 10m and all branches and change of directions.

Service	Colour	Colour No. of
Sea or river water (untreated)	Base – Sea green Band - White	217 -
Cooling water	Base – Sea green Band - White	217 166
Boiler feed water	Base – Sea green	217
Condensate	Base – Sea green Band – Light brown	217 410
Drinking water	Base – Sea green First band - French blue Second band – Signal red	217 166 537
Industrial water	Base – Sea green Band – Light orange	217 557
Compressed air	Base – Sky blue	101

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Instrument air	Base – Sky blue Band – Light brown	101 410
Drainage	Base – Black	-
Fire-fighting system	Base – Signal red	537
Rain water down pipes	Base – Sea green Band – Sky blue	217 101

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23. Data Sheets

23.1. Data Sheet For Pumps

A. Horizontal Centrifugal Pump Sets (To be furnished by the Tenderer separately for each group of pumps)

Sl. No	DESCRIPTION	Data to be filled in by Tenderer
1	Type of pump	
2	Make and model of pump	
3	Pump operating characteristics	
a)	Rated capacity of each pump m3/h	
b)	Total dynamic head (TDH) at rated capacity mWC	
c)	Shut off head mWC	
d)	Speed rpm	
e)	Pump efficiency at rated conditions %	
f)	Pump shaft power at rated capacity kW	
g)	Required NPSH mWC	
h)	NPSH available	
h)	Type of gland sealing	
i)	Mode of connecting pump to motor	
j)	Direction of rotation	
k)	Impeller diameter (min, rated, max)	
l)	Type of end connection - Suction flange bore - Discharge flange bore - Drilling standard for flanges	
4 a)	Type of shaft seal	
b)	In case of external water seal (required water pressure)	
5	Bearings	
	a) Type	
	b) Make	
	c) Quantity provided	
	d) Type of lubrication required	
6	Couplings	
	a) Type	
	b) Make	

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Sl. No	DESCRIPTION	Data to be filled in by Tenderer
	c) Coupling guard provided or not	
7	Base plate with holding down bolts and nuts provided or not	
8	Companion flanges at suction and delivery of pump included or not	
9	Weight	
	a) Pump	
	b) Base plate/motor stool	
	c) Accessories	
10	Materials of Construction of pump components (Indicate the applicable IS/BS/ASTM standard and grade)	
	a) Impeller	
	b) Casing	
	c) Casing ring	
	d) Impeller ring	
	e) Shaft	
	f) Shaft sleeve	
	g) Gland	
	h) Base frame	
	i) Companion flanges	
	j) Bearing	
	k) Suction strainer	
11	Drawings enclosed	
	a) GA drawing	
	b) Catalogue	
	c) Predicted performance curves	
	d) Speed vs torque curve for pump considering open valve operation	
	e) Pump family curves	
12	Noise level at 1.0 m distance	

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B. Vertical Centrifugal Pumps

Sl. No	DESCRIPTION	Data to be filled in by Tenderer
1	Type of pump	
2	Make and model of pump	
3	Quantity	
4	Pump operating characteristics a) Capacity of each pump (Rated, Min. and Max.) m^3/h	
	b) Total dynamic head (TDH) at rated capacity and Shut off Head mWC	
	c) Speed rpm	
	d) Pump efficiency at rated conditions %	
	e) Pump shaft power at rated capacity kW	
	f) Required NPSH mWC	
	g) NPSH available	
	g) Type of gland sealing	
	h) Mode of connecting pump to motor	
	i) Direction of rotation	
	j) Impeller diameter (min, rated, max)	
	k) Type of end connection - Suction flange bore - Discharge flange bore - Drilling standard for flanges	
5	a) Type of shaft seal	
	b) In case of external water seal (required water pressure)	
6	Bearings	
	a) Type	
	b) Make	
	c) Quantity provided	
	d) Type of lubrication required	
7	Couplings	
	a) Type	
	b) Make	
	c) Coupling guard provided or not	
8	Base plate with holding down bolts and nuts provided or not	
9	Companion flanges at suction and delivery of pump included or not	
10	Weight	
	a) Pump	
	b) Base plate/motor stool	
	c) Accessories	

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Sl. No	DESCRIPTION	Data to be filled in by Tenderer
11	Materials of Construction of pump components (Indicate the applicable IS/BS/ASTM standard and grade)	
	a) Impeller	
	b) Casing	
	c) Casing ring	
	d) Impeller ring	
	e) Shaft	
	f) Shaft sleeve	
	g) Gland	
	h) Base frame	
	i) Companion flanges	
	j) Column pipe	
	k) Suction strainer	
12	Drawings enclosed	
	a) GA drawing	
	b) Catalogue	
	c) Predicted performance curves	
	d) Speed vs torque curve for pump considering open valve operation	
	e) Speed vs torque curve for motor	

C. **Vertical Turbine Pump Sets** (To be furnished by the Tenderer separately for each group of pumps)

S.No	DESCRIPTION	Data to be filled in by Tenderer
1	No. of pumps	
2	Pump make & model no	
3	Pump operating characteristics	
i.)	Rated capacity of each pump (m3/hr)	
ii.)	Total dynamic head(tdh) at rated capacity (mWC)	
iii.)	Range of operation	
iv.)	SHUT OFF HEAD, (mWC)	
v.)	Speed (nominal) rpm	
vi.)	Pump efficiency at rated conditions (%)	
vii.)	Pump shaft power at rated capacity (kW)	
viii.)	Type of gland sealing	
ix.)	Mode of connecting pump to motor	
x.)	Direction of rotation	
xi.)	Impeller diameter (min / rated / max) mm	
xii.)	Input at rated capacity and head for pump, kW	

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S.No	DESCRIPTION	Data to be filled in by Tenderer
xiii.)	Power input to motor, kW	
xiv.)	Motor input power at shut-off head, kW	
xv.)	Pump suitable for parallel operation	yes/ no
xvi.)	Motor power requirement due to overloading of pumps in the event of tripping of one pump in parallel operation, kW	
xvii.)	Designed flow for reverse flow through the pump, m^3/h	
xviii.)	Run-away speed of pump under reverse rotation, kW	
xix.)	Thrust bearing losses, kW	
xx.)	Transmission losses, kW	
xxi.)	Pump column losses at design capacity, kW	
xxii.)	Specific speed, metric units	
xxiii.)	No of stages	
xxiv.)	Minimum positive head required	
xxv.)	Diameter and thickness of discharge pipe	
xxvi.)	Total flooded length with strainer, mm	
xxvii.)	Impeller type and diameter	
xxviii.)	Impeller shaft diameter and type of joint	
xxix.)	Recommended crane hook height, mm	
xxx.)	Maximum length of single piece of column pipe, mm	
xxxi.)	Average velocity of water through column pipe, m/sec	
xxxii.)	Type of lubrication	
xxxiii.)	Type of non-reverse ratchet and its details	
xxxiv.)	Size of suction bowl, mm	
4	Type of end connection • Discharge flange bore mm : • Drilling standard for flanges	
5	Column length (mm)	
6	Type of shaft seal	
7	Bearings type : make :	
8	Quantity of bearing provided	
9	Type of lubrication required	
10	Couplings type	
11	Base frame with holding down bolts and nuts	
12	Companion flanges	
13	Drawings enclosed	
	a) GA drawing	

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S.No	DESCRIPTION	Data to be filled in by Tenderer
	b) Catalogue	
	c) Predicted performance curves	
	d) Speed vs torque curve for pump considering open valve operation	
	e) Speed vs torque curve for motor	
13	**MATERIALS OF CONSTRUCTION**	
A	Impeller	
B	Casing	
C	Casing ring	
D	Line shaft	
E	Shaft sleeve	
F	Gland	
G	Base frame	
H	Companion flanges	
I	Column pipe	
J	Suction strainer	
K	Impeller lock nut	
L	Wearing rings	
M	Impeller shaft	
O	Line shaft bearings	
P	Weight a) Pump assembly, kg b) Motor, kg c) Total weight, kg	
Q	Noise limits, db at 1.0 m distance	

23.2. Diesel Engine

ENGINE DESIGN DATA	
No. of cylinder	
Model no.	
Rotation (facing flywheel) (CW/CCW)	
Configuration(Inline/Vee)	
Bore stroke (mm)	
No of cycles (2/4)	
Turbocharged/supercharged (Yes/ No)	.
No. of valves per cycle inlet/exhaust	

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Displacement (litres)		
Intercooler / aftercooler (Yes/No)		
Av piston speed @ max speed (m/s)		
Combustion air flow @ max power(m^3/min)		
Engine speed max/ continuous(RPM)		
Compression ratio (mech/overall)		
Gross continuous engine output (kW)		
Max turbocharger speed (RPM)		
Deductions		
BMEP*(Kg/cm^2G)		
Jacket water pump(kW)		
Jacket/after cooler water pump flow (m^3/hr)		
After cooler water Pump (kW)		
Jacket water max outlet temp(ºC)		
Radiator fan (if direct)(kW)		
Exhaust temp. after cooler inlet/outlet(ºC)		
Other auxiliaries (kW)		
Exhaust manifold (Wet/Dry)		
Net cont engine output (kW)		
Max output 1 hr in 12(kW)		
Specific fuel consumption at loads (APP)(kW)		
100% : load	Lb/bhp/hr	
75% : load	Lb/bhp/hr	
50% : load	Lb/bhp/hr	
* BMLP-brake mean effective pressure SFC guaranteed at full load only with 5% prod tol.		
Governing type(Single/Multiple/All Speeds)		
Governing speed range		
Governing accuracy class		
Time establish controllability (Sec)		
Governor mfr/model		
Governor operation		
Pump power normal /max 9kW)		
Pump speed normal/max (RPM)* excluding gear losses		
HEAT REJECTION DATA		
To exhaust @ 100% load (kW)		

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To atmosphere @ 100% load (kW)	
To cooling system @ 100% load (kW)	
To oil cooler @100% load (kW)	
LIQUID FUEL SYSTEM	
Filter configuration Simplex/duplex	
Filtration absolute particle size(um)	
Filter Mfr	
Normal/Max. Difference Pr.(Kg/cm^{2}G)	
Min. inlet press (Kg/cm^{2}G)	
Fuel Day tank by Vendor(Yes/No)	
Fuel pump(Engine/Motor drive)	
Fuel Tank Volume	
Fuel tank elevation (m)	
Fuel Tank Retention	
GAS FUEL SYSTEM	
Press regulator make/model	
Press before/after regulator (bar g)	
Gas valve make/model	
Temp before/after regulator(^{0}C)	
BASIC CONSTRUCITON	
Cylinders	
Removable	
Wet or dry	
Integral jacket	
Crank shaft	
Forged welded or cast	
Heat treated	
Conn rods	
Forged	
Heat treated	
Rifle drilled	
Articulated	
Valves	
No per cylinder	
Removable seats	
Lifters (hyd) (rollers)	
Compression release	
Pistons	
No oil rings	
No compr rings	

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Cooling method	
Cam shaft	
Diameter	
Type of drive	
Fly Wheel	
Weight (Kg)	
Diameter(mm)	
Barring device (hand) (air)	
Frame (cast) (fabricated)	
Wrist pin (full float)	
MATERIALS	
Cylinder heads	
Pistons	
Crankshaft	
Frame	
Base	
Main-shell	
Crankpin	
Cylinder liner	
Connecting rings	
Cam shaft	
Valves	
Lube oil, tank	
Bearings	
WEIGHTS & DIMENSIONS	
Bare engine with flywheel	
Dry/operating weight(Kg)	
Length/width/height(mm)	
Min distance between engines(mm)	
Min height to remove pistons/rods(mm)	
Oil cooler	
Dry/operating weight (Kg)	
Length/width/height(mm)	
Max maintenance weights	
Item Weight(Kg) Item Weight(Kg) Item Weight(Kg) Item Weight(Kg)	
SITE CONDITIONS	
Altitude	

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Ambient temp ^{0}C (Min/max)	
Air humidity % (Min/max)	
Back press (air cooler/radiator) (Kg/cm2)	
Electrical supply	
Motors (Hz)	
Heaters/chargers (Hz)	
Location (In/Outdoor/Roof/Walls)	
Fuel type(High Speed Diesel/Gas/Dual)	
Winterisation required(Yes/No)	
Fuel specification	
Fuel gross calorific value(kJ/kg) Winter temp(^{0}C)	
Cooling medium	
Equipment duty	
Continuous/Intermittent /Attended/Unattended	
Area class	
Temp class	
Gas group	
AIR INTAKE SYSTEM	
Filter manufacturer	
Blow in doors(Yes/No)	
Inlet Duct Size(mm)	
Air Intake Shut off Valve(Yes/No)	
Intake shut off Valve actuated	
Filtration	
Absolute particle size (Um)	
Filter type	
Diff press indicator(Yes/No.)	
LUBRICATION SYSTEM	
Main oil pump drive(Engine / Motor)	
Pump Drives Power(KW)	
Auxiliary pre lube oil pump(Yes/No)	
Engine sump capacity(m^3)	
Pump Mfr	
Oil press to engine, normal/min (PSI/Kg/cm^2G)	
Sump heater NO	
Heater rating (kW)	

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Pump type/model	
Cooling(Water/Air Cooler/Direct Air)	
Cooler mfr	
Cooler in/outlet temp (ºC)	
Oil filter con figuration	
Full flow % flow/ Simplex/ Duplex	
Filter mfr(um)	
Filtration	
Absolute Particle Size	
Filter Element Type	
COOLING SYSTEM	
Jacket water cooler (Water/Water)	
Cooler configuration (Simplex /Duplex)	
Turbocharger aftercooler (Air/Water)	
Cooling system normal operating press(Kg/cm^{2}G)	
Circulating pump mfr	
Pump model/type	
Pump rated power (KW)	
Cooler mfr	Design code
Materials Shell	Tubes
Flow Shell	Tubes
MAWP Shell	Tubes
Test Pr. Shell	Tube
Water temp @inlet to jacket (^{0}C)	
Jacket water heater(Yes/No)	
Heater rating(kW)	
STARING SYSTEM	
Battery start (Yes/No)	
No of battery set(One/Two)	
Capacity per set(A/hours)	
Time to recharge (Hours)	
Battery charger(Alternator/and/Static)	
Recharging pump drive(Engine/Motor)	
Hydraulic start(Yes/No/Auxiliary)	
Air start (Yes/No)	
Start system(Air Motor/Direct Injection)	
Air receiver design press(Kg/cm2G)	
Air compressor mfr	

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Compressor installed power(kW)	AT MINIMUM RECOMMENDED CRANKING SPEED
Air compressor drive (Engine/Motor/Aux. Engine)	
Air receiver capacity	
Air receiver design code (M3)	
No of starts	
Receiver operating press normal/min (Kg/cm^2G)	
EXHAUST SYSTEM	
Exhaust ducting system (Seller/Purchaser)	
Ducting layout refer sheet	
BARRING SYSTEM	
Type (Manual/Power Assisted)	
Air operated (Yes/No)	
Electrically operated (Yes/No)	
TESTS	
Inspection	
Witnessed performance test	
Certified brake data	
AUTO SHUT DOWN CONTROLS	
Lube oil failure	
Lube oil temp	
Water failure	
Water temp	
Overspeed	
REMARKS * Engine with heat exchanger cooling	

23.3. Data Sheet for Cooling Tower

DESCRIPTION	**Data to be filled in by Tenderer**
GENERAL	
Name of manufacturer	
Manufacturer's plant location	
Tower model no.	
Type of tower	
Number of cells	
Capacity per cell , m^3/hr	

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DESCRIPTION	Data to be filled in by Tenderer
TOWER OVERALL DIMENSION, m	
a) Length	
b) Width	
c) Height (to fan deck)	
DIMENSION OF EACH CELL, m	
♦ Length ♦ Width ♦ Filled height ♦ Louvre height and angle from horizontal	
BASIC PARAMETERS PER CELL	
Rated water flow, m^3/hr	
Design wet bulb temp., ^0C	
Approach, ^0C	
Cooling range at rated flow , ^0C	
Evaporation loss at rated condition, $m^3/hr/cell$	
Temp. of leaving air ♦ Dry bulb ♦ Wet bulb	
Total air area, m^2/cell (full plan area)	
Total louvred area, m^2/cell	
Dry air flow per m^2 of air area, (G) $kg/h/m^2$	
Water flow area, m^2/cell	
Water flow rate per m^2 of water area, (L), $m^3/h/m^2$	
TOWER FILL	
Material	
Type of treatment	
Expected life, years	
Type of flow,	
No. of full and partial decks	
Equivalent fill decks	
Equivalent fill height, m	
Number, splash bars in direction of air flow (cross -flow)	
Size, splash bars, mm (nominal)	
Splash bar position	
Splash bar spacing ♦ Horizontal ♦ Vertical	

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DESCRIPTION	Data to be filled in by Tenderer
Fill stringer size, m	
Total fill volume, m^3/cell	
Wetted surface area, m^2/m^3	
Splash surface area, m^2/m^3	
Fill performance characteristics	
Total vertical water fall height, m	
Solidity ratio of fill, cross flow	
FILL SUPPORT AND GRIDS	
Type	
Material	
Size	
GRID SUPPORT FRAME	
Type	
Material	
Type of treatment, if any	
FAN	
Type and Make	
No. of fans / cell	
Diameter of fan, m	
No. of blades per fan	
Blade tip clearance, mm	
Hub diameter, m	
Net discharge area, m^2	
Blade width at ¾ radius, m	
Capacity, m^3/min per fan	
Speed , rpm	
Fan stack ♦ Height , m ♦ Type (std or velocity recovery) ♦ Stack exit air velocity, m/sec (based on NDA)	
Air density at fan, kg/m^3 ♦ Dry air ♦ Mixture	
Fan pressure, mmWC ♦ Louvres ♦ Filling ♦ Eliminator ♦ Velocity head ♦ Total head	

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DESCRIPTION	Data to be filled in by Tenderer
♦ Velocity recovery, if any ♦ Net head	
Fan efficiency., % ♦ Static ♦ Overall	
Brake power Kw at motor shaft	
Power at fan shaft, Kw per shaft	
Motor size, Kw	
Material of construction ♦ Blades ♦ Hub ♦ Fan shaft	
Type of connection with gearbox shaft	
REDUCING GEAR UNIT	
Make	
Type	
Model No	
Reduction ratio	
Rated input, Kw	
Service factor at design point	
Material of construction ♦ Gear ♦ Shaft ♦ Enclosure	
"No load loss" at gear box	
Gear box oil ♦ Type ♦ Trade name ♦ Approximate quantity of oil required in each box, m^3	
Details of bearing	
Efficiency	
DRIVE SHAFT	
Diameter, m	
Approximate length, m	
Material of construction	
Type of coupling	
Type of support	
DRIVE MOTORS	
Make	
Voltage	

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DESCRIPTION	Data to be filled in by Tenderer
Phase	
Frequency	
Rated, Kw	
Shaft / pull out torque	
Full load current, Amp	
Starting current, Amp	
Efficiency	
Class of insulation	
Type of enclosure	
Degree of protection	
Recommended DOL	
Starting current	
Speed, rpm	
HOT WATER DISTRIBUTION SYSTEM	
Type	
Nozzle spacing	
Elevation, inlet above curb, m	
Water pressure required at battery limit	
No. of nozzles per cell	
COLD WATER BASIN	
Basin dimension, m (L X W)	
Basin curb elevation, m	
Normal water level, m	
Maxi. Water level, m	
Basin invert level, m	
Effective capacity, m^3	

VALVE DETAILS				
Make	Cell inlet water control valve	Header isolating valve	De-sludging valve	Other
Type				
Number & size				
Material of construction ♦ Body ♦ Trim				

MATERIAL OF CONSTRUCTION	
Structural member	
Casing and louvres	
Inner and outer casing	

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DESCRIPTION	Data to be filled in by Tenderer
Fan stack	
Distribution header	
Hardware	
MATERIAL HANDLING SERVICES	
Type	
Capacity	
Material of construction	
Protection against corrosion	

23.4. Data Sheet for Plate Heat Exchanger

S. No.	Description	Unit	Data to be filled in by Tenderer	
1	General			
1.1	No. of Plate heat exchangers	Nos.		
1.2	Manufacturer			
1.3	Model No. / Type			
1.4	Whether single or double pass			
2	Design			
2.1	Design Pressure	Bar(g)		
2.2	Design Temperature	^{0} C		
2.3	Heat Load	Kcal/h		
2.4	LMTD(Corrected)	^{0} C		
3	Guaranteed performance for each heat exchanger		Primary Side(Soft Water)	Secondary side(Industrial water)
3.1	Flow rate	M^3/h		
3.2	Inlet Temperature	^{0} C		
3.3	Outlet temperature	^{0} C		
	a) In fouled conditions			
	b) In clean conditions			
3.4	Total Pressure drop across heat exchanger from inlet to outlet	Bar(g)		
	a) For design flow			
	b) For 110% of design flow rate			
4	Heat transfer and fluid flow data		Primary Side(Hot fluid)	Secondary side(Cold Fluid

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S. No.	Description	Unit	Data to be filled in by Tenderer	
4.1	Film heat transfer coefficient	Kcal / hr/M^2/ ^0C		
4.2	Fouling factor	M^2/hr ^0C / Kcal		
4.3	Overall fouling	M^2/hr ^0C / Kcal		
4.4	Overall heat transfer coefficient	Kcal / hr/M^2/ ^0C		
	a) In fouled conditions			
	b) In clean conditions			
4.5	Total Effective heat transfer area per heat exchanger	M^2		
4.6	Average velocity	m/s		
	a) Through ports			
	b)Through plate channels			
4.7	Pressure drop in ports	Bar(g)		
	a) In clean conditions			
	b) In fouled conditions			
4.8	Pressure drop in channels	Bar(g)		
	a) In clean conditions			
	b) In fouled conditions			
4.9	Maximum differential pressure between hot and cold fluids in plate channels(Operating)	Bar(g)		
5	Heat transfer Plates			
5.1	Area of each plate	m^2		
5.2	Dimension(Width x height)	mm x mm		
5.3	Thickness	mm		
5.4	Material and chemical composition			
5.5	Number of plates per heat exchanger	Nos		
5.6	Maximum number of plates that can be accommodated in the heat exchanger frame	Nos		
5.7	Type of corrugation			
5.8	Maximum plate pack length	mm		
	a) as per 5.5 above			

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S. No.	Description	Unit	Data to be filled in by Tenderer	
	b) As per 5.6 above			
5.9	Average spacing between two plates	mm		
5.10	Number of contact points for each plate	Nos		
5.11	Hold up volume of each passage	M3		
5.12	Port Size(Diameter)	mm		
6	Plate Gaskets			
6.1	Type			
6.2	Material and chemical composition			
6.3	Thickness of gasket	mm		
6.4	Hardness of gasket			
6.5	Expected life of gasket	Years		
7	Carrying bar			
7.1	Type of construction			
7.2	Number per heat exchanger	Nos		
7.3	Size			
7.4	Material			
8	Guide bar			
8.1	Type of construction			
8.2	Number per heat exchanger	Nos		
8.3	Size			
8.4	Material			
9	Frame plate			
9.1	Type of construction			
9.2	Material			
10	Pressure plate			
10.1	Type of construction			
10.2	Material			
11	Supporting columns			
11.1	Type of construction			
11.2	Material			
12	Clamping / Gasket compression arrangement			
12.1	Type of arrangement			
12.2	Bolt size and material			
12.3	Nuts size and material			
13	Inlet and outlet nozzles		Primary Side(Hot	Secondary side(Cold

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S. No.	Description	Unit	Data to be filled in by Tenderer	
			fluid)	Fluid
13.1	Size	mm		
13.2	Rating			
13.3	Facing and drilling standard			
13.4	Flange material			
13.5	Are all nozzles counter flanges, bolts, nuts and gaskets etc. included in the offer			
14	Cleaning frequency of the heat exchanger for assumed fouling factor	months		
15	Is backwash necessary			
16	Are all auxiliaries and accessories included in the offer			
17	Local temperature indicators			
17.1	Manufacturer & Type			
17.2	Number per heat exchanger	Nos		
17.3	Dial size	mm		
17.4	Range			
17.5	Accuracy			
17.6	Material of construction			
18	Local Pressure gauges			
18.1	Manufacturer & Type			
18.2	Number per heat exchanger	Nos		
18.3	Dial size	mm		
18.4	Range			
18.5	Accuracy			
18.6	Material of construction			
19	Differential pressure gauges			
19.1	Manufacturer & Type			
19.2	Number per heat exchanger	Nos		
19.3	Dial size	mm		
19.4	Range			
19.5	Accuracy			
19.6	Material of construction			
20	Relief and other valves(If applicable)			
20.1	Location			

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S. No.	Description	Unit	Data to be filled in by Tenderer
20.2	Type and size		
20.3	End details		
20.4	Materials		
	a) Body		
	b) Trim		
20.5	Pressure rating		
20.6	Number per heat exchanger	Nos	
20.7	Manufacturer		
21	Are all counter flanges, bolts, nuts and gaskets etc. for all terminal points included in the offer		
22	Are all heat exchangers supplied with necessary foundation plates, anchor, bolts, sleeves, inserts, lifting lugs etc., as specified		
23	Shot tests & Inspection		
23.1	Whether all tests and inspections as detailed in specification / quality plan will be carried out		
23.2	Hydrostatic test		
	a) Test Pressure	bar(g)	
	b) Test duration	min.	
23.3	Are all plates checked for cracks and other defects by penetration method? If not, what percentage is checked		
23.4	Whether hardness test will be conducted for plate gaskets		
24	Details of painting		
24.1	Exterior surface		
	a) Surface preparation		
	b) Primer		
	c) Finish Preparation		
24.2	Interior surface		
	a) Surface preparation		
	b) Primer		
	c) Finish Preparation		
25	Weight of each heat exchanger	Kg	
	a) Empty		
	b) Flooded		

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S. No.	Description	Unit	Data to be filled in by Tenderer
26	Overall Dimensions		
	Length x breadth x height	mm x mm x mm	
27	Withdrawal space		
28	Other information (If any)		

23.5. Data Sheet for Soft Water Plant

A. Pressure Filter & Activated Carbon Filter

Sl. No.	Description	To be filled in by tenderer	
		Pressure Filter	A C F
1.	Shell dimension: diameter and length, mm		
2.	Vessel design code adopted		
3.	Design pressure, kg/cm^2		
4.	Hydro-test pressure, kg/cm^2		
5.	Guaranteed output between two successive backwash		
6.	Guaranteed effluent quality		
7.	Flow rate, m^3/h		
	Normal		
	Maximum		
	Backwash		
	Rinse		
8.	Head loss through bed, mWC		
	Normal		
	Maximum		
	Backwash		
	Rinse		
9.	Filter Materials		
	Type		
	Size of grading, mm		
	Quantity per filter, m^3		
	Life of filtering material year		
10.	Bed depth and free board provided		
11.	Time required for backwash		

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Sl. No.	Description	To be filled in by tenderer	
		Pressure Filter	A C F
12.	Time required for rinse Minimum		
13.	Material of construction of vessel		
14.	Type and material of inlet distributor and under drain system		
15.	Material and detail of nozzle		
16.	Filter shell and dished End thickness, mm		
17.	Flooded weight, kg		
18.	Empty weight, kg		
19.	Compressed air requirement and pressure		
20.	Time of air scouring in min.		

B. Base Exchangers

Sl. No.	Description	To be filled in by Tenderer
1	Nos. offered	
2	Shell Dimension dia x ht	
3	Design pressure, kg/cm^2	
4	Vessel design code adopted	
5	Thickness of a) Dished end b) Shell	
6	Regeneration Cycle	
7	Guaranteed output between two successive regenerations (12 hr cycle)	
8	Flow rate, m^3/h	
	Normal	
	Maximum	
	Backwash	
	Regeneration	
	Slow Rinse	
	Fast Rinse	
9	Head loss through bed, mWC	
	Normal	
	Maximum	

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Sl. No.	Description	To be filled in by Tenderer
	Backwash	
	Regeneration	
	Slow Rinse	
	Fast Rinse	
10	Time required for regeneration	
	Back wash	
	Salt Injection	
	Slow Rinse	
	Fast Rinse	
	Total time	
11	Type of resin	
12	Make of resin	
13	Volume of resin	
14	Depth of resin bed	
15	Free board provided	
16	Guaranteed life of resin	
17	Expected rate of deterioration of resin per year	
18	Regeneration level by 100% NaCl per m^3 of resin	
19	Exchange capacity of resin for above regeneration level	
20	Guaranteed quality of out-let water (a) total hardness as $CaC0_3$ ppm (b) pH	
21	Quality of 100% NaCl required per regeneration Kg	
22	Type and material of inlet regeneration, distributor and under drain system	

C. Blowers

Sl. No.	Description	For filter	For degasser tower
1.	Nos offered		
2.	Make		
3.	Capacity, m^3/min		
4.	Total head, mWC		
5.	Rpm of blower		

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Sl. No.	Description	For filter	For degasser tower
6.	kW of motor		
7.	Rpm of motor		
8.	Type of coupling		
9.	Size of suction/ discharge, mm		
10.	Make of motor		
11.	Material of construction		
12.	Total weight, kg		

D. Brine measuring tank / brine saturator

Sl. No.	Description	To be filled in by Tenderer
1	Capacity	
2	Size	
3	Material of construction	
4	Thickness of plate	
5	Thickness of lining	

23.6. DATA SHEET FOR DM PLANT

A. Activated Carbon Filter & PSF

Sl. No.	Description	To be filled in by Tenderer
1.	Shell dimension: diameter and length, mm	
2.	Vessel design code adopted	
3.	Design pressure, kg/cm^2	
4.	Hydro-test pressure, kg/cm^2	
5.	Guaranteed output between two successive backwash	
6.	Guaranteed effluent quality	
7.	Flow rate, m^3/h	
	Normal	

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Sl. No.	Description	To be filled in by Tenderer
	Maximum	
	Backwash	
	Rinse	
8.	Head loss through bed, mWC	
	Normal	
	Maximum	
	Backwash	
	Rinse	
9.	Filter Materials	
	Type	
	Size of grading, mm	
	Quantity per filter, m^3	
	Life of filtering material year	
10.	Bed depth and free board provided	
11.	Time required for backwash	
12.	Time required for rinse Minimum	
13.	Material of construction of vessel	
14.	Type and material of inlet distributor and under drain system	
15.	Material and detail of nozzle	
16.	Filter shell and dished End thickness, mm	
17.	Flooded weight, kg	

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Sl. No.	Description	To be filled in by Tenderer
18.	Empty weight, kg	
19.	Compressed air requirement and pressure	
20.	Time of air scouring in min.	

B. Cation Exchanger

Sl. No.	Description	To be filled in by Tenderer
1.	Shell dimensions: diameter x overall height, mm	
2.	Lining material and thickness	
3.	Vessel design code adopted	
4.	Design pressure, kg/cm^2	
5.	Hydro-test pressure, kg/cm^2	
6.	Thickness of shell and dished end, mm	
7.	Guaranteed output between two successive regeneration, m^3	
8.	Flow rate, m^3/h	
	Normal	
	Maximum	
	Backwash	
	Regeneration	
	Slow rinse	
	Fast rinse	
9.	Head loss through resin bed, mWC	

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Sl. No.	Description	To be filled in by Tenderer
	Normal	
	Maximum	
	Backwash	
	Acid injection/ Brine injection	
	Slow rinse	
	Fast rinse	
10.	Time required for regeneration in minutes	
	Backwash	
	Acid injection	
	Slow rinse	
	Fast rinse	
	Total time	
11.	Type and make of resin	
12.	Depth of resin bed and free board provided, m	
13.	Volume of resin/exchanger, in litres	
14.	Guaranteed life in years and rate of deterioration of resin per year	
15.	Regeneration level kg of 100% HCL per m^3 of resin	
16.	Exchange capacity Kg of cation (as $CaCO_3$)/m^3 of resin	
17.	Net exchange capacity (as $CaCO_3$)/m^3 of resin after derating	

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Sl. No.	Description	To be filled in by Tenderer
18.	Quantity of HCL required for each regeneration, kg	
19.	Strength of acid during injection	
20.	Dilution water required per regeneration, m^3	
21.	Effluent quantity per regeneration, m^3	
22.	Flooded weight, kg	
23.	Empty weight, kg	

C. Anion Exchanger

Sl. No.	Description	To be filled up by Tenderer
1.	Shell dimensions: diameter x overall height mm	
2.	Lining material and thickness	
3.	Vessel design code adopted	
4.	Design pressure, kg/cm^2	
5.	Hydro-test pressure, kg/cm^2	
6.	Thickness of shell and dished end, mm	
7.	Guaranteed output between two successive regeneration, m^3	
8.	Flow rate, m^3/h	
	Normal	
	Maximum	
	Backwash	
	Regeneration	

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Sl. No.	Description	To be filled up by Tenderer
	Slow rinse	
	Fast rinse	
9.	Head loss through resin bed, mWC	
	Normal	
	Maximum	
	Backwash	
	Alkali injection	
	Slow rinse	
	Fast rinse	
10.	Time required for regeneration in minutes	
	Backwash	
	Alkali injection	
	Slow rinse	
	Fast rinse	
	Total time	
11.	Type and make of resin	
12.	Depth of resin bed and free board provided, m	
13.	Volume of resin/exchanger in litres	
14.	Guaranteed life in years and rate of deterioration of resin per year	
15.	Regeneration level kg of 100% NaOH/m^3 of resin	
16.	Exchange capacity of resin	

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Sl. No.	Description	To be filled up by Tenderer
	kg of anion (as $CaCO_3$)/m^3 of resin	
17.	Net exchange capacity (as $CaCO_3$)/m3 of resin after derating	
18.	Quantity of 100% NaOH required for each regeneration kg	
19.	Strength of alkali during injection	
20.	Dilution water required per regeneration, m^3	
21.	Effluent quantity per regeneration, m^3	
22.	Flooded Wt, Kg	
23.	Empty Wt, Kg	

D. Mixed Bed Exchanger

Sl. No.	Description	To be filled up by Tenderer
1.	Shell dimensions: diameter x overall height, mm	
2.	Lining material and thickness	
3.	Vessel design code adopted	
4.	Design pressure, kg/cm^2	
5.	Hydro test pressure, kg/cm^2	
6.	Thickness of shell and dished end, mm	
7.	Guaranteed output between two successive regeneration, m^3 (180 hour cycle)	
8.	Flow rate, m^3/h	
9.	Head loss through resin bed, mWC	

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Sl. No.	Description	To be filled up by Tenderer
10.	Time required for regeneration in minutes	
11.	Compressed air requirement per regeneration and pressure	
12.	Type and make of resin	
13.	Depth of resin bed and free board provided, m	
14.	Guaranteed life in years and rate of deterioration of resin per year	
15.	Regeneration level kg of 100% NaOH/m^3 of resin kg of 100% HCL/ m^3 of resin	
16.	Volume of resin exchanger Cation resin, m^3/litre Anion resin, m^3/litre	
17.	Exchange capacity of resin kg of cation (as $CaCO_3$)/m^3 of resin kg of anion (as $CaCO_3$)/m^3 of resin	
18.	Quantity of regenerant 100% HCL required per regeneration, kg 100% NaOH required per regeneration, kg	
19.	Strength of regenerant Strength of acid during injection Strength of alkali during injection	
20.	Dilution water required per regeneration, m^3	

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Sl. No.	Description	To be filled up by Tenderer
21.	Effluent quantity per regeneration, m^3	
22.	Flooded Wt, Kg	
23.	Empty Wt, Kg	

E. Degasser Tower

Sl. No.	Description	To be filled up by Tenderer
1.	Shell dimensions: diameter x overall height, mm	
2.	Lining material and thickness	
3.	Vessel design code adopted	
4.	Design pressure, kg/cm^2	
5.	Hydro test pressure, kg/cm^2	
6.	Thickness of shell and dished end, mm	
7.	Type of Fill	

F. Storage tanks

Sl. No.	Description	Filtered water	Degassed water	DM Water	Acid	Alkali
1.	Nos. offered					
2.	Chemical to be stored					
3.	Type of tank					
4.	Nominal capacity, m^3					
5.	Diameter, mm					

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6.	Height/ length, mm					
7.	Material of construction					
8.	Internal surface protection					
9.	Thk.of shell & dished ends, mm					

G. Measuring Tanks

Sl. No.	Description	Acid measuring tanks		
		SAC	MB	Neut. pit
1.	Nos. offered			
2.	Chemical to be stored			
3.	Nominal Capacity, litres			
4.	Diameter, mm			
5.	Depth, mm			
6.	Material of construction			
7.	Internal surface protection			
8.	Agitator - kw (estimated) - rpm			

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Sl. No.	Description	Alkali measuring tanks		
		SBA	MB	Neut. pit
1.	Nos. offered			
2.	Chemical to be stored			
3.	Nominal Capacity, litres			
4.	Diameter, mm			
5.	Depth, mm			
6.	Material of construction			
7.	Internal surface protection			
8.	Agitator - kw (estimated) - rpm			

H. Dosing Pumps, (if provided)

Sl. No.	Description	Acid dosing pumps	Alkali dosing pumps
1.	Nos. offered		
2.	Type		
3.	Capacity, m^3/h		
4.	Discharge head, mLC		
5.	Material of construction Casing Impeller Motor – hp, - rpm		

mLC - Meter of liquid column.

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I. Blowers - Same as provided above.

J. Pumpsets – Same as provided above.

K. Regeneration Flow

Sl. No.	Description	Basis	Flowrate (m3/h)	Duration (min.)	Volume (m3)	Source
	DM WATER PLANT					
	Cation Exchanger					
1.	Backwash					
2.	Acid injection					
3.	Rinse					
	Anion Exchanger					
1.	Backwash					
2.	Alkali injection					
3.	Rinse					
	Mixed Bed Exchanger					
1.	Sub-surface wash					
2.	Backwash					
3.	Acid injection					
4.	Acid Rinse buffer during 3 & 4					
5.	Alkali injection					
6.	Alkali Rinse buffer during 5 & 6					
7.	Drain down					
8.	Air mix					

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Sl. No.	Description	Basis	Flowrate (m3/h)	Duration (min.)	Volume (m3)	Source
9.	Final Rinse					

L. Process calculation summary

Sl. No.	Parameters	Units	DM Water Plant			
			Cation	Anion	MB cation	MB Anion
1.	Exchangeable Ionic load	ppm				
2.	Flowrates normal /maximum	m^3/h				
3.	Exhaustion time	hrs				
4.	Net output per cycle	m^3				
5.	Regn. Water-downstream unit	m^3				
6.	Regn. water - self	m^3				
7.	Gross output per cycle	m^3				
8.	Resin type	-				
9.	Regn. level (as 100%)	kg/m^3				
10.	Exchange capacity	kg/m^3				
11.	Derated capacity	kg/m^3				
12.	Net Exch. Cap. used	kg/m^3				
13.	Leakage	kg/m^3				

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Sl. No.	Parameters	Units	DM Water Plant			
			Cation	Anion	MB cation	MB Anion
14.	Resin Volume (active)	m^3				
15.	Cross sectional area	m^2				
16.	Inert resin volume	m^3				
17.	Total resin quantity	m3				
18.	Total bed depth	mm				
19.	Dia and Height on straight	mm				
20.	Surface flow rate	m/hr				
21.	Specific flow rate	BF/h				
22.	Chem. per regn. (as 100%)	kg				
23.	Work done by resin (as $CaCO_3$)	kg				
24.	Regeneration efficiency	%				
25.	Excess regenerants (as $CaCO_3$)	kg				
26.	100% chemical required for neutralisation	kg as $CaCO_3$				
27.	Composition of effluent	ppm				

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23.7. Data Sheet for Oil Skimmer

1.	Required nos.	
2.	Place of Installation	
3.	Type	
4.	Mounting	
5.	Capacity, LPH	
6.	Type of Operation	
7.	Fluid to be skimmed	
8.	Temperature, ^{0}C	
9.	Flow Rate, m^3/hr	
10.	Specific Gravity	
11.	Viscosity, centistokes	
12.	Oil and Grease Loading, mg/l	
13.	Oil Film Thickness, mm	
14.	Tube Length, m	
15.	Tube Speed, m/min	
16.	Pulley speed, RPM	
17.	Direction of Rotation	
18.	MATERIAL OF CONSTRUCTION	
	• Frame	
	• Tube	
	• Shaft	

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	• Wiper	
	• Bonnet	
19.	Accessories	

23.8. Data Sheet for Filter

A. Simplex Filter

Sl. No.	Description	Parameters
1.	Flow, m^3/hr	
2.	Inlet Pressure, Kg/cm^2	
3.	Line Size	
4.	Sieve Size, micron	
5.	Operation	
6.	Qty.	

B. Duplex Filter

Sl. No.	Description	Parameters
1.	No. of filters installed	
2.	Place of installation	
3.	Inlet nozzle	
4.	Outlet nozzle	
5.	Type of filter	
6.	Flow (m^3/h)	
	- Maximum	

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Sl. No.	Description	Parameters
	- Normal	
7.	Temperature of water(^{0}C)	
8.	Pressure (kg/cm^2)	
	- Maximum	
	- Normal	
	- Test	
9.	Degree of filtration	
10.	Filter element	
11.	Ratio of free flow area to nozzle area	
12.	Pressure loss (kg/cm^2) at maximum flow	
13.	Differential Pressure Gauge	
14.	Drain with valves (Plug type valves)	
15.	Vent with valves	
16.	Pressure equalising arrangement with plug type valve	
17.	Materials of construction (main components)	
18	Body	
19	Filter element (including handle) & wire Mesh.	
20	Inspection hole covers, Drain covers, Top & bottom covers.	
21	Spindles	
22	Valve disc	

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Sl. No.	Description	Parameters
23	Valve seating	
24	Gaskets sealing rings	
25	Companion flanges at inlet and outlet	

C. Y - Strainer

Material Of Construction

BODY :

MESH :

GASKET :

BODY COVER :

Pressure loss (kg/cm^2) at

maximum flow

a) Clean condition -

b) 50% clogged condition -

Size of drain along with plug valve:

D. Automatic backwash filter

Sl. No.	Description	Parameters
1.	Flow, m3/hr	
2.	Inlet Pressure, Kg/cm2	
3.	Line Size	

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4.	Sieve Size, micron	
5.	Operation	
6.	Degree of filtration	
7.	Qty.	

23.9. Data Sheets for Various Equipment of Treatment Plant

23.9.1. Data Sheet for Flash Mixer:

- Nos. offered :
- Design flow rate :
- Detention time :
- Size of flash mixing tank :
- Material of construction of tank :
- Type and details of mixer mechanism :
- Material of construction of mixer :
- Ratio of impeller diameter to tank diameter :

- Rotational speed of impeller :
- Velocity gradient :
- Details of drive :
- Rated kW of motor :
- Motor rpm :

23.9.2. Data Sheet for Clariflocculator

- Design Flow (m^3/h) :
- Assumed underflow losses :
- Design Inflow (m^3/h) :
  of influent raw water (ppm) :

- Maxm. suspended solid content of effluent clarified water (ppm) :

- Sedimentation velocity :
- Retention time
  a) Flash mixer zone (minutes) :

  b) Flocculator zone (minutes) :

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c) Clarifier zone (minutes) :

- Design Sedimentation Area (m^2) :
- Quantity of media required (m^2) :
- Required plan area of each clarifier (m^2) :

- Surface loading rate (SLR)
  a) Normal ($m^3/m^2/h$) :

  b) Maximum ($m^3/m^2/h$) :

- Surface area of each clarifier(m^2) :
- Overall dimension of each clarifier
  a) Dia (m) :

  b) Height (m) :

- Sludge Zone Volume :
- Sludge bleed off system : Intermittent/Continuous
- Sludge consistency :
- Sludge retention time (min) :
- Weight of assembly :
- GA drawing submitted :

23.9.3. Data Sheet For Chemical Solution Preparation cum Dosing Tanks

- Nos. offered :
- Chemical to be handled :
- Nominal capacity :
- Dimensions of tank :
- Material of construction & thickness :
- Interior surface protection :
- Mixer/Stirrer Mechanism
  i) Number :

  ii) Manufacturer :

  iii)Speed (rpm) :

- Material of construction of
  i) Propeller/agitator :

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ii) Shaft :

iii)Fixing bracket :

- Drive details :
- Rated kW of drive :

Note : Separate data sheet shall be furnished for each type of the above tanks.

23.9.4. Data Sheet For Metering Pumps

- Nos. offered :
- Type, make :
- Capacity (lph) :
- Discharge head :
- Material of construction of
  i) Casing :

  ii)Impeller :

- Drive details :
- RPM :
- Rated kW of motor :

(Note : Separate data sheets shall be furnished for each type of the above pumps)

23.9.5. Data Sheet for Pressure Filter

- Type :
- Nos. offered :
- Design flow rate
  i) Normal (m^3/h) :

  ii) Maximum (m^3/h) :

  iii)Back wash :

  iv) Rinse :

- Quality of influent water :
  i) Total suspended solids (ppm) :

  ii) pH :

- Guaranteed effluent quality
  i) Total suspended solids (ppm) :

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ii) Micron size :

iii)pH :

- Filtration rate ($m^3/h^2/h$) :
- Vessel dimensions

i) Shell diameter (mm) :

ii) Straight length (mm) :

iii)Overall length (mm) :

- Plate specification and thickness

i) Shell :

ii) Dished end :

- Vessel design code :
- Design pressure (Kg/cm^2) :
- Test pressure (Kg/cm^2) :
- Filtration area :
- Filter media

i) Type :

ii) Effective size (mm) :

iii)Volume per filter(m^3) :

iv) Life of filtering media :

- Media depth (mm) :
- Free board (mm) :
- Type & MOC of inlet distributor :
- Type & MOC of under drain collection system :
- Back-wash cycle period :
- Guaranteed output between two successive backwash (m^3) :

- Duration of air scour (minutes) :
- Specific consumption of scour air ($m^3/h^2/h$) :

- Pressure of backwash water (mWC) :

- Quantity of backwash water

a) Flow rate (m^3/h) :

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b) Total consumption (m^3) :

- Quality of backwash water :
- Time required for backwash (minutes) :

- Time required for rinse (minutes) :
- Arrangement of disposal of waste wash water :

- Empty weight of filter (kg) :
- Flooded weight of filter (kg) :
- Details of dosing system required for
  i) When influent water is received from

  inclined plate clarifier :

  ii) When influent water is received

  directly from the raw water reservoir :

23.9.6. Sludge Agitator Data Sheet

- Nos. offered :
- Type and make :
- Design considerations
  i) Slurry viscosity (CP) :

  ii) Max. solid size (mm) :

  iii)Max. dry solids sp. gravity :

  iv) Max. liquor sp. gravity :

  v) Max. solids content (by weight) :

- No. of propellers :
- Propeller diameter :
- No. of blades :
- Tip speed
- Power (kW) at tip speed :
- Weight (kg) :
- Details of agitator features :
- Details of drive system :
- Material of construction for
  i) Propeller blades :

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ii) Propeller shaft :

iii)Gear box housing :

iv) Output shaft :

v) Bearing (upper/lower) :

vi) Bearing housing :

- Details of gear reducer :
- Details of V-belt drive :
- Details of electric motor :

i) Rated kW of motor :

ii) RPM of motor :

- Details of super structure :
- Weight of super structure :
- Details of tank fittings :

23.9.7. Dewatering Station Data Sheet

- Type of filter press :
- Quantity :
- Operating temperature :
- Capacity :
- Solid content :
- Cake Solid content :
- Flammable conditions :
- Area classification : :

Construction Features

- Cake holing capacity :
- Type of operation :
- Filtration cycle time :
- Plate size :

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- Filtration area in m^2 :
- Piping battery limit connection :
- Maximum design temperature :
- Cake thickness :
- Design service pressure :
- Feed inlet pipe size :
- Filter outlet :
- Plate movement :
- Drive for movement :
- Filter cloth size :
- Filter plate type :
- Plate thickness :
- Cake removal method :
- Total installed power :

Material of Construction

- Main frame :
- Filter plates :
- Filter cloth :

Electro Hydraulic System

- Operation :
- Distributor (opening/closing) :
- Relief valves :
- Lower pressure pump :
- Flow rate / pressure (max) :
- High pressure pump :
- Flow rate / pressure (max) :
- Pump assembly :
- Assembly position :
- Electric motor :

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- installed power :
- RPM :
- Power supply voltage (service tension)
- Protection :
- Oil tank :
- No of pressure transmitter :
- Connections to piston :

Valves And Instruments :

- Diameter of pressure gauge :
- Pressure indication :
- Assembly of pump and motor :
- Actuator :
- Solenoid valve :

23.10. Data Sheet for Sludge Scrapper Assembly

1.	No of assemblies	
2.	Name of foreign collaborator (if any)	
3.	a) Distance between rails b) Size of rails	
4.	Dimension of equipment	
5.	<u>Bridge drive</u> a) type of motor b) K.W c) Motor speed d) Output RPM e) Class of Insulation/degree of protection	
6.	<u>Hoist drive</u> a) Type of motor b) kW c) Motor speed d) Output RPM e) Class of Insulation/degree of protection	

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7.	Scrapper speed	
8.	Skim speed	
9.	Type of Brakes	
10.	Type and make of gear boxes	
11.	Power Transmission arrangement.	
12.	a) Make of control panel b) Degree of protection c) Type of panel d) Location of panel	
13.	Over load protection system	
14.	Materials of construction of various components	
15.	G.A drawings and cross section enclosed or not	
16.	Write-up on control scheme enclosed or not	
17.	List of drawings proposed to be submitted for approval enclosed or not	
18.	Quality assurance plan as submitted in Mecon, Performa or not	
19.	a) time bar chart submitted or not b) Delivery period	
20.	List of 2 year's spares and commissioning spares submitted or not.	
	A.C MOTORS	
1.	Make	
2.	Type	
3.	kW , at 40 deg. And at 55 ^{0}C and R.P.M	
4.	Voltage	
5.	Frequency	
6.	Frame size	
7.	Duty	
8.	Class of Insulation	
9.	Enclosure Class	

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	D.O.L STARTERS	
1.	Make	
2.	Enclosure Class	
3.	Make of components	
4.	Sheet Steel thickness	
5.	Compliance with T.S	
	LIMIT SWITCHES	
1.	Type	
2.	Make	
3.	Enclosure Class	
4.	No. of N.O + N.C Contacts	
	CABLES Power Cables/Control cables/Festoon Cables	
1.	Make	
2.	Conformity with T.S	

23.11. Datasheet for Scale Removal Filter

Sl. No.	Description	
1.	Shell dimension: diameter and length, mm	
2.	Vessel design code adopted	
3.	Design pressure, kg/cm^2	
4.	Hydro-test pressure, kg/cm^2	
5.	Guaranteed output between two successive backwash	
6.	Guaranteed effluent quality	
7.	Flow rate, m^3/h	
	Normal	

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Sl. No.	Description	
	Maximum	
	Backwash	
	Rinse	
8.	Head loss through bed, mWC	
	Normal	
	Maximum	
	Backwash	
	Rinse	
9.	Filter Materials	
	Type	
	Size of grading, mm	
	Quantity per filter, m^3	
	Life of filtering material year	
10.	Bed depth and free board provided	
11.	Time required for backwash	
12.	Time required for rinse Minimum	
13.	Material of construction of vessel	
14.	Type and material of inlet distributor and under drain system	
15.	Material and detail of nozzle	
16.	Filter shell and dished End thickness, mm	
17.	Flooded weight, kg	

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Sl. No.	Description	
18.	Empty weight, kg	
19.	Compressed air requirement and pressure	
20.	Time of air scouring in min.	

23.12. Chemical Dosing System

Trade Name / No.	
Manufacturer	
Recirculation System	
Base Group	
Function	
To be dosed during	
Dosage Basis	
Dosage rate ppm	
- precleaning	
- passivation	
- regular operation	
Dosage frequency	
Dosing point	
Total chemical consumption for	
Precleaning Kg	
Passivation Kg	
Regular dosage Kg	

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Dosing method	
Metering Pumps	
No.	
Make	
Model	
Capacity	
Power requirement	
Capacity adjustment	
Carbuoy / Drum	
Capacity lit.	
Total weight Kg	
Size	

23.13. Data Sheet for Effluent Treatment Plant

Dewatering Station Data Sheet- Same as above

Construction Features

- Cake holing capacity :
- Type of operation : fully automatic
- Filtration cycle time : one hour
- Plate size :
- Filtration area in m^2 :
- Piping battery limit connection : welded
- Maximum design temperature :
- Cake thickness :
- Design service pressure :

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- Feed inlet pipe size :
- Filter outlet :
- Plate movement : cam
- Drive for movement : hydraulic motor
- Filter cloth size :
- Filter plate type :
- Plate thickness :
- Cake removal method :
- Total installed power :

Material of Construction

- Main frame :
- Filter plates :
- Filter cloth :

Electro Hydraulic System

- Operation :
- Distributor (opening/closing) :
- Relief valves :
- Lower pressure pump :
- Flow rate / pressure (max) :
- High pressure pump :
- Flow rate / pressure (max) :
- Pump assembly :
- Assembly position :
- Electric motor :
- installed power :
- RPM :
- Power supply voltage (service tension)
- Protection :

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- Oil tank :
- No of pressure transmitter :
- Connections to piston :

23.14. Data Sheet for Valves

1.	Type of valve	
2.	Constructional length, flange to flange with tolerances.	
3.	Height of hand wheel from centre line of valve	
4.	Fixing of seat rings to body and gate.	
5.	Hand wheel diameter	
6.	Force required on hand wheel/ chain for opening and closing of valves.	
7.	Number of hand wheel revolutions for full opening.	
8.	Height of lift per revolution.	
9.	Spindle diameter	
10.	Type of spindle threads	
11.	No. of starts of spindle thread	
12.	Weight of each valve	
13.	Pressure drop	

Material of Construction

A. Gate Valve/Globe Valve/Butterfly/Ball (As Applicable)

1.	Body	
2.	Bonnet	
3.	Yoke	
4.	Wedge/Disc	

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5.	Spindle	
6.	Seat ring	
7	Yoke Sleeve	
8	Hand Wheel/Chain wheel	
9	Gland Bush	
10	Gland Packing	
11	Gland Flange	
12	Body Bonnet Gasket	
13	Bonnet Bush	
14	Bonnet Stud	
15	Bonnet Stud Nut	
16	Hand Wheel Nut	
17	Lifting Lugs	
18	Companion Flanges	
19	Gasket for Companion Flanges	
20	Fasteners for Companion Flanges	
21	Type of Wedge for Gate Valve	

B. Non - Return Valve

1.	Body	
2.	Cover	
3.	Hinge	
4.	Hinge Pin	
5.	Hinge Pin Spacer	

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6.	Disc	
7.	Seat ring	
8.	Disc Nut	
9.	Disc Washer	
10.	Cotter Pin	
11.	Cover Stud	
12.	Cover Stud Nut	
13.	Gasket for Cover	
14.	Companion Flanges	
15.	Gasket for Companion Flanges	
16.	Fasteners for Companion Flanges	

**** End of Clauses ****

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4.3. AIR CONDITIONING & VENTILATION SYSTEM

4.3.1. Scope of work:

i. The scope of work of the turnkey supplier shall also cover design, engineering, manufacture / procurement, inspection, assembly, shop testing & painting, packing, supply F.O.R. ISP, Burnpur, site storage, erection, Testing, trial run, Commissioning and PG test of ACVS till successful handing over to ISP (client / purchaser). The scope also includes complete electrics & instrumentation excluding civil associated with the entire air conditioning & ventilation systems of the Captive Power Plant (CPP).

ii. The successful bidder's liability shall be limited to the replacement of any defective parts in the equipment of his own manufacture or those of his sub-vendor (s) or replacement of the complete equipment till the Defect Liability Period (DLP) as mentioned in the SBD.

iii. Submission and approval of Design basis report with heat load calculation, P&ID, PFD / Schematic drg., GAD of all equipment, Equipment & piping layout, SLD, Drive list, Sizing calculation for AHU room, ventilation room, tunnel shaft (if any), chiller capacity, capacity of chiller & condenser cooling pumps & cooling tower, etc.

iv. Operation and interlock philosophy of ACVS equipment / system w.r.to the technological requirement.

v. Interlocking of FDA system with the operation of ACVS equipment / systems.

vi. Chilled water pipe routing drg. (plan & elevation with cross-sections) within the CPP complex and upto the TOP indicating flow, pressure, temperature, load & support details for chilled water pipes (supply & return).

vii. Pressure drop calculation for the chilled water pipe routing from the furthest AHU room to the T.O.P.

viii. O&M manpower will be provided by the SAIL with the start of trial run and O&M manpower will work under the guidance and supervision of successful tenderer during PAC, Start up, Commissioning and PG Test.

ix. The list of recommended spares for 2 years Operation shall be furnished by the bidder.

x. All commissioning spares as required along with consumables for the ACVS shall be supplied by the Successful Tenderer.

xi. Any other drawing / document as felt necessary during the course of engineering.

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4.3.2 Special Instructions of Tenderer

4.3.2.1. General

The completeness of the Air conditioning and Ventilation systems in terms of its equipment and accessories for safe, smooth and trouble free operation is the sole responsibility of the successful Tenderer. With this objective in mind, the Tenderer shall include all the items essential for efficient operation of the Air conditioning and Ventilation systems.

The Anchor bolts, nuts, foundation plates and inserts shall be provided by the successful Tenderer.

Civil data including foundation details (if any) and the drawings showing the general layout, elevations and cross sections of the equipment, its auxiliary equipment and services shall be furnished within the given time period.

The equipment and materials to be supplied shall comply with the latest relevant Indian and International Standards specification or in absence of relevant Indian Standard, it should conform to the generally accepted standards and makes.

The tenders shall include supply of necessary service tools, erection, operation and maintenance manuals, drawings of the fast wearing parts of the equipment and auxiliaries along with supplies. The manuals shall be in English language and should be submitted in durable folders.

The Tenderer shall adhere to the schedule for supply and commissioning.

The specification is intended for general description and guidance as regards quality, workmanship and specification. The specifications are not intended to cover all the minutedetails and the work shall be executed according to the spirit of the specification. In the absence of specification for any particular item or work, the same shall be executed as per relevant Indian Standards.

The equipment offered shall be suitable for smooth, efficient and trouble free service in the climate prevailing at Captive Power Plant site, ISP,Burnpur, India.

The equipment and its accessories shall be so designed as to achieve efficient and reliable performance under heavy duty conditions of an Iron & Steel Plant. These items shall be rendered proof against rats, lizards and other vermins.

Each equipment shall be provided with suitable lifting attachment namely lifting lugs, eye bolts etc. to facilitate erection and maintenance.

The Tenderer shall not off-load the contract or part thereof to any sub-succesful tenderer without written permission of the purchaser. In the event subletting of contract or any part thereof, is permitted by the purchaser, the fact that such permission has been accorded shall

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not establish any contractual relationship between the approved sub-succesful tenderer and the purchaser, nor shall release obligations under the contract.

Any additional equipment and material which are not specifically mentioned but are required to make the systems complete in every respect in accordance with technical specification and for safe operation and guaranteed performance shall be under the scope of this specification.

In the interest of standardization, purchaser reserves the right of selecting a particular manufacturer of equipment / components as indicated in the specification.

Depending on the performance, purchaser reserves the right to cancel the order or increase or decrease the quantity ordered at the same price / rate without any financial implications on the purchaser's part or any compensation to the supplier.

All drawings shall be prepared as per relevant current Indian Standard / International Standard and up-to-date engineering practices with clear and legible fronts, dimension & legends in English Language.

Preparation, submission and getting approval on Engineering drawings and document by MECON/ ISPshall be the whole and sole responsibility of the successful tenderer.

In general, the successful Tenderer is supposed to re-submit the revised drawings within seven days of receipt of comments from MECON/ ISP. However, approval of drawings by MECON/ ISPshall not relieve the successful tenderer of his responsibilities for correctness, adequacy of the design and completeness of his work.

MECON/ ISP shall have the final say in the approval of drawings & document and the same shall be adhered to by the successful bidder. Drawings / document so submitted will become the property of MECON/ ISP. The approval of the drawings does not absolve the successful Bidder from its overall responsibility of the equipment / plant for its successful operation. The successful Bidder shall be responsible for and shall pay for any alterations of the work due to any discrepancy, errors or omissions in the drawings or particulars supplied by him, irrespective of approval given by MECON/ ISP.

After Completion of Project, one set of reproducible soft copy in Auto Cad format of all design and installation drawing (as built drawings), all documents, test certificates, etc shall be presented after completion of project to the client.

Any loss of plant and equipment after receipt at site due to imprudence, negligence and unsuitable treatment and handling on part of the bidder shall have to be replaced by the bidder at his own cost.

MECON/ ISP reserves the right of selecting the make/model of equipments as well as instrumentation items and any other item to be used for the project wherever necessary and the supplier shall agree to supply the equipment of that particular make/model without any cost implication to MECON/ ISP.

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The bidder shall take all precautions against damages if any due to rains / storms / floods / earthquake / other natural calamities and no liability against such losses / damages shall lie with MECON/ ISP.

Manufacturing shall be taken up only on the basis of drawings duly approved / Approved As Noted (after complying the comments, if any).

4.3.3. Quality Assurance Plan (QAP)

4.3.3.1. For item like special casting and other tailor made items which are to be supplied strictly as per the purchaser's design/specification, the relevant preliminary Quality Assurance Plan (QAP). The Tenderer shall confirm adherence of the same during submission of their offer. In any case, successful tenderer shall get the QAP approved before taking up manufacturing and Inspection by MECON/ISP.

4.3.3.2. Items for which only analogous drawings are furnished by the purchaser but items shall be supplied as per the design of succesful tenderer and for the standard bought out items,QAP shall be prepared and furnished by the Tenderer.

Inspection for all items shall be carried out only as per the QAP approved by MECON/ ISP

4.3.4. Applicable Codes & Standards and Design Criteria

The following acts, rules, standards / internationally accepted norms shall also be taken into considerations:

a) B.I.S Publications
b) Indian Electricity Rules & statutory requirements of Central Govt. and State Govt. and Inter Plant Steel Standard, IPSS.
c) ISHRAE handbook
d) ARI publication
e) I.S.O Publications
f) ASME codes for unfired pressure vessels
g) VDI stipulation for vibration level
h) AMCA standard for fan balancing
i) Occupational safety and health act (USA)

In addition to the above, the following Indian Standards shall be referred in general:

IS 655: 2006	HVAC System duct
IS-659-1964 (RA-2001)	Safety code for air conditioning system
IS 778:1984 (RA 2005)	Specification for Copper Alloy Gate, Globe and Check Valves for Waterworks Purposes
IS 1239 : Part 1 : 2004	Steel Tubes, Tubulars and Other Wrought Steel Fittings - Specification - Part 1 : Steel Tubes

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IS 1239 : Part 2 : 1992 (RA 2002)	Mild steel tubes, tubulars and other wrought steel fittings, Part 2 Mild steel tubulars and other wrought steel pipe fittings
IS 1391 : Part 1 : 1992 (RA 1999)	Room Air Conditioners - Specification - Part 1 : Unitary Air Conditioners
IS 1391 : Part 2 : 1992 (RA 1999)	Room air conditioners: Part 2 Split air conditioners
IS 2712 : 1998 (RA 1999)	Gaskets and packings - compressed asbestos fibre jointing
IS 3588 : 1987 (RA 1999)	Specification for Electric Axial Flow Fans
IS 3589 : 2001 (RA 2006)	Steel Pipes for Water and Sewage (168.3 to 2 540 mm Outside Diameter) - Specification
IS 3677 : 1985 (RA 2006)	Specification for Unbonded Rock and Slag Wool for Thermal Insulation
IS 4671 : 1984 (RA 2004)	Expanded polystyrene for thermal insulation purposes
IS 4894 : 1987 (RA 1999)	Centrifugal fans
IS 5312 : Part 1 : 2004	Swing Check Type Reflux (Non-Return] Valves for Water Works Purposes - Specification - Part 1 : Single-Door Pattern
IS 5822 : 1994 (RA 2000)	Code of Practice for Laying of Electrically Welded Steel Pipes for Water Supply
IS 7613 : 1975 (RA 2001)	Method of testing panel type air filters for air conditioning and ventilation purposes
IS 7896 : 2001	Data for Outside Design Conditions for Air Conditioning for Indian Cities
IS 8148 : 2003	Package air conditioner
IS 8183 : 1993 (RA 2004)	Thermal Insulation – Bonded Mineral wool
IS 10470 : 1983 (RA 2000)	Specification of air cooled heat exchanger
IS 11304 : 1985 (RA 2003)	Code of practice for control of air pollution in iron and steel plants
IS 11327:1985	Requirements for refrigerants condensing units
IS 11329 : 1985	Specification for Finned Type Heat Exchanger for Room Air Conditioner
IS-11338-1985 (RA-1991)	Specification for Thermostats for Use in Refrigerators, Air Conditioners, Water Coolers and Beverage Coolers
IS 11446: 1985	Method of Measurement of Airborne Noise Emitted by Compressor Units Intended for Outdoor Use
IS 11461 : 1985	Code of practice for compressor safety
ASHRAE Handbook	'Fundamentals' 'Equipment'
CARRIER Handbook	Air Conditioning System Design by 'Carrier Air Conditioning Company'
ISHARE Handbook	ISHRAE Handbook
IS 638 : 1979 (RA 1999)	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
IS 800 : 1984 (RA 1998)	Code of practice for general construction in steel

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IS 822 : 1970 (RA 2003)	Code of procedure for inspection of welds
IS 875 : Part 1 to Part 5: 1987 (RA 2003)	Structural design
IS 1239 : Part 1 : 2004 & IS 1239: Part 2: 1992 (RA 2002)	Steel Tubes, Tubulars and Other Wrought Steel Fittings - Specification - Part 1 : Steel Tubes & Mild steel tubes, tubulars and other wrought steel fittings, Part 2 Mild steel tubulars and other wrought steel pipe fittings
IS 1364 : Parts 1 to 6: 2002	Hexagonal nuts & bolts
IS 2062 : 2006	Hot Rolled Low, Medium and High Tensile Structural Steel
IS 2712 : 1998 (RA 1999)	Gaskets and packings - compressed asbestos fibre jointing
IS 4894 : 1987 (RA 1999)	Centrifugal fans
IS 3588 : 1987 (RA 1999)	Specification for Electric Axial Flow Fans
IS 8183 : 1993 (RA 2004)	Bonded Mineral Wool Insulation
IS 2312 : 1967 (RA 2000)	Propeller type AC ventilating fans

4.3.5. Design Consideration for Air Conditioning & Ventilation Systems (ACVS)

a) The following design data will be considered for the heat load calculation of the ACVS equipment / system :

Air Conditioning system:

SEASON	TEMPERATURE 0C (DBT)	RELATIVE HUMIDITY (%)
SUMMER	45	30
Hot Zone side (20 m from hot zone)	60^0C	
MONSOON	33	80
WINTER	10	30

Ventilation system:

SEASON	TEMPERATURE 0C (DBT)	RELATIVE HUMIDITY (%)
SUMMER	45	30
Hot Zone side (20m from hot zone)	60^0C	

b) Heat load of AHU room / PAC room for concerned premises shall also be considered during the estimation of cooling load of that premises.

c) The capacities of the ACVS systems shall be selected considering atleast 10% excess margin over the calculated values.

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d) Two nos. AHU (1W+1S) shall be considered for all the critical premises where inside condition to be maintained at 23±2 ^{0}C & 55±5 % RH.

e) Two nos. AHU (both working) shall be considered for all the other premises where inside condition to be maintained at < 35 ^{0}C &< 70 % RH.

f) ACVS equipment / system shall be designed & selected considering the safety of personnel, uninterrupted operation of plant, long life of equipment, easy maintenance at low cost and least inventory.

g) Environment friendly refrigerant considering its less future impact shall be considered for the design of air conditioning systems.

h) Maximum capacity for water cooled packaged AC shall be 30TR. Central AC system (chilled water based) shall be designed by the tenderer if the cooling load exceeds 30TR.

i) Split air conditioner with 5 stars BEE rating shall be considered.

j) Industrial Split AC shall be considered for hot zone areas, operator's cabin of EOT crane & loco cars(as applicable within the battery limit of the CPP).

k) Handling and hoisting facilities shall be provided for the impellers; motors of pumps, fans and compressors of chillers, etc.

l) The saturation efficiency of the air washer equipment shall be 90% minimum.

m) The ventilation systems shall be designed based on minimum 15 air changes/ hour in case of washed air supply system and 20 air changes/ hour in case of fresh filtered air supply system & exhaust ventilation systems or the heat loads of the premises whichever is higher.

n) FDA system shall be interlocked with AC & VS equipment / system such that in the event of fire, the ACVS systems / equipment can be tripped automatically.

o) Refer relevant chapter of water system for the design & specification of pumps, water piping, valves, fittings and cooling tower.

p) The air duct lines & water pipe lines shall be designed as self-balanced systems. Necessary pressure drop / balance calculation shall be submitted to this effect during basic engineering.

q) Duct lines shall have measuring hatches of size 50- 75mm with air tight seals, approach, platforms & ladders.

r) Noise of all rotating equipment shall be limited to 85dB(A) at 1m distance from the source.

s) Noise level inside the air conditioned premises shall be limited to 65dB(A). Design of supply air grille / diffuser, ducting & its acoustic insulation inside the air conditioned premises shall accordingly be considered.

t) Sizing of AHU rooms & Ventilation rooms shall be considered with proper handling facilities and maintenance area.

u) All the rotating parts shall be statically and dynamically balanced as per ISO.

4.3.6. Premises to be Air Conditioned

The following areas shall be air conditioned:

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Sl. No.	Name of Premise/Location	Type of Air conditioning System
1.	VFD Room, Control Room, Panel Room, IMCC Room, UPS Room, Battery charger Room, SWAS rooms, DM Plant Control Room, DM Plant RIO room, SCADA room, C&I Laboratory, Electrical Laboratory, DM Plant Laboratory, Shift I/c Rooms etc.	Centralized AC System with chilled water
2.	CEMS Room	Split AC System
3.	CW & ACW PH RIO room and any other RIO room	Split AC System
4.	Electrical / panel room in hot zone areas, operator's cabin of EOT crane & loco cars (as applicable)	Industrial Split AC system

4.3.7. Premises to be Ventilated

The following areas shall be ventilated:

Sl. No.	Name of Premise/Location	Type of Ventilation System
1.	Cable Cellar	Wet pressurized Ventilation System with Air Washer System
2.	Switchgear room	Wet pressurized Ventilation System with Air Washer System
3.	M/c Hall (A-B bay)	Wet pressurized Ventilation System with Air Washer System
4.	Battery Room	Exhaust Ventilation System with Tube Axial Fan
5.	Pump Houses	Exhaust Ventilation System with Tube Axial Fan
6.	Compressor House and DG Room	Exhaust Ventilation System with Tube Axial Fan
7.	Toilets at Control room / plant office building, Electrical and Mechanical Store Room	Exhaust Ventilation System with Propeller Fan

Notes:

a) The above lists are only tentative. Any other area that needs Air conditioning or ventilation and not covered above shall also be provided with necessary air conditioning and ventilation facilities within the battery limit. The Bidder shall include all other item / work not specifically mentioned in the specification but are required for the completion of the project in all respects within battery limits in the scope and any exclusion to this effect is not acceptable.

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b) Electrics and Instrumentation for ACVS are included in scope of the Successful Tenderer.

4.3.8. Description of Air Conditioning System

Centralized Air Conditioning system with chilled water shall be envisaged for the list of premises as mentioned above. Chilled water as per requirement will be made available at the T.O.P for use by the successful tenderer to serve the requirement of AHUs planned to be located at different premises.

Water cooled packaged AC with 100% standby shall be provided for isolated area(s) which are not covered under the above mentioned Centralized Air Conditioning system and whose cooling load is > 6TR. The same shall be decided during detailed engg.

Remotely located control / electrical rooms (with cooling load $\leq$ 6 TR) shall be served with Split AC (n working + 1 standby fashion).

4.3.9. Specification of Equipments and Accessories

a) Air Handling Unit

The air handling units shall be draw through type. The housing/casing shall be of double skin construction. The frame work shall be extruded aluminium profile frames and peralluman nylon glass fibre reinforced corner joints. Double skin sandwich panels shall be fabricated from inside with 0.63 mm (24g) galvanised sheet steel and outside with 0.63 mm (24g) high polymer polyester coated (pre painted) galvanised sheet steel with protection films on top. The 25thk. panels are of PUF injected with PUF density of 40 kg/m3 resulting in high rigidity and sound attenuation characteristics.

Suitable door with SS/chrome plated hinges shall be provided for access to various panels for maintenance. The complete housing shall be mounted on steel channel framework. Drain pan shall be constructed from 16G (min.) GI sheet with necessary bi-directional slope to facilitate fast removal of condensate. Necessary supports shall be provided to slide the coil in the drain pan. Outlet shall be provided on both sides of the drain pan. The AHU shall comprise of the following:-

Pre-filter section.
Cooling coil section
Fan section

Filter section shall house 48-50 mm thk. pleated filters conforming to EU-3 Class. These filters are vertically arranged in the frame and all mounted directly on AHU for ease of removal.

Coil section will have cooling coil manufactured from hard drawn quality copper tube with mechanically bonded aluminum fins. The coil should be 4 / 6 row deep. Drain pans (thermally insulated) are to be provided for cooling coil. Drain pan shall be made of minimum

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16G G.I. sheet. Face velocity of coil shall not exceed 2.5 m/sec and pressure drop across the coil shall not exceed 15 mm WC. Water carry over from the cooling coil shall be arrested, by providing mist eliminator section, if so desired. The minimum wall thickness of cooling coil tube shall be 26G and minimum number of fins shall be 10 per inch with thickness (fins) 0.16 mm (Min.). The fins of the coil shall have a mild ripple with die formed directional guide channels to improve heat transfer efficiency.

Fan shall be of centrifugal, forward curved,multiblade double width double inlet type. The wheel & housing shall be fabricated from heavy gauge galvanised steel. The fan section is mounted above the coil section.

b) Water Cooled Packaged Air-Conditioner

The air-conditioner will be designed for continuous duty. The package air conditioner will comprise of compressor, condenser, cooling coil, refrigerant circuit, blower, air filter, electric drive, instruments & controls and other standard accessories assembled in steel cabinet.

The compressor will be hermetically sealed scroll, mounted on anti-vibration pads & dynamically balanced.

The condenser will be water cooled shell and tube type with effective surface area for heat transfer taking into consideration the scale factor of 0.0006 for water side and optimum number of passes to achieve desired duty conditions. Provision will be made in the steel cabinet for tube side cleaning during maintenance. The condenser will also serve as refrigerant receiver of refrigerant circuit with fusible relief valve.

Cooling coil will be direct expansion type with integrally finned copper tubes and fitted with equalising distributors to ensure equal amount of refrigerant in each circuit. Condensate drip pan will be provided below the cooling coil for collecting the condensate.

The refrigerant circuit will be completely piped at factory and charged with required amount of refrigerant. The circuit will comprise of thermostatic expansion valve, distributor, liquid strainer, liquid line shut off valve, dehydrator etc. The circuit will be protected with safety devices such as high and low pressure cut-outs, fusible plug, water flow/ differential pressure switch, oil safety switch, time delay relay etc. to protect the unit from damage due to sudden and serious fluctuations in operating conditions.

For control of temperature and humidity of the conditioned premises, thermostat and humidistat will be provided in the package A.C. plant room in the return air path.

The centrifugal blower will be designed for distribution of the conditioned air through the network of duct and supply air diffusers. The impeller will be of forward curved, dynamically balanced for low noise and vibration free operation. The fan will be coupled with motor by V-belt and mounted on anti vibration mounting.

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The necessary control and instruments include thermostatic expansion valve, sight glass, strainer, cooling thermostat, heating thermostat, humidistat, dehumidifier, strip heater, shut off purge valve and drain valve, dial type pressure and temperature gauges etc..

The pressure gauge will be with isolating cocks/ valves. Flow/ differential pressure switch will be installed in condenser water lines to stop the compressor while water supply stops. Strip heater will be installed in the supply air duct at the discharge end of package AC unit and the strip heater will be interlocked with the blower of the package AC unit to prevent independent control/ switching of heaters.

The blower and the evaporative coil sections of the package AC unit will be thermally insulated to minimise thermal leakages. The unit will be supplied with rubber pads for installation on PCC pedestals.

c) Split Type Air Conditioner (with 5 star BEE rating)

Indoor Unit:

1. Type of mounting – Wall mounting
2. Fan Speed regulation – Not less than 3 speed regulation
3. Temperature control – Through thermostat electronic control

The indoor unit shall have an elegance appearance and adjustable louvers for the diversion of airflow.
The unit shall be provided with the facility for draining the condensed water to the nearest drain, control for switching on / off the fan motor, speed regulation and temperature etc. The unit shall be supplied with a remote.

The unit shall be mounted properly in position and necessary electrical wiring, 5 KVA stabilizer, switchgears, insulated copper tubing and any other accessories required for erection & commissioning shall be provided.

Outdoor Unit:

The refrigerant shall be environmental friendly refrigerant..

Compressor shall be hermetically sealed with internal overload protection, energy efficient and suitable for 230V, 50 cycles/sec, single phase AC Supply.

The outdoor unit shall be mounted on a fabricated frame at an appropriate location in consultation with the Client / MECON. The outdoor unit shall be connected with the indoor unit by means of insulated copper tubing.

Special Features:

1. The indoor unit of the Split AC unit shall have the local as well as cordless remote control with the following features:

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a) Timer setting
b) Louver angle position
c) Swing operation
d) Temperature setting.
e) Blower fan motor on / off control
f) Fan speed regulation
g) LED display for room temperature, setting temperature and timer
h) Power on indicator

2. Also the outdoor unit shall have delayed restart for preventing immediate restart in case of frequent power failure to safeguard the compressor motor.

d) **Split AC (for hot zone application / area) shall be of Industrial grade.**

e) Condenser cooling water and chilled water piping with accessories

Medium class GI piping is to be used as per IS: 1239 for interconnecting water piping network

Pipe fittings like bends, elbows, flanges, sockets, nipples., etc. will be as per relevant IS/BS standards.

Drain piping network is to be included as required for condensate drain, with isolation valves at proper places.

f) Dry Panel Filters

Dry panel type air filter shall be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It shall be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It shall be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel shall be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air shall not exceed 1.8 m/sec. The resistance of air filter shall not exceed 10 mm WC when dirty. Efficiency of the filter shall not be less than 90% down to 10 microns. The whole filter and frame assembly shall be mounted at the wall.

g) Duct Work

Supply air duct of G.I. construction is to be connected with air handling fan / Package A.C. fan outlet with flexible connection. The duct will supply conditioned air to the served premises.

Supply air duct will be fabricated from GI sheet of minimum 1 mm thick as per IS: 655 standards. The ducting will be properly reinforced and braced to prevent sagging, buckling or vibration.

h) Supply Air Diffusers

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Supply air diffusers will be Square/rectangular in shape for air-conditioning application. The throat of a diffuser will be connected with collar piece provided at the duct bottom for holding the diffuser as well as for supply of air. No part of diffuser will project into the main duct. Each diffuser will be provided with volume control damper. Each diffuser will comprise of fixed plate, damper blade, damper blade operating knob, spindle, connecting rod etc and shall be of removable core type duly powder coated. The diffuser bottom should flush / match with the false ceiling. False ceiling will not bear the load of any diffuser. The load of any diffuser will be borne by the duct and collar. Each diffuser will be powder coated with appropriate colour to match with the colour of the false ceiling. The diffusers will be true to shape and will be checked with level gauge before being secured in position. No distortion or warping is permitted.

i) Return Air Duct

In general the air supplied in the served premises will return above false ceiling through the return air slit of 50mm / 75mm (as required) all around false ceiling along the walls of the served premises.

j) Strip Heater Box

Strip heater box will comprise of finned heater, mounting plate, heater box/ casing made of 20 SWG G.I. sheet, cable terminal, terminal box with handle, 40x40x3 MS angle flange/ frame. Strip heater box will be placed/ inserted in supply air duct. Safety thermostat will be mounted on strip heater package to prevent overheating. Strip heater box assembly shall be a pre-fabricated unit with all its terminals and controls pre-wired.

k) Make Up Air Filter With Damper

Make up air for packaged air conditioner / AHU will be drawn from ambient through filter and volume control damper.

l) Insulation

Acoustic insulation

Acoustic insulation will be provided in the supply air duct upto 5m from the outlet of packaged AC unit / AHU.

For applying acoustic insulation inside duct hot bitumen/ cold adhesive will be provided at the clean inside surface of duct. Then 25mm thick mineral wool will be provided. To hold the insulation 30 SWG perforated aluminium sheet will be provided and riveted with duct. Perforation will be of 5mm □ and 8 to 10mm center to center distance.

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Thermal insulation

Thermal insulation will be provided on a portion of supply air duct, pan humidifier, drain pipes connected with insulated equipment etc. Thermal insulation of tail end duct will be provided to avoid condensation of moisture on the outside surface of the duct. The return air duct outside conditioned premises will also be insulated.

For applying thermal insulation, the outside surface of the duct/ pipe should be cleaned first, then hot bitumen/ cold adhesive should be applied on the clean surface. Then 50mm thick insulation material (mineral wool mat) with wire netting on outside will be provided. Then polythene with 50mm overlap will be sealed with adhesive. The polythene will be covered with 26 SWG aluminium sheet. All joints will be locked with self locking screw at a pitch of min 100mm.

m) Flexible Connection

Suitable flexible connection of tarpaulin will be provided at blower discharge line above multi louver damper.

n) Multi louver Damper (M.L. Damper)

Multi louver damper (M.L. Damper) will be provided on the AHU unit and below flexible connection in the supply air ducting. The damper blades/ louvers will be provided with external operating links for manual operation of the damper to control air flow. The damper will be made of GI sheet with MS frame. The fully close/ open/ partial closing position of the damper will be marked on the damper casing.

o) Thermometer and Pressure Gauge

Dial type (150 mm) mercury in steel thermometer will be provided for measuring the water temperature at inlet & outlet of condenser. The range of thermometer will be 0-100oC.

Dial type (150 mm) pressure gauges will be provided at inlet as well at outlet of condenser water lines.

p) Cooling Tower

Induced draft type, FRP cooling tower shall be provided for the cooling of condenser water. Accordingly cooling tower shall be selected with respect to condenser capacity. Fan speed of cooling tower shall not exceed 500RPM for chilled water plant and 750 RPM for packaged A/C plants.

The capacity of the cooling tower basin shall be adequate to take care of the entire cooling water required for the air conditioning plant. Only make up water shall be made available from the circulation network within a distance of 10m.

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The cooling tower shall be mounted on masonry pillars on the roof of the building. The vibration limit for the cooling towers shall be limited by the requirements of VDI 2056.
The cold water basin shall be of FRP construction. Cooling tower basin shall have accessories and connections for make up, quick fill, drain and over flow. Ball and float valve is to be provided for make up water line. Basin capacity shall be equivalent to at least 12mins. Circulation capacity of the system.

Eliminators shall be provided in removable sections and installed in the cell of the tower. The number of deflections in the eliminators shall be so arranged as to limit the drift loss to 0.01% of the circulated water.

All the fasteners shall be of stainless steel or hot dip galvanised steel. Rubber / Neoprene gaskets must be used on all bolted joints as a seal against water leakage.

Motor of induced draft fan shall be of weather proof construction.

The cooling tower shall be provided with fan, drive motor.

The cooling tower shall be complete with ladder for maintenance and service requirements

q) Valves, Strainers, Thermometers and Pressure Gauges

Gate Valve

1.	Type	:	Gate valve with non-rising spindle & bolted bonnet
2.	Body	:	Below 50 mm Bronze. 50mm & above Cast iron as per IS: 210-1993,GR.200
3.	Bonnet	:	Bolted
4.	Spindle	:	SS as per AISI 410
5.	Disc	:	Cast iron as per IS:210-93 GR 200
6.	Body seat ring &	:	SS as per AISI 410 Disc facing ring
7.	End connections	:	Below 50 mm - Screwed. 50 mm & above - flanged end, to be drilled as per ANSI B.16.5
8.	Pressure rating	:	PN = 1.6 N/mm2
9.	Flange facing	:	Flat Face
10.	Manufacturing std.	:	IS:778/ IS:780/ IS:2906
11.	Bolts & nuts	:	Black Hexagonal bolt with nut as per ASTM307 Gr B.
12.	Gaskets	:	Compressed Asbestos Fibers to IS-2712-1979 1.5 mm thick
13.	Hand wheel	:	CI Gr 200 as per IS : 210 - 1993
14.	Packing	:	Asbestos
15.	Companion Flanges	:	ANSI B16.5 Class 150
16.	Hydrostatic testing	:	As per relevant IS & Pressure rating of PN 1.6
17.	Test certificates	:	For Physical/chemical analysis & metallurgical tests for body parts , Hydro testing

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18.	Service	:	Re-circulation water/ Make up water/chilled water

Globe Valve

1.	Type	:	Globe valve for water supply pipelines
2.	Body/Bonnet	:	Bronze As per IS : 318 Gr 2
3.	Disc	:	-- do --
4.	Stem	:	Brass as per FHTB 1 of IS 6912
5.	Hand wheel	:	CI FG 200 as per IS 210 RA - 93
6.	Gland, Gland nut,	:	As per IS 318 Gr 2 spindle nut
7.	Gland Packing	:	Asbestos
8.	Pressure rating	:	PN 1.6 N/mm2
9.	Manufacturing std.	:	IS : 778 : 1984 (RA 1990)
10.	Max. Operating temp	:	50 0 C
11.	Operation	:	Manually operated hand wheel with open and close Direction indication.
12.	End connection	:	Screwed as per IS-554 upto 40 mm except otherwise mentioned. Flanged end for 50 mm and above.
13.	Special features need	:	1) Arrow indicating flow direction 2) Embossed nameplate-giving details of tag nos., type and size.
14.	Service water	:	Re-circulation water/ Make up water/chilled
15.	Hydrostatic Testing	:	As per relevant IS and pressure rating of PN 1.6

Non-Return Valve

1.	Type	:	Swing check type
2.	Body	:	Cast iron as per IS: 210-1993 GR. 200.
3.	Cover	:	- do -
4.	Hinge	:	Cast iron as per IS:210-1993GR.220.
5.	Hinge pin	:	HT brass IS : 320 HT-2
6.	Body Seat Ring & Disc ring	:	IS : 318 Gr 2
7.	Disc	:	C.I as per IS : 210 – 1993 Gr.200
8.	Gasket	:	CAF gasket as per IS:2712-1979 of thickness 1.5 mm
9.	End connections	:	Flanged end . Drilling as per ANSI B16.5
10.	Pressure rating	:	PN = 1.6 N/mm2
11.	Manufacturing Std	:	IS: 5312(Part-1)-1984(RA'90)/BS-5153-1991)
12.	Bolts & Nuts	:	Hexagonal type as per IS:1367-1967 Cl.-4.614.4
13.	Companion Flanges	:	ANSI B 16.5 class 150
14.	Hydro static testing	:	As per IS: 5312(Part-1)-1984 (RA'90)/ BS 5153 (1991) and pressure rating of PN-1.6
15.	Test certificates	:	For Physical/chemical analysis & metallurgical tests for body parts , Hydro testing

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16. Service : water/chilled water

4.3.10. Description of Ventilation System

4.3.10.1. Centrifugal Fan

These are used for ventilation system . The fans shall be of limit load design. The fan shall be of rugged steel construction and suitable for industrial duty condition. Fan housing shall be of welded construction and provided with flanges at inlet and outlet sides for duct connections. The housing shall be provided with lifting eye for ease of handling and bolted type access door.

The fan unit shall be reasonably noise and vibration free in operation. The noise level for fan and motor assembly at 1 meter distance shall be limited to 85 dB (A).

The fan shall be SISW type as per requirement. The fan shall be both statically and dynamically balanced.

The fan impeller shall be backward curved.

Variable in let vane (VIV) damper shall be provided at the fan inlet.

Drain connection shall be provided at the lowest point of scroll.

Fan bearing shall be of self-aligning, heavy duty type. Bearing shall be selected with ample safety factor for longer life.

Sufficient number of suitable vibration isolators of approved make shall be provided to ensure isolation of vibration from the equipment to foundation.

Fabricated steel bracket of M.S. angles, channels and chequered plates shall be provided to take static and dynamic load of the fan and motor assembly.

Anchor bolts, nuts, foundation plates and inserts shall be supplied with the fan. The fan shall be designed to permit interchange ability of parts and ease of access during inspection, maintenance and repair.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

The fan shall have following minimum thickness of materials for different parts unless otherwise specified.

a) Capacity up to 30,000 m3/hr :

Casing : 2.5 mm (minimum)
Back plate : 3.15 mm (minimum)

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Impeller : 3.15 mm (minimum)

b) Capacity above 30,000 m3/hr and up to 70,000 m3/hr

Casing : 3.15 mm (minimum)
Back plate : 4 mm (minimum)
Impeller : 4 mm (minimum)

c) Capacity above 70,000 m3/hr

Casing : 6 mm (minimum)
Back plate : 8 mm (minimum)
Impeller : 6 mm (minimum)

4.3.10.2. Air Washer Unit

General

Air washer unit shall comprise intermediate chambers at inlet and outlet and cell deck pad chamber with water tank. Adapter section shall be provided for connecting air washer unit with other equipment. Descriptions of these items are given below:

The evaporative cooler shall be a self-contained, single skin housing unit consisting of MS intake louver of 75 mm deep with bird mesh, dry filter section, wet section and fan section. The dry filter shall be 6 ply HDPE as specified. The wet section shall consist of cooling media, water delivery system and sump including piping. The fan section shall consist of fan with motor, drive arrangement to deliver specified air volume against specified static pressure.

Housing

The housing shall be constructed from 16G GSS whereas the tank shall be of SS304. Hinged access panel shall be provided in the fan section of the housing on both sides. The access panel shall be gasketed or formed to preclude air or water leakage into the interior of the housing. The opening shall provide easy access to the blower to allow for service of the motor, belt adjustment, bearing and possible shaft replacement. The housing shall be airtight and waterproof.

The wet section shall consist of a sump, sides and top. A side lift – off or hinged panel for media access and service of the float valve assembly for make-up water shall be provided. Removal and replacement of the media can be made through either a side lift off panel, top removal, intake or discharge side of the section as the case may be. The wet section shall be mechanically attached through the frame work to the fan section housing and shall be supported across it's entire width.

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Internal components of the wet section shall be cooling media, water delivery system, internal plumbing including a header pipe, make –up water, overflow and drain fittings.

Fan Section

The fan shall be heavy duty centrifugal type, DIDW backward curved impeller blades with non- overloading characteristics and shall be capable of delivering air volume at external static pressure as per requirement. The fan shall be AMCA certified for performance, noise level with balancing grade of G6.3. The fan shall have solid, ground and polished C45 steel shaft with self-aligning type bearing on both ends.
Vibration isolation shall be provided under the fan and motor and shall be of spring type. Isolators shall be selected for minimum deflection. Flexible neoprene rubberized steel impregnated connection shall be provided between the fan discharge and the housing at the outlet duct connection.

Wet Section

Sump construction in wet section shall include TIG (fusion) welded corners and joints. The sump shall be leak proof without the use of fillers, sealants or coatings. A media support channel shall be included. This channel shall extend across the full width of the media. The channel shall provide a minimum of 50% open area for water to flow freely from the media into the sump.

An air bypass inhibitor plate shall be provided from the intake bottom of the media and designed to preclude any untreated air flow under the media.

Stainless steel couplers with female pipe thread shall be welded into the sump and side to provide for make-up water, overflow and drain. Make up, overflow and drain connection of suitable size shall be provided.

Water distribution system shall be pump re- circulating system with mechanical float valve assembly to maintain water level in the sump. A bleed – off system shall be provided. Bleed-off rate shall be minimum of 20% of evaporation rate. Pump shall be sized to deliver water flow rate at the head and pressure required. Flow rate shall be determined at three (3) times the evaporation rate plus the bleed-off rate. Pump shall be vertical submersible type of SS construction. One working plus one standby pump shall be provided for each air washer.
Water distribution system shall incorporate perforated SS deflector trough to redirect the water from the header pipe discharging upwards back on to the media to attain even distribution across the full width of the media. A union shall be provided in the riser pipe below the header pipe to facilitate removal of the header pipe.

Cooling media shall be celdek or glacier-cor or approved equivalent imported makes having rigid media12” thick . This media shall be cross- fluted pad of cellulose material impregnated with anti-rot slats and rigidifying saturants and wetting agents with at least 123 square feet of evaporative surface area per cubic foot of media. The transverse flutes shall be 60 degree and 30 degree with water flow in the direction of the 60 degree flute against the air flow and air flow in the direction of the 30 degree flute with the direction of air flow. Media shall have no

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more than 0.7" w.g. air pressure drop at 500 feet per minute face velocity and shall develop a saturation efficiency of not less than 95% for 12" thick media.

Media access and removal shall be accomplished through a removable side or top panel provided for this purpose or from the intake or discharge side of the media by removing retaining rails provided for media support and removal purposes as specified.

Dry Filters

A Dry filter stage will be provided to cover the entire intake face area of the cooling module. Filters are extended surface, pleated type, with 90% average dust arrestance efficiency, 2" thick cleanable type with maximum velocity of 500 FPM. Filters shall be removable from the intake side of the frame using bracketless lift and remove rack system or side removable from a hinged panel provided for this purpose.

Low Water Level Pump Protection

A low water level protection system with float type level switch shall be used to provide dry run protection for the pump.

Moisture Drift Eliminator

A moisture drift eliminator stage will be provided to prevent entrainment of water droplet in the air stream from the cooling media. The mist eliminator shall be made of HDPV.

Magnehelic Gauge

Magnehelic differential pressure gauge shall be provided to measure the pressure drop across the cooling media to indicate the change in the resistance to air flow which relates to the cooling media condition. The detector tubing shall be placed immediately upstream and downstream of the media. Gauge shall be mounted externally on the unit for manual reading of the pressure drop.

Dial type (150mm) mercury in steel thermometers shall be provided for measuring the water temperature (basin), temperature of outgoing air from the air washer. One dry and wet type thermometer shall be provided for installing in the served premises.

Dial type (150 mm) pressure gauges shall be provided at the outlet of the pump along with its dry run protection.

4.3.10.3. Tube Axial Flow Fan

These fans shall be of heavy duty (continuous) type and of two kinds, as per service requirement as follows:

a) Wall mounted supply air fan, & b) Wall mounted exhaust air fan.

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Axial fan design shall confirm to IS: 3588–1987 (Reaffirmed 1994).

The fan shall have multi-bladed cast aluminum impeller with short duct casing while the wall exhauster / wall mounted supply air fan shall have cone inlet suitable for ducted / free discharge of air. The fans shall be capable of withstanding the stresses which may be experienced during normal operation under the condition which it is required for and during over speed test. The noise level shall not exceed 85dB (A) at 1.5m distance from fan casing.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed. The speed of the fan shall be limited to 1500RPM for fan with diameter 600mm or less and 960RPM for fans with diameter more than 600mm to limit the noise generation.

Impeller

The impeller shall be of cast aluminum alloy construction of high efficiency aerofoil section blades. The fan impellers shall be cast in one piece, finished all over and carefully balanced both statically and dynamically as per ISO – 1940. Finally the assembled rotor shall be dynamically balanced.

Casing

Axial flow fan casing and their components shall be suitable for outdoor installation. The casing shall be minimum 3.15 mm thick. The casing shall be provided with flanges at inlet and outlet. All nuts & bolts associated with it shall be of zinc or cadmium plated. Easily removable inspection cover having galvanised fly nut shall be provided. The covers shall be located such that the grease nipple for all bearings, and in particular motor terminals are easily accessible through the cover.

Installation

All the TA Fans shall be provided with suitable ISMC frame work bracket for fixing with building column / wall openings. In no case fans shall be supported within the brick wall openings alone. Wall bracket shall be fully grouted / welded with wall insert mounted on locally made RCC block within brick wall.

Hood and Cowl

a) Roof exhauster/supply air fans shall be provided with hood for protection against rain and other contingencies. It must ensure no dripping of rain water under any circumstances and will have low pressure drop of air. The hoods shall be provided with a heavy gauge expanded metal bird screen.

b) Rain protection cowls shall be designed to suit wall exhausters for protecting fans from rain. The cowls shall be provided with bird screen of heavy gauge expanded metal netting. The rain protection hood & cowl shall be fabricated from minimum 14G thick MS sheet (Hot dip galvanised).

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Coned Inlet

Wall exhausters shall be provided with coned inlet made of MS 2 mm thick or 16G, GI sheet.

Inlet Screen

Inlet screen shall be manufactured with minimum 14 SWG galvanised wire knitted in 25 mm square mesh. Suitable flanges to protect the edges of the screen shall be provided.

Fans for Special Application

These fans & motor when used in fume extraction system shall be of spark proof or flame proof construction. Fan impeller and inside surface of the casing shall be epoxy painted. In case of exposure to acid fumes, the fan along with drive motor, accessories & supports etc. shall have acid proof painting.

Fan Drive

All direct drive axial flow fan impellers shall be directly mounted on extended motor shafts special constructional features shall be applicable as for fan. Alternatively as per job specification requirement bifurcated type V-belt drive may be considered.

Materials of Construction

The following materials shall be used for the construction of various parts:

a)	Impeller	:	Cast Aluminium Alloy
b)	Shaft	:	EN-8 as per BS-900 or its equivalent
c)	Fan Scroll	:	Heavy gauge M.S.
d)	Fan Supports, Frames	:	M.S. of adequate thickness and Structures
e)	Coned inlet for wall Exhausters/supply fans	:	M.S. 2mm thick
f)	Dampers	:	M.S. of heavy gauge
g)	Connection pieces	:	Galvanised/M.S. unless otherwise specified
h)	Bolts and Nuts	:	Galvanised/M.S. unless otherwise specified
i)	Rain protection cowls, hoods and casing for wall & roof exhausters	:	GI/MS sheet

4.3.10.4. Propeller Type Axial Flow Fan

This type of fan is used for general air exchange of the premises. The fan shall be heavy duty and wall mounted type. Fan impeller blade shall be of aerofoil section and mounted directly

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at the motor shaft. The RPM of the fan shall be restricted to 1500 RPM. Noise level should not exceed 85 dB(A) at 1 m distance. Air entry shall be from motor side. Louvre shutter/self acting damper and rain cowl shall be provided at the outlet side of fan to prevent back draft. The fan shall be provided with fixing frame, supporting lugs and other standard accessories.

4.3.10.5. Dry Panel Filters (ACVS system)

Dry panel type air filter shall be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It shall be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It shall be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel shall be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air shall not exceed 2.0 m/sec. The resistance of air filter shall not exceed 10 mm WC when dirty. Efficiency of the filter shall not be less than 90% down to 10 microns. The whole filter and frame assembly shall be fitted at the inlet side of wall mounted tube axial flow fan. For air washing systems, the filter shall be fixed at air washer entry with suitable access for cleaning. Fresh air inlet shall also have filters for efficiency 80% down to 20 microns.

4.3.10.6. Ducting work

All ducting work for air flow from / to fan shall be fabricated from GI sheet as per IS : 655-2006. The supply air duct shall be of suitable size, selected for the specified range of velocity.

All ducting work shall be properly reinforced to prevent sagging, buckling or vibration. All joints shall be flanged. Flanges made of angle shall be provided at 2.5-3 m interval.

The interior of all ducts shall be smooth for free flow of air. The radius to bend shall be preferably 1.5 D. Guide vane shall be provided in all large duct bends and bends with radius less than 1.5 D for proper air flow.

Access eye for measurement shall be provided in ducting at convenient locations. Nut, bolts, washers & gaskets required for duct-work and duct fitting shall be supplied.

All Exposed ducts shall be thermally insulated.

Adjustable Louver Grills (Supply Air Grills)

1.00 mm GI sheet shall be used for the manufacture of grills. All grills shall be true to shape and shall be checked with a level gauge before being secured in position. No distortion or warping is permitted.

All duct mounted grills shall be complete with natural rubber gaskets and flanged holding frames of suitable design for the intended installation. They shall be mounted on collar extending from the duct. No part of grilles shall project into the main duct. The adjustable louvers grills shall be provided with volume control damper as well as double deflection flap/ grill for direction control.

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Self Acting Damper (Gravity Damper)

Self-acting dampers are provided to maintain pressurisation inside the premises. The damper shall be of gravity type designed such as not to allow infiltration of air from outside. The damper shall be multi blade type made of Aluminium flaps of not less than 24G thickness and MS frame. These shall be designed such that these shall operate when the pressure inside the premises exceeds 2-3 mm WC. It can operate in fully open or partial open positions.

4.3.10.7. Hangers & Supports for Ducting

All duct work shall be provided with adequate supports as required to ensure rigid support and to prevent vibration.

The fixing and supports interval shall not exceed 2.5 meters. Hanger rods having U-bend at top end and threading at bottom end shall be hanged/ attached to the ceiling by anchor fasteners/ expansion bolts. Hangers shall be trapeze type constructed from angle iron (as per size of duct) and hung from steel rods of adequate size. Ducts supported on wall and building structures shall be suitably fixed with angle, rod and flat etc. Wherever required duct support shall be taken from RCC beam/slab through properly sized anchor fasteners of minimum 10mm size to be used for fixing duct supports.

4.3.11. Electrical System

Refer Electrical Specification (Clause. 5.) of the TS.

4.3.12 Battery limit

The battery limit shall be as mentioned in the TS / TS drg. However, bidder may note that layout and sizes of the units, location shown therein are indicative and will be finalized during detailed engineering. Finalized drawings shall be made available to successful bidder. No claim or extra claim on such account shall be entertained after placement of order.

4.3.13. Commissioning spares

Commissioning spares including all consumables as required till successful commissioning and handing over shall be supplied by the Tenderer without any extra cost and the same is deemed to be part of the order.

4.3.14. Painting

Painting shall be done as per the TS Clause No. 8.

4.3.15. Inspection and Testing

Inspection and Testing shall be as per the TS Clause No. 7.

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04.3.14 Preferred makes

Preferred make list shall be as per the make list given in TS Clause No. 14.

4.3.15. Performance Guarantee Tests

After successful completion of trial run and liquidation of defects (if any), the system / individual components shall be subjected to the phase of commissioning wherein 72 hrs continuous trial run shall be achieved.

After successful commissioning, the system shall be subjected to performance guarantee tests (to be conducted by the Succesful tenderer in presence of Purchaser) after the following check /rectification:

- Capacity rating for all system components / system as a whole to be established during summer.
- To check the temperature during summer & monsoon in the air conditioned space.
- To check safe & healthy operation of all equipment including safety switches and electrical interlocks forming the total air conditioning & ventilation system.
- To check the power consumption of the motors for which power consumption limits are guaranteed at specified capacity of the equipment.
- Vibration and noise level to be measured for all rotating equipment.
- Noise of all rotating equipment shall be limited to 85dB(A) at 1m distance from the source.
- Any other relevant test parameters as found necessary.

PG test shall be conducted by the successful Tenderer at site during peak summer condition and when the plant (CPP) is operating under full rated capacity.

The Tenderer shall guarantee the performance of ACVS on the following accounts:

a. Capacity of AC system.
b. 23 ± 2 deg. C inside the premises served by AC System
c. Within 38 deg. C inside the premises served by Air Washer System with a positive pressurization of 2-3 mm inside the served premises.
d. No undue vibration of the equipment
e. No overheating of bearings
f. Noise of all rotating equipment shall be limited to 85dB(A) at 1m distance from the source

In case, the above designed / performance parameters for ACVS are not established by the successful tenderer, the Purchaser at his discretion may reject or accept the plant after assessing its technical suitability.

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4.3.16. Final Acceptance

All the equipment, plants and system under this T.S. shall be taken over by the Purchaser in running condition and final acceptance certificate shall be issued by the Purchaser when :

a) Performance guarantee tests in respect of sub-units as well as the unit/ system as a whole have been carried out and integrated performance guarantee values have been achieved as mentioned under above clause.
b) All other supplies and services have been completed w. r. to ACVS.
c) Final documentation (including As-Built Drawings) incorporating latest modifications as built have been submitted by the Successful Tenderer.
d) The Successful Tenderer has rectified all objections/observations / punch points mentioned in the commissioning certificate and (or) PG test in a definitive manner.

4.3.17. Data to Be Furnished by the Tenderer along with the Offer

a) Type of refrigeration / air conditioning system& Ventilation system
b) Total capacity of air conditioning system& Ventilation system
c) Indoor climatic condition shall be maintained
d) Total power requirement
e) Total space requirement
f) Total water requirement
g) Any specific design consideration
h) Noise level at 1m distance from the AC equipment
i) Noise level inside served premises

4.3.18. Technical Data to be furnished During Engineering

4.3.18.1. AHU

A. General

a) Make & Model No.
b) Type of unit (Horizontal/vertical)
c) Overall dimensions (mm)
d) Weight (kg)
e) Noise level at 1 meter distance in dB(A)
f) Vibration level
g) Vibration isolations details

B. Fan Section

a) Air quantity (m3/hr)
b) Total/static pressure (mmWC)
c) Fan speed (RPM)
d) Fan dia (mm) & number

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e) Balancing (Static and dynamic)
f) Fan motor (KW)
g) Type of fan/size/make
h) kW
i) Type of starter

C. Cooling coil

a) Coil fin materials
b) Tube dia (mm) and thickness
c) Fin size (mm)
d) No. of fins per inch
e) Outside coil surface (m2)
f) Face area (m2)
g) Row deep
h) ADP (deg C)
i) Bypass factor
j) Selected air velocity across coil (m/sec)
k) Make of cooling coil
l) Water through coil in m3/hr.
m) Water velocity through coil in m/sec.
n) Water coil pressure drop in kg/cm2
o) Water temperature in/out in degree C.

D. Filter section Pre filter

a) Type & make
b) Gross filter area (m2)
c) Velocity through filter (m/sec)
d) Pressure drop through filter when dirty & when clean (mmWC)
e) Efficiency with micron size
f) Filter box construction details
g) Overall dimensions & No. of filters
h) Fixing frame details
i) Recommended methods of cleaning

4.3.18.2. Centrifugal Fan

A. CENTRIFUGAL FAN

a) Make & Model No.
b) Quantity, no.
c) Type of blade
d) Capacity(m^3/h for HVAC application and Am3/hr& Nm3/hr for Dedusting, Combustion & process application)
e) Static pressure and total pressure, mm WC
f) Operating speed, RPM

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g) Critical speed, RPM
h) Shaft power, kW
i) Static &Total Efficiency, %
j) Motor rating, kW / pole
k) Fan Characteristic Curves
l) Impeller Diameter in mm
m) Impeller weight in kg.
n) GD2 value
o) Velocity at inlet & outlet of fan, m/sec
p) Static weight & dynamic weight of fan and motor, kg
q) Coupling details/V-belt details
r) Vibration level
s) Vibration isolator type & quantity.
t) Outlet damper size
u) Material of construction & thickness of scroll, blade, shroud,
v) backplate, shaft diameter in mm
w) Noise level at 1m distance in dB(A)
x) Bearing details
y) Acoustic lagging / silencer, if included :
Material of construction
Insertion loss
z) Overall size
aa) Drive Motor rating suggested w.r.to the hot & cold condition of operation
bb) Special constructional features, if any

B. Fan Drive motor details

a) Type & make
b) Voltage, phase & frequency
c) Rated power, kW
d) Speed, RPM
e) Starting/ pull out torque when inlet damper is closed & open
f) Starter details
g) Line current
h) Starting current
i) Overall efficiency
j) Class of insulation
k) Type of enclosure
l) Any other information

C. VIV damper

a) Make, model and type
b) Material of construction and thickness
c) Type of actuator
d) Motor kW/pole
e) Utility requirement

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f) Size of VIV

4.3.18.3. Axial fan

a) Make & Model No.
b) Quantity, no.
c) Type of blade
d) Capacity(m^3/h)
e) Static pressure and total pressure, mm WC
f) Operating speed, RPM
g) Critical speed, RPM
h) Shaft power, kW
i) Static &Total Efficiency, %
j) Motor rating, kW / pole
k) Fan Characteristic Curves
l) Impeller Diameter in mm
m) Impeller weight in kg.
n) Wheel dia
o) Velocity at inlet & outlet of fan, m/sec
p) Static weight & dynamic weight of fan and motor, kg
q) Coupling details/V-belt details
r) Vibration level
s) Air flow direction to be marked on the casing
t) Fixing details
u) Material of construction
v) Noise level at 1m distance in dB(A)
w) Bearing details
x) Special constructional features for explosive area / zone, if any

4.3.18.4. Air washer

i) Air washing chamber with water tank

a) Make & Model No.
b) Overall dimensions (mm)
c) Weight (kg) with and without water
d) Air flow capacity in m^3/h & Air flow velocity in m/s
e) Total Pressure drop, kgf/ m^2
f) MOC, diameter and numbers of spray header pipes and nozzles
g) Make up water requirement
h) Details of make up, over flow, drainage, supply and return water pipe lines
i) Saturation efficiency
j) Amount of water and its pressure at the nozzle
k) Material of construction and thickness of casing, tank, air distributor plate
l) Water tank capacity
m) Details of mist /droplet eliminator : MOC, material thickness and depth.

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ii) Intermediate chamber

Size, Material of construction & Thickness of material.

iii) Adapter section

Size, Material of construction & Thickness of material.

iv) Re-circulating water system

a) Pump capacity & head, motor KW
b) Details of piping, fittings, strainer, valves
c) Instruments – pressure gauge, temperature gauge, water flow switch

**** End of Clauses ****

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4.4. HANDLING & HOISTING FACILITIES

4.4.1. EOT Crane

The scope of work of the Tenderer shall consist of Design, Manufacture, Fabrication, Procurement, Inspection, Shop Testing, Assembly, Painting, Supply and Transportation to site, Unloading and Storage of consignment at site and Re-conservation, Erection, Testing and Commissioning of Double Girder EOT Cranes complete with their Electrical Equipment with all its accessories and attachments, Rail, Supporting Structure, Power Supply, Safety devices, Standard Accessories with Attachments and Controls etc.

4.4.1.1. The detailed Technical Specification of the above equipment is as follows:

a) DG EOT Crane shall be designed as per latest Indian Standard of IS: 3177 & IS; 807.
b) All brakes shall be DCEM Brake
c) Min. Size of LT Wheel shall be min.500 mm and CT wheel shall be min.320 mm.
d) For Double girder EOT cranes, LT drive shall be of two corner drive/four corner drive arrangement
e) All wheels shall be of solid type which shall be either of forged or rolled or cast steel. Material for wheel shall be 55C8 conforming to IS: 1875-1992 or 42CrMo4 or better (EN-8).
f) Straight and helical spur gearing shall only be used for all motions. All gears shall be hardened and tempered alloy or carbon with machine cut ground teeth in metric module system. All pinions shall be of nickel-chrome. The gears shall have positive addendum modification to improve contact & sliding conditions and to increase the bending strength of pinion and the surface strength of tooth flank by approximately30%.
g) List of spares for two (2) years normal operation and maintenance of the equipment.
h) The make of all equipment as well as bought out items shall be as per the list of acceptable makes.
i) The span, height of lift shall be decided during detail engineering.
j) The Tenderer shall also render all assistance to the purchaser in obtaining statutory clearance, if any from the concerned statutory authorities of that region.
k) Supply of drawings and documents.
l) No cast iron parts shall be used except for electrical equipments, Plummer block and no wood or combustible material shall be used unless specifically mentioned otherwise
m) All working parts requiring replacements or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.
n) Supply of maintenance tools and tackles with tool box for normal maintenance of the Crane. A list of maintenance tools and tackles shall be furnished along with the tender. The price of same shall be included on the price of Crane itself.

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4.4.1.2. Technical Parameters of EOT Crane

Sl. No.	Description	Qty.	Location	Remarks
1.	90/25t DG EOT Crane, Duty Class –M5, Speed m/min MH-8, AH-10, CT-20, LT-40 VVVF Drive, Cabin + Radio Remote Control	1	Turbine Hall	Cabin Controlled with split AC of 2TR capacity, Main Hook shall be Ramson Hook IS: 5749 -1970. Auxiliary Hook shall be as per latest IS: 15560.
2.	20T ,D.G.EOT Crane - Duty Class- M5 Speed m/min, MH-5, CT-20, LT-30 Cabin + RRC	1	CW Pump House	Hook shall be as per latest IS:15560.
3.	3T SG Under-slung Crane Speed m/min MH-5, CT-20, LT-30	2	Main Cooling Tower	Hook shall be as per latest IS:15560.
4.	3T SG Under-slung Crane Speed m/min MH-5, CT-20, LT-30	2	Auxiliary Cooling Tower	Hook shall be as per latest IS: 15560.

4.4.2. Electric Hoist

The scope of work of the Bidder shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site, supply and transportation to site, unloading and re-conservation at site, erection, testing and commissioning and performance guarantee of Electric hoist of various capacity complete with their Electrical Equipment with all its Accessories and Attachments, Mono Rail Structure , Supporting Structure, Power Supply, Safety Devices, Standard Accessories with Attachments and Controls etc.

4.4.2.1. The detailed Technical Specification of the above equipment are as follows:

a) The electric hoist shall conform to the latest applicable Indian Standard of IS: 3938.

b) The make of all equipment as well as bought out items shall be from approved make of ISP/MECON.

c) Supply of drawings and documents

d) Hoisting brake shall be designed to hold 1.5 times full load torque while trolley travel brake shall be designed to hold 1.25 times full load torque. All brakes shall have weather-proof enclosures. Coupling halves shall not be used as brake drums.

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e) DC Electro-magnetic shoe brakes shall be provided for hoist motion of 5T or more Capacity. For hoist motion of less than 5T Capacity, DC disc brakes may be used. For CT motion, DC disc brakes shall be used.

f) For Hoists of capacity 5 T & above, the motor (Foot mounted B3 type) shall be connected to its gear drive by a flexible coupling

g) No cast iron parts shall be used except for electrical equipments and no wood or combustible material shall be used unless specifically mentioned otherwise

h) All working parts requiring replacements or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

i) Suitable capacity electric hoist/ (capacity 1.2 times the heaviest part to be lifted) shall be provided for each crane & equipment as required for maintenance.

j) The track for electric hoist shall be provided by the Contractor. Also the capacity of the maintenance hoist shall be such that it can lift/ handle the rope drum and drive shaft assembly as a whole as well as motor and Gear Boxes.

k) List of spares for two (2) years normal operation and maintenance of the equipment.

l) Supply of maintenance tools and tackles with tool box for normal maintenance of the electric hoists. A list of maintenance tools and tackles shall be furnished along with the tender. The price of same shall be included on the price of EWRH(s) itself.

m) The Tenderer shall also render all assistance to the Purchaser in obtaining statutory clearance, if any from the concerned statutory authorities of that region

n) The Electric hoists shall be inspected and tested as per IS: 3938 – 1983

4.4.2.2. Technical Parameters of Electric Hoist

Sl. No.	Description	Qty.	Location	Remarks
1.	3t Electric Hoist, Speed m/min – Hoisting – 6, Travel – 20	1	Turbine Hall	For maintenance of 90/25t crane
2.	5t Electric Hoist, Speed m/min – Hoisting – 6, Travel – 20	3	One No. per Boiler for the maintenance of ID fans and FD fans.	For maintenance of ID fans & FD fans.
3.	2T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	1	Compressor room	
4.	2T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	3	DM Plant	
5.	2T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	2	ECS Building	
6.	2T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	1	Recycle Water Pump House	
7.	2T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	3	Industrial Water Pump House & SSF Area	
8.	3T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	1	Towards CW pump house side	

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Sl. No.	Description	Qty.	Location	Remarks
			for Screen Handling	
9.	2T Electric Hoist, Speed m/min – Hoisting – 3, Travel – 20	2	Sluice Gate Handling near Cooling Tower	

4.4.3. Battery Operated Fork Lift

The scope of work of the Bidder shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site, supply and transportation to site, unloading and re-conservation at site, erection , testing, painting, commissioning and performance guarantee of Fork Lift.

The make of all equipment as well as bought out items shall be as per the list of acceptable makes.

Sl. No.	Description	Qty.	Location	Remarks
1.	2t capacity battery operated Fork lift	2	Captive power plant	

4.4.4. Passenger cum Goods Elevator

The scope of work of the Bidder includes Design, Engineering, Manufacture, Assembly, Inspection and Testing, Painting at Manufacturer's Shop as well at site, Supply including dismantling for Transportation, Packing, forwarding, Loading and Transportation to site, Receipt, Unloading, Storage and Re-Conservation at site, Erection , Testing, Commissioning and Performance Guarantee of the Elevators at site complete with their Electrical Equipment with all its Accessories and Attachments, Supporting Structure, Power Supply, Safety Devices, Standard Accessories with Attachments and Controls etc.

4.4.4.1 The Detailed Technical Specification of the above equipment are as follows:

a) All necessary minor civil, mechanical and electrical works connected with the supply at site, storage at site, erection , testing and commissioning of the elevator shall be included in the scope of work. Requirement of fixers for lift well with load data shall be furnished by the lift supplier.
b) Scaffolding required during elevator erection shall be arranged by the Lift supplier.
c) Supply of drawings, documents and manuals.
d) The elevator shall be designed in accordance with applicable norms of latest Indian Standard of IS: 14665-2000 (Part 1, 2 & 3) and IS: 14665-2001 (Part-4).
e) The elevator shall be suitable for continuous 24 hours round-the-clock operation.
f) The make of all equipment as well as bought out items shall be as per the list of

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acceptable makes.

g) The elevator shall be equipped with all standard safety systems such as alarm bell/hooter in case of power failure, Automatic Rescue Device (ARD), battery backup for ARD & Emergency lights, hand wheel connected with motor shaft for manual lowering of elevator to the nearest landing level in case of power failure and failure of ARD., limit switches, indicators, over speed safety governor for car, emergency light fittings, fire man switch etc.

h) The motor for the elevator shall be squirrel cage induction motor with VVVF control for controlling the speed during starting and stopping at landings.

i) The minimum diameter of rope for cars and counter weight of passenger and goods lift shall be 12mm and shall confirm to IS 14665 (Part 4/Sec.8):2001 including all amendments. The Factor of Safety based on Maximum Static Load for car & counter weight ropes shall be at least 12.

j) The elevator control shall be through digital controls and VVVF drives.

k) The operation of the elevator i.e. Method of actuating the control shall be "Selective Collective Automatic Operation" as per clause 3.41.3 of IS-14665(Part2/Sec1):2000 with and without attendant. The controller shall be microprocessor based.

l) A signal indication shall be provided by the appropriate numeral (which shall be floor no./level of respective floor) being illuminated when the car is passing the corresponding floor.

m) The Automatic Rescue Devices (ARD) is meant for the purpose of bringing the lift car to the nearest landing door in case of power failure.

n) The lift shall be tested as follows.

o) Load test with 100% and 110% of rated load as per clause no.8.1.6 of IS 14665 (Part 2/Sec 1): 2000.

p) A static load test with 125% of rated load as per IS 14665 (Part 2/Sec 1): 2000 to check that the brake will sustain the car.

q) All other tests on electrical system as mentioned in IS 14665 (Part 3/ Sec 1 & 2) -2000 clause 11.

r) Any other test felt necessary by Purchaser and supplier to ensure proper functioning and installation of the lift.

s) Demonstration of the functioning of all safety provisions made available in the elevator.

t) All other inspection as per IS 14665 (Part – 5) – 1999.

u) List of spares for two (2) years normal operation and maintenance of the equipment.

v) Supply of maintenance tools and tackles with tool box for normal maintenance of the elevator. A list of maintenance tools and tackles shall be furnished along with the tender. The price of same shall be included on the price of Elevator itself.

w) The Tenderer shall also render all assistance to the Purchaser in obtaining statutory clearance, if any from the concerned statutory authorities of that region

x) Rack & Pinion Elevator shall travel at a speed of 40.0 m/min. However this shall be finalized during detail engineering.

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4.4.4.2. Technical Parameters of Elevators

Sl. No.	Description	Qty.	Location	Remarks
1.	Passenger Cum Goods Elevator of capacity of 2T	2	Power House Building	
2.	Passenger Cum Goods Elevator of capacity of 2T	3	One no. for Each Boiler	
3.	Rack and Pinion Elevator of capacity of 500 kg(Outdoor Operation)	1	Chimney	

**** End of Clauses ****

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4.5. FIRE DETECTION, ALARM & PROTECTION SYSTEM

4.5.1. Fire Protection System

An elaborate system of fire protection shall be provided to fight as well as reduce any occurrence of fire in various areas/units of the proposed Captive Power Plant premises. The system shall be planned in conformity with Tariff Advisory Committee guidelines, BIS, NFPA and other relevant standard/codes.

Major Facilities envisaged shall be as following:

i) Fire detection and alarm system (FDA) – Refer Clause no. 5.4.22.

ii) Fire Hydrant System – Refer Clause no. 4.2.2.6.

iii) Water spray system comprising of HVWS and MVWS.

iv) Automatic Clean agent gas system

v) Portable Fire Extinguishers

vi) Passive Fire Protection system

vii) Manual low expansion foam flooding system

4.5.2. Water Spray System Comprising of HVWS & MVWS

Systems shall comprise network of pipelines with distribution control units, open spray nozzles (capable of spraying water with medium velocity for cable premises and high velocity for oil premises and transformers), automatic fire detection cum alarm facility, deluge valves, on line strainers, instrumentation (pressure switches, limit switches, pressure gauges) gate valve & deluge valve housing / room etc. Bypass gate valves shall also be provided for each deluge valve.

A common pump house (Fire water pump house) shall be planned which shall house pumps for hydrant and water spray system. However headers for both systems shall be separate with interconnectivity with non-return valve and gate valves. The construction of Fire Water Reservoir, Fire Water Pump House (FWPH) and erection of all related equipments therein, shall be under the scope of the Tenderer.

The water spray system shall be designed as per TAC and NFPA guidelines.

4.5.2.1. Main Components of the System

The HVWS/MVWS System shall be provided with the following major components:

a) Water Supply at high Pressure
b) Arrangement of Spray Nozzles
c) Arrangement of Quartzoid Bulb Detectors (for HVWS & MVWS)
d) Deluge Valve

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e) Y-type Strainers just before deluge valve
f) Pipes, fittings and fixtures
g) Basket strainers in HVWS /MVWS system header
i) Pressure gauges, pressure switches and solenoid valves
j) Fire detectors
k) De-watering pumps

4.5.2.2. Operation of the System

Initially, delivery line should be pressurised upto deluge valve with the help of electrically driven Main Pump/Jockey pump and the water line pressure upto deluge valve should be maintained at around 10 Kg/cm^2. The Q.B. detector line should be pressurised with help of water which should be tapped from the header itself. Deluge valve clack is kept in horizontal position in normal condition due to balanced hydraulic pressure on two sides of the clack.

In case of transformer fire, temperature shall rise all around the transformer. On reaching a predetermined temperature quartozoid bulb detectors, which are installed on pressurised water line (water for which is tapped from the main header itself), shall shatter. As the bulb shatters, water in the detector line gets released through the detector openings and water pressure in detection line drops rapidly. This results in creation of pressure differential in the deluge valve and leads to latter's actuation. During this operation pressure in the water delivery line falls rapidly resulting in start up of main electrical driven pump. In case of power failure, pressure in the header shall go on decreasing causing start up of diesel engine driven pump.

In case of cable galleries / oil premises the actuation of deluge valves are effected by signal from intelligent addressable fire detection and alarm system provided in the premises. Cable galleries shall be provided with linear heat sensing cables and fixed temperature cum rate of rise heat detector (intelligent type) shall be provided for the oil premises. These have been described in detail in FDA specification. In the event of fire in the premises, the detection system shall give signal to Main Fire Alarm Panel (MFAP) which in turn shall actuate the solenoid of the deluge valve concerned. Each deluge valve shall be provided with local control panel with its normal power supply as well as battery backup with charging facility for 48 hours duration. Interface units in adequate numbers shall also be provided to transmit the signal/ control between each deluge valve and main fire alarm panel. All cabling, electrics complete in all respect shall be included in the Tenderer's scope. There shall be provision for manual operation of the system also by operating quick opening valves of each deluge valve.

Following signals shall be obtained on the local deluge valve panel and main fire alarm panel for each deluge valve.

a) DV has operated
b) DV/Solenoid valve failed to open
c) Low detection pressure
d) Fire signal

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4.5.2.3. Design Criteria for High Velocity Water Spray Systems (HVWS)

The High Velocity Water Spray System shall be designed as per the stipulation of TAC rules on the subject as well as NFPA's guidelines. Following salient parameters shall be followed by Tenderer for the design of the system.

- Water application rate – 10.2 lpm / m^2 of the surface area of the entire transformer including bottom surface, radiators etc.
- Water application rate – 10.2 lpm / m^2 of the surface area of the oil tanks and other oil facilities etc.
- The system shall be so hydraulically designed that the pressure at the hydraulically most remote projector in the network shall not be less than 3.5 bars.
- Max. permissible pressure in any projector = 5.0 bars.
- Velocity in the main header pipe shall not exceed 3m/sec & in the feed pipe after deluge valve shall not exceed 5 m/sec
- There shall be common header for (HVWS & MVWS) headers shall be inter-connected with a non-return valve in between so that hydrant system can be a back-up for the spray system.
- Q.B. detectors shall be installed in two rings one at top and another at bottom around the protected area of the transformers. Maximum spacing between detectors shall not exceed 2.5 m.
- Projectors shall be installed in rings encircling the protected area. One ring shall be provided at the top and subsequently rings for every 3 m from top to bottom shall be provided.

4.5.2.4. Design criteria for medium velocity spray system (MVWS)

The medium velocity water spray shall be designed as per the stipulation of TAC rules on the subject as well as NFPA's guidelines.

Following salient parameters shall be followed for the design of the system.

- Water application rate for cable racks – 12.2 lpm / m^2 of the exposed surface area of the cable racks.
- The system shall be so hydraulically designed that the pressure at the hydraulically remotest sprayer shall satisfy the following conditions:

For Cable Galleries/ cable tunnel

Pressure at remotest sprayer – not less than 2.8 bars

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- There shall be common header for HVWS and MVWS systems which shall be fed water from the pump dedicated for the spray system. The hydrant header and spray system (HVWS & MVWS) headers shall be inter-connected with a non-return valve in between so that hydrant system can be back-up for the spray system.
- The protected area shall be divided into several zones, each of which shall fed by individual deluge valve. In event of fire water shall be sprayed on the zone concerned (i.e. zone under fire) along with preceding and succeeding zones.
- Distribution of sprayers:

Sprayers shall be providing to spray water on both the top side and bottom side of the conveyor belts. Spacing between sprayers shall not be more than 4m.

The sprayers shall be installed in rows at the central aisle between the cable trays and spaced at not more than 3 m from each other.

Provision for manual operation of the system shall also be made to operate the system in case of failure of the automatic mode.
For the protection of deluge valves from mechanical damage and atmospheric conditions civil rooms shall be provided. Standard fence and door shall be provided in addition to illumination facility. Inside the buildings structural room can be provided with ceiling.

Water drainage is to be ensured particularly in cable tunnels / cable basement & oil premises where HVWS/MVWS system have been provided. In no case, water accumulated after spray would find its way to floors / equipments at lower elevations. Proper slope is to be provided in the cable galleries and other premises so that all the sprayed water flow through the specifically constructed drains and no water gets accumulated in the area. To stop water fall to lower elevation (below cable galleries / premises) all the openings shall be closed / properly barricaded.

4.5.2.5. Equipment Specification

Deluge Valve Assembly

Deluge valve assembly functions on differential pressure operation allowing quick opening of the valve and thereby rush of water to the protection system. The valve consists of inlet, outlet and priming chamber. The inlet and outlet chambers are separated from the priming chamber by the valve chamber and a diaphragm. In the `Set' position, pressure is applied to the priming chamber through a restricted prime line. The pressure is trapped in the priming chamber and holds the clapper on the seat due to the differential design. In the `Set' position the clapper separates the inlet from the outlet keeping the system piping dry. When the pressure is released from priming chamber, the clapper moves and allows the inlet water supply to flow through the outlet and to the fire extinguishing system. All component / equipment of the system including Deluge valve shall be UL / FM approved and marked.

The deluge valve assembly shall consist mainly of the following:

- Isolation valves on both upstream and downstream sides.

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- Inline strainer
- Deluge valve proper
- Actuator/pilot assembly
- Drain valve
- Pressure gauges
- Solenoid valve
- Deluge valve housing

The deluge valve shall be of resetting type, taking minimum time for resetting. The deluge valve shall be UL/FM/TAC/IS approved make.

Spray Nozzles (Projectors and sprayers)

Water spray nozzles for the system shall be of suitable orifice size and varying discharge angles to cover fully all the area supposed to be protected. The nozzles shall be of Stainless steel. The nozzles shall be normally open type with blowoff cap & internal strainer. Spray nozzles(projectors) shall bear UL/FM approval.

Strainer

Y type strainer shall be provided on the inlet side of each deluge valve assembly. The strainer shall prevent deposition of foreign particles in the valves and thereby malfunctioning of control valves. The material of construction of the strainer shall be of carbon steel and straining element shall be stainless steel.

Quartzoid bulb detectors

The Q.B. detectors shall bear UL/FM approval and shall have a temperature rating of minimum 79 degree centigrade. However the Tenderer shall take into account the temperature at which they shall operate.

Fire Detectors (Part of Fire Detection & alarm system)

For details refer the FDA system described elsewhere in the specification.

Pipes, valves & fittings (HVWS & MVWS)

Pipes and pipe fittings in general shall comply with the requirements of BIS codes. Piping layout must follow good engineering practice. Proper attention shall be given to obtain full functional requirement of piping system with a layout which provides sufficient clearance for other equipment and other personnel and easy access for operation and maintenance.

All piping shall be complete in all respects and shall consist of necessary valves, fittings, supports, air release and drain valves and other accessories. The air release and drain valves shall be provided at high and low points respectively. Each of the branch connection taken from the network shall be provided with an isolation valve.

Wherever over-ground pipelines are crossing roads and railway tracks, they shall be laid on pipe bridges to provide the necessary clearance for the traffic movement. A minimum

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clear height of 6.0 m above road top level shall be maintained.

All pipe work shall be designed to provide complete flexibility to prevent development of undesirable forces or moments at points of connection to equipment, at anchorages or at guide points, due to thermal expansion. Flexibility shall be provided by changes of direction or by use of bends, loops, offsets etc.

The specification of pipes are as below.

T.S. for Pipes between deluge valve and main header

i) Upto 150 mm nominal size - M.S ERW Black pipes conforming to IS-1239- 1984 Part-I (heavy grade) With Plain ends.

ii) 200 mm to 400 mm size - M.S. ERW Pipes conforming to IS-3589 -1973 but thickness as specified below

Nominal DiaO.D X Thickness in mm

DN 200 mm : 219.1 x 6.35
DN 250 mm : 273.0 x 7.14
DN 300 mm : 323.9 x 7.14
DN 350 mm : 355.6 x 7.14
DN 400 mm : 406.4 x 7.14

T.S. for Pipes and valves after deluge valve

The material of construction and manufacturing standard of pipes, fittings, valves, fasteners, gaskets, etc. shall be as described in table below:-

Nominal pressure (PN) - 10 kg/cm^2
Test Pressure (PT) - 15 kg/cm^2

S. No.	Items	Nominal dia.(mm)	Specification
1.	Pipe	65 and below	IS-1239 (Part-1) - 'Heavy, G.I.
		80	IS-1239 (Part-1) - Medium, G.I.
		100 to 150	IS-1239 (Part-1) - Medium, G.I.
		200 to 450	IS-3589 Gr.410 ERW pipe commercial quality or equivalent. Thickness same as in clause 11.02 (ii) above.
2.	Pipe fittings		A 234 Gr. IS-1239/3589/2062
2.1	Screwed fittings	65 & below	IS-1239 (Part-1) - Galvanised
2.2	Fabricated fittings		
	Bends	150 and above	Mitred bends with radius 1.5 DN from

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S. No.	Items	Nominal dia.(mm)	Specification
			black pipe.
	Tees/Crosses	150 and above	Fabricated from black pipes by smithing.
	Reducers	150 and above	Fabricated from black pipes by taper cutting and welding.
3.	Bolting	All sizes	IS - 1367
4.	Gaskets	All sizes	Sheets rubber to IS-635-`79 type-A, 3 mm thick compressed Asbestos to IS-2712-`79
5.	Flanges	All sizes	Slip on flanges to IS-6392 - `71 machined from Carbon Steel plates to IS-2002-`92 Gd. 2 with bore to suit pipe O.D.
6.	Valves		
	Isolation	50 & below	CI gate valves, screwed, as per IS-780 - `84 class - PN - 1.6
		65 to 300	CI gate valves, flanged as per IS- 780-84 class - PN - 1.6
		350 and above	CI gate valve, flanged as per IS-2906-`84, Class - PN - 1.6
	Throttling		
		50 and below	Gunmetal globe valve, Screwed, as per IS-778-`84 Class-2.
		65 to 300	CI globe valve with brass/bronze renewable seat rays flanged.

Fittings shall be supplied as per IS:1239-1992 Part II for pipes upto 150 mm dia and shall be fabricated from pipes for dia 200 mm and above.

Technical specification for valves

The valves & sluice gates shall be designed, manufactured and tested as per relevant Indian Standards or as per other International standards acceptable to the Owner and shall be suitable for the duty conditions specified below. All underground valves shall be provided with valve chambers with RCC covers. The size of chambers shall be suitable for easy maintenance of the valve. Complete civil work for this is in the Tenderer's scope.

S. No.	Items	Nominal dia.(mm)	Specification
1.	Isolation	Below 50	Forged Carbon steel gate valve, screwed as per API – 602 standard, class 800 # ASTM A-105, trim 13% Cr, Bolt/Nut – B7/2H, Socket end threading as per ANSI B.16.11 Gasket SPW S.S. 304 with CAF Hand Wheel - Cast steel

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S. No.	Items	Nominal dia.(mm)	Specification
		50 to 300	Cast Carbon Steel flanged gate valve as per standard API-600 class 150 # , Body & bonnet material ASTM A 216 Gr. WCB, Trim 13% Cr S.S, Spindle & Gland bush – A1S1 410. Hand wheel C.S, Gasket SW S.S-304 + LAF, flange drilled to ANSI – B.16.5 along with companion slipon welded flange (without hub) drilled as per B.16.5 and gasket, Nut & bolt etc. Hand Wheel - C.S.
2.	Throttling	50 and below	Gunmetal globe valve, Screwed, as per IS-778-`84 Class-2

4.5.3. Automatic Clean Agent Fire Extinguishing System

For protection of main control room including false floor & false ceiling, Automatic Clean agent fire extinguishing system (IG-541 / IG-55 / IG-100) shall be provided. This system shall function in automatic mode by actuation from Fire detection & alarm system in the respective premises. There shall be provision for manual operation also with a selector toggle. When detectors detect fire, the signal shall be communicated to the main control panel, which shows the address (along with location) of the actuated detector. On confirmation of fire by next detector falling in different software zone in the same premises, the respective Air-conditioning & Ventilation system shall first trip and evacuation alarm signal shall appear in the premises provided with these system followed by actual discharge of the gas(after time lag). The system shall be designed according to NFPA 12 and NFPA 2001. 100% reserve cylinders filled with gas and accessories shall be provided for all systems. Gas for performance demonstration shall be supplied for all systems. There shall be provision for switch over from main to reserve cylinders automatically from the panel as well as through toggle button.

All equipments/ components of the system shall bear UL/FMRC/LPCB/VDS listing and system shall have UL/FMRC/LPCB/VDS approval. Software used for calculation of pipe sizes and pressure drops shall have UL/FMRC/LPCB/VDS approval. In case European standards are followed, then gas concentration quantities shall be as per European ISO specification.

Approval certificate for the gas from the approving agency as well as from manufacturer's certificate highlighting the quality of the gas.

System shall also be provided with MRPS, Inhibitor, evacuation alarm, hooters, ventilation tripping equipments in case of fire, online automatic cylinder weighing system, trolley for the transportation of the cylinders and other equipments required for successful working of the system.

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4.5.4. Portable Fire Extinguishers

Different types of portable fire extinguishers shall be deployed in various areas / units / rooms / control rooms/various offices/ all the cable premises such as tunnel, gallery, basement, vault, MCC room, transformer room, battery room, switchgear room, PLC rooms etc. / all conveyor galleries, junction houses/ oil premises, etc of the power plant complex as a measure of first-aid fire fighting.

Portable extinguishers shall be conforming to IS 15683 - 2006 code & selection and distribution of the fire extinguishers shall be as per IS:2190 (latest revision).Bodies of extinguishers shall bear BIS stamping.

Mechanical Foam (9L&50L)	-	IS : 15683-2006
DCP extinguisher (6,9,25Kg)	-	IS : 15683-2006
CO_2 extinguishers (5&25Kg)	-	IS : 15683-2006
Clean Agent (4,6 Kg)	-	IS : 15683-2006
Fire Bucket (9l)	-	IS : 2546-1974

Note: Trolley mounted heavy duty fire extinguishers shall confirm to their respective IS standards.

All fire extinguishers & fire buckets shall bear ISI mark. The testing parameters of the portable extinguishers shall conform to as mentioned in IS:15683-2006. The material of construction of cap of all above mentioned extinguishers (except CO2) shall be of stainless steel only.

4.5.5. Passive Fire Protection System

Passive fire protection are an integral part of a complete fire protection system and are essential for prevention of spread of fire through openings in walls or floors. : All material shall have approval from UL/FM/CBRI/LPCB/ other government agencies. Test certificates/ approval certificates shall be submitted before installation of the systems. Following measures shall be provided.

- Fire Retardant Coating/Painting of cables (40 minute Fire rating)
- Fire barriers and sealing of Cable Openings
- Partitions in Cable Channels/tunnels/galleries/ basement. Partition walls with fire resistant doors at every 30 m shall be provided in all these premises.
- Fire door (2hr fire rating) as per BIS 3614 at entry/exit of cable tunnels, each compartment of cable premises.

4.5.5.1. Fire Retardant Coating/Painting

To prevent fire from spreading along the cable runs, vertical and horizontal run of cables and for horizontal length, 1 (one) m length of fire retardant coating shall be provided at every 10 m interval and full length for all vertical runs of cables with a recommended wet film thickness of 3 mm, wherever cables cross any partition wall,

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floor or pass through any opening, coating shall be provided for at least 150 mm length on either side. To maintain the power supply to important equipment where data is saved, fire retardant coating of the entire length of cables is required with a recommended wet film thickness of 3mm.

4.5.5.2. Specification

The Fire retardant coating / painting shall be in tumescent / ablative, water based compound, The coating should expand up to 10 times, supplied in a manufacturer seal container indicating manufacturing and expiry dates. The coating material shall be non-toxic, asbestos free, halogen free and shall have good mechanical strength. It shall not affect ampacity of cables and shall last the life of the cable. The white colour coating of density 1.3kg/l should have a snap time of 30 minutes, the expansion shall begin at 230OC and it should have a oxygen index of 41%

Shelf life	-	12 months (min) from the date of receipt (in original container). 20 years (min) from the date of application.
Material	-	Water based in tumescent compound resistant to hydrocarbons, acid, alkali attacks.
Fire rating	-	Up to 40 min

4.5.5.3. Method of Application

Coating shall be applied by ordinary paint brush after cleaning the cables of dust and oil deposition. A minimum textured finish of 3 mm wet film thickness shall be achieved by applying the material in 2-3 layers leaving intervals of 2 to 8 hours depending upon the moisture, thickness, and temperature of each coat.

4.5.5.4. Test

The coating should be tested to following standards:
BS 476 Part 20 (UK)
DIN 4102
IEC 331: 1970
IEC 332: Part 3: 1992

4.5.5.5. Sealing of Cable Openings

Cable fire stops/barriers shall be provided in following cases :

a) Entry/Exit area of cable/cable trays in various compartments of cable gallery/basement/tunnels having different fire loads

b) Under control panel/any other panel where cables are entering or going out.

c) In floor openings

For up to 4 hours of F-Rating the Fire barrier sheet of 7.62mm thick should be cut as

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per the profile of the penetrants and the opening. Then the individual cut pieces shall be directly fixed, on the walls or floor around the penetrants with M6 anchor bolts and washers. The small gaps left around the penetrants should be closed, with Fire Rated Putty which should be soft & moldable to any shape, to give complete L-Rating.

4.5.5.6. Components of Fire Stops/Sealing system

The Fire Barrier sheet must be designed on the intumescent technology and must be a composite construction with the qualities incorporated with organic/inorganic fire-resistive elastomeric sheet with specific gravity of 1.56gm/cm3. One side it should be bonded with 28 gauge galvanized sheet. The other side it should be reinforced with hexagonal shaped steel wire mesh and covered with aluminum foil. The Putty shall be one part intumescent elastomer. When exposed to flame or heat it shall be capable of expanding and it should be in the form of pads. The putty should allow the re-entry of cables through it whenever needed during the service period. The system should be UL approved.

4.5.5.7. Testing and Evaluation

The relevant specifications in respect of testing and evaluation of fire stop system are as under.

Building Material Testing	-	ASTM E84 [ANSI / UL723].
Through Penetration Fire Stops	-	ASTM E 814
Fire Stop Penetration – Fire Test	-	UL-1479

The System should also meet the requirements of a “High Pressure Hose Stream test.” The Putty applied should comply with paragraph 300-21 of NCE [NEPA 70] and meet requirements of UL 1479, ASTM E814.

Also the system should have a life of about 100 years.

4.5.5.8. For sealing of small openings where cable bundles and pipes are in high density and application is difficult.

The fire stopping caulk shall be a one part, intumescent, latex elastomer. The caulk shall be capable of expanding a minimum 3 times at 537OC. The product should be a premium elastomeric use as one-part fire, smoke, noxious gas and water sealant. The product should be easily applicable with a caulk rate of 1000 g/min with unique Intumescent property and should be thixotropic and be applicable to overhead, vertical and horizontal fire stops. It should have a fast drying time of 10-15 minutes. It should be totally free from Volatile organic compounds.

Testing and Evaluation

Along with all material tests and the UL certifications the complete system along with the fixtures should be tested in accordance with the criteria of ASTM E814 and UL 1479, standard method of fire tests for through penetration fire stop under positive pressure. Besides meeting surface burning characteristics ASTM E84 [ANSI / UL723], the System should also meet the requirements of a High Pressure Hose

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Stream test. It shall comply with the requirements of NEC, BOCA, ICBO, SBCCI and NFPA code. The System should also meet the requirements of a "High Pressure Hose Stream test."

Partitions in Cable Channels/tunnels/galleries

In all cable channels/tunnel/galleries partition walls shall be provided at every 30 m interval. Partition walls shall be constructed of RCC wall and shall have minimum 3 hrs fire rating. Any openings left out after construction of partition wall shall be sealed with fire stops. Steel Fire doors should be suitably provided

Steel fire door shall also be provided at every entry/exit of the cable galleries, cable tunnel, cable basement and oil cellars. Fire rating of the door shall be minimum of 3 hrs.

4.5.6. Manual Low Expansion Foam flooding system

Manual Low Expansion Foam flooding system shall be provided for the fuel oil storage tanks – LDO & HFO. System shall consist foam storage tanks (stainless steel), piping network, gate valves, inline inductor, foam proportioning units, foam pourer/ foam chambers, foam concentrate (main supply + 100% standby) etc. System shall be designed, supplied, erected and commissioned as per NFPA and BIS standard. All the pipings, valves, fittings in the foam concentrate tank and upto inline inductors shall be of stainless steel material.

Water cum foam monitor of 1800 lpm discharge capacity shall be provided all around the fuel oil storage tank. Water monitor of similar capacity shall also be provided for ESP, boiler, transformer and coal conveyor galleries.

4.5.6.1. Technical Specification for Monitors

Monitor shall satisfy the following minimum parameter. Monitors shall conform to IS - 8442

a) Water monitor

- Flow rate - 1800 lpm

- Vertical jet at 70 MWC - 30 m

- Horizontal jet at 70 MWC - 60 m

- Horizontal rotation - 360^{o}

- Vertical rotation - +105^{o} to -20^{o}

- Material of construction

Body - Seamless ASTM A-106 Sch 40 hot galvanized
Nozzle - A-16-WP aluminum alloy

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b) Foam Monitors

- Water Flow rate - 1800 lpm

- Expanded flow rate - 1:8 expansion

- Vertical jet at 70 MWC - 25 m

- Horizontal jet at 70 MWC - 50 m

- Horizontal rotation - 360^{o}

- Vertical rotation - +105^{o} to -20^{o}

- Material of construction

Body - Seamless ASTM A-106 Sch 40 hot galvanized
Nozzle - A-16-WP aluminium alloy

c) Foam concentrate - 3 % AFFF type of foam compound shall be used. The quantity of foam compound required for 65 minutes of operation of foam monitors shall be stored in barrels of adequate capacity. Inline inductors shall be included with all foam monitors. Foam concentrate shall confirm to BIS/UL standard.

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4.6. COMPRESSED AIR FACILITIES

4.6.1. Compressed air facilities comprising of oil free, air cooled screw type air compressors, heatless desiccant type air dryers along with air receiver having suitable capacity to meet the requirement of compressed air for the entire Captive Power Plant shall be provided.

4.6.2. Scope of work

The compressors, air dryer units and air receivers shall be complete with all materials and equipment whether specifically mentioned herein or not but required for satisfactory operation of plant & equipment individually as well as integrated manner.

At the outlet of compressor pressure and temperature measurement shall be envisaged & same shall be indicated in the control room or may be hooked up with the PLC/ DCS system. Electric hoisting facility for maintenance purpose shall be considered.

The compressors along with air dryer shall be located inside the structural building.

Compressed air system shall comprise of but not limited to the following main units:

Oil free, air cooled, rotary screw packaged type air compressor complete with electric motor of suitable capacity and all its accessories & auxiliaries along with pipes, fitting, valves, etc. including the following accessories / auxiliaries to meet the requirement of service/ instrument quality air for the entire Air Compressor Station. The specification of air compressor, air dryer unit and air receiver are indicated here in after.

a) Intercoolers, moisture separator with auto drain trap station,

b) Suction air filter system

c) Lube oil system.

d) Heatless Desiccant type of Air Drying unit of suitable capacity.

e) Air receiver of suitable capacity

f) All necessary interconnecting pipes, valves, fittings including supports and supporting structures.

g) Drain pipelines from compressed air station to nearest drain / drain pit.

h) Necessary electrics, instrument & Controls for compressors, air drying unit and air receiver & its auxiliaries.

i) A set of tools & tackles for repair and maintenance, as required.

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j) All anchor bolts & nuts, washers & base frame for equipment.

k) Provision of interconnection between instrument quality air line and nitrogen line with isolation valve.

4.6.3. Equipment Specification

4.6.3.1. Air compressor

No. of Compressors	:	2 nos. (1W+ 1S)
Discharge flow	:	Tenderer to indicate
Discharge Pressure at outlet flange of after cooler and moisture separator	:	Tenderer to indicate
Type	:	Oil free, air cooled, screw
Installation	:	Indoor
Service duty	:	Continuous/ intermittent
Environment	:	Dusty
Oil content	:	Nil
Dust particle size	:	Tenderer to indicate

Compressor shall be complete with motor of suitable capacity. Driving motor shall have adequate margin not less than 110% of the maximum power requirement at motor terminal (considering motor efficiency) at maximum capacity of the compressor.

Suitable lubrication system for bearings and other moving parts of the compressors shall be provided. Lubrication system shall be complete with necessary filters / strainers, oil coolers, level indicators, pumps, pipes, valves and fittings etc.

Compressor shall be provided with a dry type air intake filter system. The suction filters supplied shall be of appropriate type such as to prevent ingress of dust into the machine.

The compressor shall have capacity control with constant discharge pressure over full range. For this purpose suitable air intake control valve with other connected system shall be provided.

Compressor shall be provided with inter cooler, moisture separators etc..

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Compressors shall be provided with adequate safety, protection and control system.

4.6.3.2 Air Drying Unit

There shall be heatless desiccant air drying unit of suitable capacity. Selection of dryer shall be such that performance of the same shall not be affected at different loads of the system. This dryer shall be installed adjacent to the compressor. The system shall be designed such that under no circumstances the dry air supply shall be stopped.

The air drying and filtration shall be designed to continuously supply dry and oil free air. Both manual and automatic change over from one mode to other should be possible. The design, fabrication and materials of construction of various pressure vessels shall be as per the pressure vessel code IS:2825 latest edition or ASME Section VIII.

Pre filters shall be provided to remove dust and any other contaminant from the air stream. After filters located downstream of the absorber towers shall prevent carryover of fine particles with the efficient air stream.

Both the pre filters and after filters shall have 100% standby unit. All filters shall have individual isolation valves, safety valves and drains with trap stations and pressure gauges.

The air drying plant shall be provided with dew point measuring devices.

Design considerations of the drying unit are indicated below:

Air flow rate (each)	:	Tenderer to indicate
Normal inlet pressure	:	Same as compressor outlet
Maximum air temp (inlet)	:	Same as compressor outlet
Dew point of outlet air (ADP)	:	(-) 40^0 C
Maximum allowable pressure drop	:	0.5 kg/cm^2 g.
Oil content in the outlet air	:	Nil

The dryer shall be supplied along with all necessary auxiliaries. The operation and controls of the dryers shall be fully automatic.

The dryers shall have built control panel with auto / manual operation. Indication of outlet air temperature and pressure shall be provided at prominent place. Lifting eyebolt shall be provided for installation and maintenance purpose. First fill of all consumables

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shall be supplied along with the dryer unit.

4.6.3.3. Air Receivers

There shall be suitable capacity air receivers for service as well as instrument air separately. Air receivers shall be of carbon steel material, welded construction complete with all accessories. The air receiver shall conform to IS:7938 latest edition. The air receivers shall be designed, manufactured and tested according to IS:2825 latest edition and shall be complete with pressure gauge, lifting lugs, manhole, safety valve and foundation bolts. The material of construction of shell, header, nozzle, etc. shall be as per IS – 2002 – Gr. – 2A or SA516 Gr. 70.

4.6.3.4. Pipe work, valves & specials

Piping layout must follow good engineering practices. Proper attention shall be paid to obtain full functional requirement of air, water and oil piping with a layout which provides sufficient clearance for various auxiliaries, other equipment and operating personnel, easy access for operation and maintenance, convenient supporting arrangement.

Except otherwise specified, all pipes shall be provided with butt welded connections and with flanged joints only at the connections with equipment, vessels and valves.

Valves in the air line shall be of shall be of cast steel / forged steel full bore, two / three piece design ball valves with Stainless steel internals. For waterlines, either wafer type butterfly valves sand witched between two flanges or double-flanged butterfly valves shall be provided. In butterfly, gate, globe valves, face of the hand wheel shall be clearly marked with word `open and shut' with arrows adjacent to indicate the direction of rotation. In butterfly, non-return & globe valves, direction of flow shall also be marked on the valve body.

All the globe valves shall be designed to prevent erosion of valve seats when the valves are operated in throttled conditions. Design of valves shall be such that it shall permit packing of glands while under pressure.

Non return valves shall be of double flanged and dual plate spring design.

The solenoid valves shall have heavy duty, double impregnated tropicalised coil and shall be suitable for operating temperature and for operation continuously energised in tropical climate. The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be suitable for continuous duty. The enclosure shall be water tight, dust tight and the valve shall be suitable for mounting in any position.

All the valves for water line and air line shall be of 150 class rating. The valves with flanged ends shall be provided with flanged ends having raised face, serrated finish. The

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drilling of the flanged ends shall be done as per IS:6392 - 1971 (RA 1988) .

Valves of size NB 125 - 400 shall be of gear operated type.

Ball valves shall confirm to BS:5351 / API 608.

Cast Iron Gate valves shall conform to IS:14846.

Cast Iron Globe valves shall conform to IS:9338

Gate & Globe valves below 50 NB shall conform to IS:778 - 1984(RA1990).

Non return valves shall conform to IS:5312 - 1984(RA 1990).

All pipelines shall be provided with drain connections, generally at the lowest point for removal of accumulated condensate or water and also for draining of the water after hydro testing of the erected pipe work. Vents with valves shall be provided at highest point of the pipe line.

The drain piping shall have drain pocket followed by a connection of drain pipe with isolation valve. Line shall be provided with slope towards the drain point.

MS Pipes of following specification shall be provided for industrial water and air applications.

NB 15 - 150: ERW, Black, Heavy pipe having plain ends as per IS:1239 Part-I – 1990.

NB 150 & above: ERW, Black pipe of minimum thickness 6.35 mm having plain ends as per IS:3589-1991.

Pipe fittings conforming to IS:1239 Part-II - 1992 shall be provided for pipes of size up to NB 150. Fabricated fittings manufactured from the pipes shall be provided for pipes of sizes NB 200 and above.

Complete pipe network after erection shall be hydrostatically tested at a pressure of 1.5 times the working pressure. The pipe network shall be subjected to the test pressure for a minimum period of 4 hours.

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4.7. DIESEL GENERATOR SET

4.7.1. Engine

One (1) no. radiator cooled, silent type 750 kVA (minimum rating) Diesel Generator Set along with AMF panel, acoustic enclosure, 990L day oil tank shall be envisaged by the Tenderer. However, final rating shall be decided during detailed engineering based on actual requirement of emergency loads.

The diesel engine shall be vertical, multi cylinders, coolant / radiator cooled, turbo charged, single acting, Vee / In line construction, mechanical injection type suitable for cold starting and shall be furnished with at least the minimum equipment according to the standard practice. The horse power rating, auxiliaries, guarantee of fuel consumption, governor performance and torsional vibration shall be in accordance with BS:649 or approved equivalent standard.

4 stroke, Air cooled, turbo- charged diesel engine, capable of driving continuously synchronous Alternator to give net required output at Alternator terminals at rated speed under site conditions as mentioned in the specification.

The design of engine shall be such that it can take fluctuating load, sudden loading and load throw off from rated load to zero load without adverse effect and de-ration in the engine.

The design of the engine shall consider the case of maintenance, repair, cleaning and inspection.

The engine and DG set shall be capable to withstand 10 % overload for one hour in a period of 12 hours operation.

The engines shall be designed to burn HSD fuel oil (net calorific value of about 10,000 kcal/kg as per IS:1460 and as available in India).

Engine cylinder heads shall be suitable for heavy duty application and shall be secured firmly to the engine frame. The liners of the cylinders shall be of suitable materials to resist the wear and tear of piston rings. Cooling water space shall be provided around cylinder jackets and arrangement shall be provided to compensate thermal expansion of the liner.

Flywheel with cover including suitable coupling between engine and Alternator shall be provided.

The crank shafts shall be made of high quality forged steel with smooth machining, grinding & honing all over.

The connecting rods shall be made of high quality forged steel of suitable cross section for heavy duty application.

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The main bearings shall be made of suitable soft material. Arrangements shall be provided for lubrication of main bearings, big end and small end bearings. A vibration damper shall be provided to control torsional vibration resonances, if required. Conveniently located inspection window to facilitate removal of big bearing, piston etc. without sump removal shall be provided.

The pistons shall be made of suitable light metal having high thermal conductivity and low thermal expansion. There shall be oil scraper rings and sufficient number of compression rings.

The valve mechanism shall be actuated through cam shaft, push rods and rocker arms by means of a suitable gear train and shall be accommodated in the engine frame itself.

The diesel engine shall conform to relevant parts of ISO 8528 and ISO 3046. Performance test of DG set shall be carried out as per latest standard of ISO 8528 and ISO 3046 and other relevant standard as applicable.

4.7.2. Fuel Oil System

The fuel injection system shall be driven by the engine itself and the system must ensure the proper timing of fuel injection, control of rate of fuel injection, proper atomisation of fuel in accordance with the type of combustion chamber used, proper distribution of fuel in combustion space and arrangement to return excess quantity of fuel oil to the oil tank. Priming pump shall be provided.

Rate of fuel injection shall be automatically controlled in accordance with variation in engine load. Hydraulic/ Electronic governor [conforming to class A1 of ISO: 3046 (latest)] shall be provided to maintain the speed of the engine constant within limits of tolerances.

A “Day Tank” of 990 litres capacity with mechanical oil level indicator to indicate low and high levels shall be supplied. An engine driven booster pump shall be provided to deliver fuel oil from the supply line to the fuel oil injectors through duplex filters or two full capacity filters. Hand pump shall be supplied for pumping oil from barrels to “Day Tank”. The Day Tank shall be provided with float valve, high/ low level switches for alarm.

i) Day Oil Tank

One number cylindrical box type metallic (M.S) fuel oil day tank of capacity 990 litres shall be provided with all accessories & fittings for each DG Set. The tank shall be fabricated from MS plates of minimum 14 SWG thickness conforming to IS : 2062-1992 and shall be complete with level switch, level gauge, vent, drain, inlet & outlet connection, manhole, pocket for instruments, low level alarm, high level alarm (audio visual type in control room) and supporting structures. The fuel oil shall be brought in barrels and transferred to the above tank by hand filling pump.

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ii) **Filter**

Quantity : 2 set.

Type : Duplex type

Mesh size : at least 30 mesh

Filter element: Mild steel body and stainless steel (SS 316) wire mesh

Location : At inlet and outlet of day tank.

Capacity : As required.

iii) **Pipes & Fittings:**

All external pipes shall conform to IS:1978, line pipe, ERW medium grade. Necessary standard bends, tees, couplings, flanges, bolts, nuts and gaskets shall be used for laying the pipelines.

iv) **Valves**

All isolating valves shall be of self lubricating, taper plug, tight shut off type and of reputed make. Open/close position of valve and direction of flow shall be clearly indicated on the valve body.

v) **Hoses**

Type : Flexible
Standards : BS:1435 (latest)

vi) **Flanges**

As per ANSI B 16.5 with pressure rating of 150 class minimum.

vii) **Dip Rod**

The dip rod shall be of suitable length, calibrated and made of Aluminium. It shall be used to measure the contents of the oil in the tank. Diameter of dip rod shall be minimum 12 mm.

4.7.3. Lube Oil system

Diesel engine shall be provided with suitable lubricating system for effective lubrication of

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all components. The system should be complete with gear type lube oil pump, oil cooler and duplex fine mesh filters or two full capacity filters, differential pressure gauge across the filters or pressure gauge on either side of the filters. The system shall be provided with oil pressure and temperature indicating instruments /gauges and all control/safety devices against loss of oil pressure and high oil temperature. It shall have L.O. topping and draining arrangement, vapour extraction and oil cooling system. Lube oil heater, priming pump shall be provided, if required, for smooth starting of the engine.

4.7.4. Engine Cooling System

The engine cooling water / coolant shall be forced through the system by engine driven cooling water pump and the hot return water shall be cooled by passing it under thermostatic control through a radiator/ heat exchanger.

Jacket water system shall be complete with water cooling arrangement, thermostatic control with alarm on high jacket water temperature, expansion tank with topping arrangement, controls/ safety devices. A separate or combined close water circuit shall be provided for injector cooling, if required.

4.7.5. Air Intake and Exhaust System

The engines shall be supplied with dry type air filter or through oil bath type intake, pressurised through exhaust gas turbine driven turbo charger and if required, cooled in a charge air cooler.

The exhaust system shall consist of an exhaust gas driven Turbo-charger of reputed make, residential type exhaust gas silencer, expansion joints, necessary piping adapters, noise attenuation system, insulation supports etc.

The exhaust gas pipelines of the engines shall be led upto required height as per statutory norms and shall be provided with weather proof cowl. The exhaust pipe and exhaust silencer shall be made of carbon steel suitable for the maximum exhaust gas temp. Suitable supports shall be provided for supporting the exhaust pipe and silencer. Suitable expansion joints/flexible connections shall be provided between exhaust pipe and exhaust manifold of the engine to ensure that no undue vibration is transmitted to the piping system. The exhaust pipe shall be suitably lagged and cladded with 20 gauge Aluminum sheet for personnel protection against burning. Silencer shall be designed to have sound level below the acceptable limit. The sound level shall not exceed more than 85 dBA at the generating source.

4.7.6. DG Set Starting System

Starting of diesel engine shall be through electrical starting system. The electrical starting system shall comprise of starter, batteries, motors and battery charger and all the necessary instruments and accessories.

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The diesel Alternator set shall be normally at rest when the station AC supply is available from normal power source. Set shall have auto as well as manual starting system. In auto mode (A/M selection switch), signal to start the engine shall be initiated from AMF panel and automatically in a sequence manner. DG set shall be started and after reaching desired voltage & frequency Alternator circuit breaker shall be closed. On restoration of mains supply DG set shall be tripped automatically in auto mode of operation. In case of manual start mode, DG set shall be started manually by initiation ON push button either from panel or push button mounted on DG skid and also manual closing of Alternator circuit breaker.

As soon as the diesel Alternator set reaches its rated speed and generates its rated voltage (a period not exceeding 30 seconds) a voltage and frequency sensitive relay shall permit the closing of the Alternator circuit breaker.

4.7.7. Governing System

Engine governing shall be in accordance with BS 5514 Part 2 to 7- 88 and/or ISO 3046 Part 4 class A1. Governor shall be provided for keeping constant speed within certain limits with variable loads. The governor shall be Hydro/ Electronic class AI. It should be capable of operating on isochronous mode i.e. the speed of the engine (frequency of the Alternator set) should remain constant irrespective of the load on the DG set upto 100% capacity. A droop of 0 – 10% should also be available.

The governor shall be suitable for isochronous load sharing. It shall have external speed trim facility with speed adjustable within ± 5% of rated speed. The governor shall have automatic start fuel limit feature so that fuel is limited during start up overspeed. The automatic fuel shall be adjustable. It shall have a failed speed detector, which shall stop the engine in the event of speed sensing signal from magnetic pickup. The steady state speed band shall be ± 0.25% of rated speed. It should be capable of operating within 20V to 32 V DC in an ambient temperature of -10 C to 75 C. Remote operation of governor should be possible.

4.7.8. Technological Structures

Steel structures envisaged as supports for fuel oil tanks, starting batteries, exhaust pipes, valves, vent pipe and overhead pipelines (if any) in the DG station.

Superimposed loads considered in the design of steel structures shall be in accordance with IS:875 (part 2) in addition to technological loads, if any.

The design of steel structures shall be carried out according to IS:800 and other relevant Indian Standards. Fabrication shall be carried out in accordance with IS:800 & IS:7215.

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4.7.9. Enclosure

The acoustic enclosure shall be free standing floor mounting type independent of the DG set. It shall be an all weather proof one, pre-fabricated, factory built and modular in construction, so that it can be easily assembled at site around the DG set without any anchor to the ground. It consists of specially designed panels, sliding doors, louvers and locking arrangements. The enclosure shall have four sliding doors, two sets of detachable ventilating systems for fresh air intake and hot air exit. The attenuator openings shall take care of the temperature of the DG set. The panels are made out of CRCA sheet steels stuffed with insulation material mainly Mineral wool/Rock wool of high density covered by G.I. perforated sheet. The Enclosure shall be provided with inlet and outlet specifically designed ventilating louvers for air movement and sound absorption across the Enclosure. All the supporting structure and frame work shall be built out of ISM channels and IS Angles. Finally the Enclosure shall be finished with zinc chromate yellow suitable primer and epoxy based paint of 631 shade of IS5.

4.7.10. Painting and Packing

Equipment shall be painted with two coats of epoxy based primer followed by two Final coats of epoxy based paint. Sheet metal work shall be subjected to degreasing, Pickling and phosphating prior to painting. Exhaust pipe shall be painted with heat resistant paint for high temperature.

The equipment shall be shipped to site suitably packed to prevent any damage. Each Package shall have labels to show purchaser's name, purchase order and equipment number suitable lifting lugs etc. shall be provided and lifting points shall to clearly marked on the package. Packing shall be suitable for storage at site for a minimum period of six months.

4.7.11. Electrics

4.7.11.1. One (1) number Diesel Generating set (D.G.) of capacity 750 kVA (minimum), 415 V, 3 Ph, 50Hz., 0.8 p.f. complete with all auxiliary systems, equipments, instruments and accessories, battery & battery charger etc. as described in this specification. Any item not specifically mentioned but required for completeness and trouble free operation of the equipment and system shall be deemed as included in the scope of the Tenderer.

4.7.11.2. Codes and Standards

Alternator	:	IS-4722/IEC-60034, IS12065, IS12075
Speed of Diesel Generator	:	BS649 / 195B
Permissible limits of noise level of rotating machines	:	IS 12065

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Measure, evaluation and limit of Vibration severity of rotating Electrical machines shaft 65 mm dia or higher	:	IS 12075
Code of practice for Fire Safety	:	IS 3034
OSID standard on lightning protection	:	OISD-GDN-180

4.7.11.3. Equipment complying with other internationally accepted standards such as ASA, IEC, BS, VDE etc. shall also be considered if they ensure performance and constructional features equivalent to or superior to standards listed above. In such a case, the Tenderer shall clearly indicate the standard(s) adopted and also furnish a copy in English of the latest revision of the standards along with copies of all official amendments in force as on date of opening of bid. Tenderer shall clearly bring out the salient features for comparison.

4.7.11.4. Technical Requirements

4.7.11.4.1. The DG set shall be suitable for industrial duty, and the same shall be used as source of back-up power for the emergency loads of crusher package.

4.7.11.4.2. Provision for both Manual as well as Auto (AMF type) starting of DG set shall be there, with facility of selection of the mode.

4.7.11.4.3. The DG Set shall be silent type suitable for indoor/outdoor (as per technological requirement) installation with acoustic enclosure complying to CPCB standards

4.7.11.4.4. Supply of one set of special tools and tackle. Tenderer shall submit a separate list for all such special tools and tackles being supplied by them. Item wise price of each of such item shall be submitted by the Tenderer separately

4.7.11.4.5. Noise level of DG set shall be within limits as stipulated in relevant standards.

4.7.11.4.6. Tenderer shall submit all relevant drawings, data and instruction manuals for the offered equipment.

4.7.11.4.7. The D.G. set shall start from the battery set and charger through an engine mounted magnet switch. Diesel engine shall be started manually through push button. Starting system shall be such that the D.G. set shall start, come up to speed, and be ready to accept full load within a time of 30 seconds of starting command. Starting system shall be suitable for starting D.G. set after prolonged period of non-operation. Provision of mechanical starting shall also be provided to take care of situation like failure in electrical starting, including providing de-compression lever and all other required accessories.

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4.7.11.5. Generator

4.7.11.5.1. The generator shall be of synchronous generator, totally enclosed or screen protected drip proof and self-air cooled type. The generator shall be driven by the Diesel engine specified in other chapters of the specification and shall match the same in all respects. The generator shall conform to IS 4722 or IEC-60034.

4.7.11.5.2. AC generator shall be supplied along with generator protection, DG power cum Control Panel, circuit breaker & electrical protective relays / devices, electrical starting arrangement complete with DC cranking motor, VRLA batteries, dual float-cum-boost battery-chargers, associated cables, mechanical starting arrangement, exhaust duct/piping, industrial type silencer, along with all other associated auxiliaries.

4.7.11.5.3. Generator shall be suitable for direct coupling to diesel engine through a sturdy flexible coupling.

4.7.11.5.4. Generator shall be continuously rated to deliver the rated output at rated voltage, frequency and power factor under the ambient conditions specified in the specification. Rated capacity of generator shall be the net output of the generator after accounting for any auxiliaries.

4.7.11.5.5. Generator shall have overload capacity of 10% for one hour in any period of twelve hours, and overload capacity shall be as per relevant standard.

4.7.11.5.6. Neutral shall be solidly earthed through protective disconnecting device like MCB and disconnecting switch.

4.7.11.5.7. Generator shall have degree of protection IP23, and self- ventilated. Acoustic enclosure shall be weather proof type suitable for outdoor application.

4.7.11.5.8. Stator and rotor winding insulation shall be Class F with temperature rise limited to Class B.

4.7.11.5.9. Winding shall be capable of withstanding a three phase short circuit at generator terminals for three seconds without any damage. Stator windings shall be double layer type formed coils. All external bolts / nuts shall be of cadmium plated material.

4.7.11.5.10. Bearings shall be of heavy duty pre-lubricated cartridge design ball or roller bearings.

4.7.11.5.11. Drain plug shall be provided for drainage of any condensate.

4.7.11.5.12. Two earthing terminal shall be provided.

4.7.11.5.13. Space heater shall be provided, which shall automatically be switched on when the generator is idle, and its terminals shall be brought out in a terminal box.

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4.7.11.5.14. All six stator terminals shall be brought out to the terminal box of the generator, and shorting to be made therein. Terminal box shall be liberally sized to accommodate termination of armoured power cable.

4.7.11.5.15. Brush-less excitation system shall be provided.

4.7.11.5.16. Generator shall be provided with automatic voltage regulator. The regulator shall be able to maintain the terminal voltage of generator automatically within +/-1% of the rated voltage for a load variation of 0-100% and at any power factor from 0 to 0.8 lag including speed variation of 4%.

4.7.11.5.17. Short circuit ratio of generator at rated KVA and rated voltage shall not be less than 0.5.

4.7.11.5.18. Critical speed of the machine shall not be lesser than 120% of the normal speed.

4.7.11.5.19. All couplings shall be capable of withstanding the maximum generator sudden short circuit torque.

4.7.11.5.20. The field winding shall be fully insulated from the core. The field system shall have low inductance to allow good voltage regulation.

4.7.11.5.21. Suitable cable glands shall be provided on the enclosure to facilitate entry of the cables. The cable terminal box size shall be adequately dimensioned to accommodate PVC insulated, aluminium power cables of required size.

4.7.11.6. Instrumentation, Metering, Protection, Control Panel etc.

4.7.11.6.1. Shutdown system shall be initiated for:

a) Low lube oil pressure
b) High jacket water temperature
c) Engine over speed
d) Emergency stop (through stay put type push button)
e) Other fault conditions as required

4.7.11.6.2. Audio visual alarm system in DG control panel with acknowledge, reset and test features for:

a) Low lube oil pressure
b) High lube oil temperature
c) High jacket water temperature
d) Engine over speed
e) Fuel tank level low
f) Mains supply failure

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g) Mains supply available
h) DG breaker trip on fault (lockout feature)
i) Generator voltage / frequency abnormal
j) DC supply failure
k) Any other item as deemed required by the Tenderer

4.7.11.6.3. All instruments / auxiliary relays / timer / control & selector switches / push buttons / indicating lamps etc. as required for the effective performance and completeness of the system shall be provided.

4.7.11.6.4. Control panel shall be of minimum 14 gauge CRCA sheet steel construction, IP54 enclosure, floor mounting free standing, single front cubicle type panel. All wiring shall be done by 2.5sq mm Cu stranded PVC insulated wire as minimum. Panel shall be complete with terminal blocks, grounding terminals, double compression type cable glands and gland plate, ferrules for wiring marking, spare terminal (minimum 20%), all door mounting flush type instruments, isolating switch / fuse for auxiliary supply etc.

4.7.11.6.5. Following locally mounted instruments, but not be limited to, with adequate no. of contacts shall be provided:

a) Pressure switch for lube oil
b) Temperature switch for jacket water
c) Level switch for fuel day tank level
d) Fuel day tank level indicator sight gauge
e) Tube type level gauge for radiator water level, with isolating valve at radiator bottom

4.7.11.6.6. Generator Protection / Control /Metering / Interlock

a) Draw-out Air Circuit Breaker, 50kA breaking capacity, adequate continuous current rating, both electrical as well as manual closing / tripping / spring charging, 110V DC control voltage, with auxiliary contacts as required for the system.
b) Current transformers of adequate VA, for metering (class 1.0) and protection (class 5P20)
c) Voltage transformer
d) Adjustable voltage sensing relay, frequency sensing relay etc. as necessary for metering, protection and interlock.
e) kW meter, kWh meter, Ammeter, Voltmeter, Power Factor meter, Frequency meter and corresponding meter selector switches
f) Temperature indicator as required
g) Over-current and Earth Fault protective relays as required (50, 51, 50N/2), earth leakage relay shall be provided separately.
h) Complete protection system as per the recommendation of the Tenderer for effective performance and protection of their offered system.

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i) High speed hand reset lockout relay (86), anti-pumping relay (94), master relay and necessary auxiliary relays for smooth and safe operation of the DG set.

j) Interlock circuit as per approved scheme, and programmable logic controller if required.

k) Clustered LED type Indicating lamps for ON / OFF / TRIP / TRIP CHECK / DC FAIL / Line Charged

l) All components for incoming and outgoing cable termination.

m) Additional one energy meter for tariff purpose with requisite accuracy classes of CT, PT and Tariff Meter, from approved meter list of West Bengal State Electricity Board shall be provided. Approval shall be taken before first charging from Electricity Authority of West Bengal

4.7.11.6.7. Monitoring signals, fault/alarm parameters for Engine, Generator, Generator Breaker Panel shall be communicated to DDCMIS.

4.7.11.6.8. Brief details of Generator

a)	Continuous rating at specified site conditions at generator terminal	:	750 kVA (minimum)
b)	Output	:	415 V, 0.8 pf ,3 phase, 4 wire,50 Hz AC
c)	Allowed voltage drop	:	15% on start of biggest motor
d)	Allowed frequency drop	:	5% transient
e)	Ambient temperature	:	45 degree C
f)	Relative Humidity	:	100%
g)	Operating Speed	:	1500 rpm
h)	Noise level at source	:	85 dB(A)
i)	Starting System	:	Manual & Auto Both

Manual start by push button starter from DG control room & sub-station control room/electrical switchgear. Machine shall have single push button start/ stop from control room. Starter

j)	Type of alternator	:	Air cooled.
k)	Type of enclosure	:	Shall be totally enclosed or Screen protected, drip proof, self ventilated with removable covers to easy access to excitation unit, enclosure IP-23.
l)	Mounting	:	Horizontal, foot mounted with end shield bearings.
m)	Excitation	:	Brushless static excitation

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n)	Insulation	:	Class H, temperature rise limited to class F
o)	Acoustic Enclosure	:	Yes, if required for keeping the noise level within specified limit for DG
p)	Vibrations	:	Within limits as per IS:12075
q)	Battery System	:	Battery Charger with Lead Acid Battery
r)	Other details		
	Engine Control Panels	:	Yes
	Gauges	:	Yes
	Meters	:	Yes
	Alarms	:	Yes
	Trips	:	Yes
	DG Control Panel	:	Yes
s)	Applicable Standard	:	Conforming to IS:4722 – 1992

4.7.11.7. Battery and Battery Charger

4.7.11.7.1. Starting and control requirement of DG set shall have power supply from Battery and Battery Charger unit.

4.7.11.7.2. Tenderer 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% compensation for ageing and 15% for unforeseen future growth plus temperature correction factor. The maximum and minimum ambient, design altitude shall be as per the details furnished in elsewhere in this specification. The minimum voltage at the end of the load cycle shall not be less than 1.85 Volts per cell.

4.7.11.7.3. The battery shall be sealed maintenance free lead acid type and shall be housed inside the DG set enclosure in case of acoustic proof DG.

4.7.11.7.4. The battery charger shall be natural air-cooled, solid state type bridge configurations and complete with all switches, fuses, contactors and instruments. The battery charger shall be suitable for 415 Volts ± 10%, 3 phase, 50 Hz, 4 wire A.C. supply.

4.7.11.7.5. Battery charger shall be with dual provision of float charging and boost charging. The battery charger shall be capable to float charge battery set apart from system D.C. loads if any.

4.7.11.7.6. Battery charger shall recharge the completely discharged battery to full capacity in eight (8) hours. The charger unit shall have 15% excess capacity. Provision shall be made to ensure that battery shall be charged during operation of D.G. Set.

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4.7.11.7.7. Transformer shall be dry type, double wound, with copper conductor and Class-B insulation with temperature rise limited to Class-A insulation.

4.7.11.7.8. Isolation switch shall be heavy duty, load break type, operated by an external handle.

4.7.11.7.9. Fuses shall be HRC type and arranged for easy replacement. Semi- conducting device fuses shall be fast-acting type.

4.7.11.7.10. Indicating Meters (voltmeter and ammeter) shall be 96 mm x 96 mm, flush type 240º scale with antiglare glass ± 1% accuracy with zero adjuster on the front of the meter.

4.7.11.7.11. The following indications shall be provided:

a) Failure of input A.C. supply to the charger
b) Battery voltage
c) D.C. output fuse blown

4.7.11.7.12. Battery charger shall be furnished with the following equipment and material mounted and wired on the front panel of charger enclosure.

a) Input voltmeter, scale 0-500 Volts (1% accuracy) with voltmeter selector switch
b) Output voltmeter, scale 0-40 Volts (1% accuracy)
c) Output ammeter, scale 0 to full load with 25% margin (to be decided by the Tenderer) having 1% accuracy
d) Selector switch for selecting “Float Charge”/ “Boost Charge”/OFF
e) Isolating switch for incomer
f) Indicating lamps
g) Accessories as required for the type of charger offered.

4.7.11.8. Operational Philosophy

4.7.11.8.1. The DG shall run during Emergency condition. It shall be connected to 415V emergency power control center (EM PMCC) located at switchgear room. The EMPMCC shall have normal incomers interlocked with DG incomer. When normal AC supply is healthy, DG set is in off condition. On loss of normal AC supply, DG set shall be manually / automatically (as per selection) given command for electrical starting sequentially. In auto mode, if the engine fails to start in first impulse, two more successive automatic starting impulses shall be given to the engine. Once the terminal voltage builds up, DG circuit breaker (at DG end) is closed automatically. After closing of DG breaker the DG power shall be available to EMPMCC through incoming breaker / switch with necessary interlock with normal incoming breaker.

Also in auto change over facility in DG-EM PMCC control system no operator intervention shall be needed during failure as well as restore of mains power.

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4.7.11.8.2. When normal supply is restored, changeover from DG supply to normal supply shall be effected automatically or by operator with brief voltage interruption on EM PCC. After the changeover, DG set shall automatically/manually stop. On stopping DG set, DG breaker shall open automatically.

4.7.11.8.3. DG set shall have facility to stop from DG control panel under all operating conditions.

4.7.11.9. Inspection and Testing

4.7.11.9.1. The testing of the different equipments and components shall be carried out as per relevant IS /IEC /BS and other applicable codes/IE acts and rules /factory acts and as per specification.

4.7.11.9.2. Material Test

All materials used for construction shall be tested for quality. Physical and chemical tests of materials shall be conducted as per the relevant standards and test certificates shall be made available.

4.7.11.9.3. Testing of D.G. Set

Performance Test: To be carried out at factory as per relevant codes and standards.

a) High voltage tests on stator and rotor winding of generator.
b) Insulation resistance of stator and rotor windings of generator.
c) Mechanical balance.
d) Stator, voltage and current tests on generator.
e) Stator phase sequence check of generator.
f) Exhaust system backpressure test.

4.7.11.9.4. Type Tests

All equipment to be supplied shall be of type tested quality. The Tenderer shall submit for owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar 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.

In case the Tenderer is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Tenderer shall conduct all such tests under this contract free of cost to the owner and submit the reports for approval.

All acceptance and routine tests as per the specification and relevant standards shall be

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carried out. Charges for these shall be deemed to be included in the equipment price.

Type test reports for the following type tests shall be submitted:

Type test reports on Alternator

(a) Measurement of resistance
(b) Phase sequence test
(c) Regulation test
(d) Measurement of open circuit and short circuit characteristics
(e) Efficiency test
(f) Temperature Rise Test
(g) Momentary overload test
(h) Over speed test
(i) High Voltage test
(j) Insulation resistance test (both before and after High Voltage Test)
(k) Noise level as per IS: 12065
(l) Vibration as per IS: 12075.
(m) Determination of Deviation of voltage waveform from sinusoidal.
(n) Degree of protection test on control panel
(o) Battery and battery charger as per relevant standards.

4.7.11.9.5. Reports and test certificates of the above tests shall be submitted.

4.7.11.9.6. During the tests the Tenderer/supplier shall establish the performance of all instruments, protection and interlock circuits associated with D.G. Set.

4.7.11.9.7. All rotating components and the assembly of the equipment shall be subjected to dynamic balancing test.

4.7.11.10. Acceptance Test

For the purpose of acceptance test at site after commissioning, DG shall be started, terminal voltage shall build up, and intended loading shall be successfully applied including starting of motors and running with total load continuously for four (4) hours without any trouble.

**** End of Clauses ****

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4.8. LABORATORY EQUIPMENT

4.8.1. Chemical Laboratory for CPP

4.8.1.1. pH METER

Standard Bench Type pH meter with temperature compensation, pH electrode, temperature probe, electrode holder, recorder output, stability indicator & Hold mode having following features:

Sl. No.	Items	Technical Specification
1.	pH Range	1.0 to 14.00 pH
2.	Resolution & accuracy	0.01 & ± 0.01 pH
3.	mV range	0 to ± 1999.9 mV
4.	Resolution & Accuracy	0.1 mV & ± 0.2 mV (within 200 mV); 1 mV & ± 2 mV (Beyond 200 mV)
5.	Temperature Range	0 to 100 °C
6.	Resolution & Accuracy	0.1°C & ± 0.3°C
7.	Calibration	Up to 3 points push button calibration with auto buffer recognition for 4.0, 7.0 and 9.2 pH buffer
8.	Memory storage	Bidder to specify.
9.	Temperature compensation	Automatic/ Manual or both (0 to 100°C)
10.	Power requirement	9V DC & 220 volt AC both
11.	Operating conditions	Ambient to 50°C temperature & 5 to 99% Relative Humidity
12.	Display	Dual LCD display of pH & Temperature.
13.	Required accessories/ consumables, buffers etc.	Calibration buffers of pH 4.0,7.0 &9.2 to be supplied with equipment. Other accessories bidder to specify.
14.	Operation/ Service manuals	To be provided with equipment.

4.8.1.2. Conductivity Meter

Sl. No.	Items	Technical Specification
1.	Range	0.0 to 199.9 µS 200 to 1999 µS 2.00 to 19.99 mS
2.	Temperature Range	0.0 to 100°C
3.	Temperature Accuracy	+/- 0.5^0C

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4.	Auto Ranging Resolution	0.1µS 1µS 0.01ms
5.	Accuracy	(+/- 2% Full scale)
6.	Resolution	0.1ºC
7.	Calibration	Up to 3points(push button; 1 point per range (Offset 0.10C increments)
8.	Cell Constant	1
9.	Facility	Auto Shutoff (Approx. after 15 min.)
10.	Automatic Temp. Comp	0.0 to 50.0 ^{0}C
11.	Reference Temperature	Factory set at 25^{0}C
12.	Temperature Coefficient	Factory set at 25^{0}C
13.	Keys	For ON/OFF, Calibration & other functions
14.	Power	Batteries and AC 220V supply
15.	Size/ weight	Potable & Light weight
16.	Warranty	One year from date of installation

4.8.1.3 DO Meter

Sl. No.	Items	Technical Specification
1.	Description	Portable Dissolved Oxygen Meter that can be easily taken to site for digital measuring of Dissolved oxygen (DO). The equipment shall be water resistant, impact and corrosion resistant. DO meter can be either operated by Mains (230 ± 10 volts/50 Hz AC) and through rechargeable batteries. System shall be complete with all essential accessories for D.O. measurements.
2.	Control	Microprocessor with functions automatically controlled
3.	Modes	mg/l, %, °C
4.	Display	LCD graphic, backlit
5.	Atmospheric Pressure Correction	Automatic
6.	Calibration	Automatic
7.	Concentration measuring range	0 – 20.0 mg/l
8.	Resolution	0.01 mg/l
9.	Accuracy	± 0.5% of value
10.	Temperature	Ambient to 50°C
11.	Temperature Compensation	Automatic
12.	Salinity correction	Automatic
13.	Calibration Sensor/probe	Optical Dissolved oxygen sensor with 3 mt cable (approx)

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14.	Oxygen Sensor Probe	Optical Dissolved oxygen sensor with cable of 3.0 mt. approx to be provided for the measurement of DO up to 3.0 depths shall be zero current free and pressure resistant. Shall be provided with calibration, maintenance kit and protective armor made of stainless steel. Calibrated sensor cap to be provided.
15.	Standard Accessories	i) 3.0 mt Cable for sensor ii)Suitable rechargeable batteries iii)Universal power adapter iv) Portable case for carrying the meter and sensor to site. v) Operational manual, dust cover, power cable, charger for Battery (230 ± 10) V 50 Hz and plug with spare parts for one year operation.

4.8.1.4. UV-Visible Spectrophotometer

Sl. No.	Items	Required Technical Specification
1.0	Schedule of Requirement	
1.1	Description	PC Controlled / Microprocessor based Double Beam UV-Vis Spectrophotometer. The minimum technical specification of Double Beam UV-Vis Spectrophotometer is given below:
1.2	Quantity Required	01 Set
1.3	Make and Model	Bidder to furnish
Technical Specification		
2.1	Principle	PC controlled/ Microprocessor based Double Beam UV-Vis Spectrophotometer along with built-in printer or with printing facility, required software, and all required accessories, consumables .such as printing paper etc.
2.2	Operating / Measuring Mode	Transmittance (%), Absorbance and Concentration by K-factor & multi standard
2.3	Source of light	Tungsten-Halogen (Visible) and Deuterium lamp for UV-region with automatic source change/xenon Flash Lamp
2.4	Measuring wavelength range	190-1100 nm
2.5	Wave Length accuracy	Better than or equal to ± 1 nm (full range 190 to

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Sl. No.	Items	Required Technical Specification
		1100 nm)
2.6	Wave Length Reproducibility	Better than or equal to < 0.1 nm
2.7	Base Line Correction/ Wavelength selection	Automatic
2.8	Spectral Band width	Variable band width from 0.5 to 2.0 nm
2.9	Resolution	Ratio of absorbance at λmax (269 nm) and at λmin (266 nm) of 0.02 % v/v toluene in hexane (UV grade) should be greater than 1.5
2.10	Photometric range	- 0.4 to 3.5 Abs or better
2.11	Photometric accuracy	± 0.005 at 1A
2.12	Detector	Photo Multiplier Tube/ Solid State silicon photo diode
2.13	Scan Speed	900 nm/min(in 1nm steps)
2.14	Basline flatness	±0.001 Absorbance or better
2.15	Baseline Stablity or Drift	0.0002 A/hr or better
2.16	Stray Light	<0.05 % at 220 nm and 340 nm or better
2.17	Photometric system	Double beam
2.18	Monochromator	Diffraction Gratings with 1200 lines/mm or more
2.19	Sample Cell quartz (Cuvettes) - 10 mm	5 nos. with 10 mm path length and shall be made of quartz or UV grade silica, fused together rather than cemented. 5 nos. with 10 mm path length and shall be made of Glass. Optical windows shall be highly polished, parallel and flat. Entrance & exit surfaces should be exactly parallel
2.20	One set NIST SRM (Optional) for: 4% Holmium Oxide in 10 % perchloric acid for checking wave length accuracy Metal on Quartz Filters for checking photometric accuracy 0.02 % v/v toluene in hexane and hexane blank (UV grade) for checking resolution KCl and water blank for checking Stray Light	Flame-sealed quartz cuvette liquid standards of 3ml capacity in 10mm path length cuvette Consisting 3 filters and a blank Flame-sealed quartz cuvette liquid standards of 3ml capacity in 10mm path length cuvette Flame-sealed quartz cuvette liquid standards of 3ml capacity in 10mm path length cuvette

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Sl. No.	Items	Required Technical Specification
2.21	Back up Memory	System should have backup memory to save minimum 10 sets of working curves with analytical conditions
2.22	Weight	kg or less
2.23	Power Requirement	220 ± 10 V ; 50-60 Hz AC
2.24	Accessories	Bidder shall offer all necessary cables, power cord etc. and any other component required making the instrument complete in all respect.
2.25	Printer Facility	Bidder shall supply the instrument along with built-in printer or with printing facility and consumables such as printing paper etc
3.0	Accessories	
3.1	Operation/ maintenance manual	One set
3.2	Service manual	One set
3.3	Tool kit	One set of required tools
3.4	Other Accessories	Bidder shall offer all necessary cables, power cord etc. and any other component required making the instrument complete in all respect.
3.5	Technical Catalogues	Bidders shall submit technical catalogues in support of the technical parameters
4.0	Warranty	The bidder shall provide the warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation, Demonstration, Commissioning& Performance	i) The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory. (ii) Performance tests shall be carried out by the successful bidder during demonstration & commissioning, for WAVE LENGTH ACCURACY, PHOTOMETRIC ACCURACY, RESOLUTION and STRAY LIGHT. (iii) All consumables including standards required for successful installation and demonstration of performance shall be arranged by the bidder.
6.0	Training	Successful bidder shall provide training to Laboratory personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

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4.8.1..5 Prismatic Comparator

Sl. No.	Items	Technical Specification
1.	Description	Required for testing Silica, Phosphase and Hydrazine. The equipment should be supplied field-ready in a carrying case with reagents and accessories for minimum 30 tests
2.	Range	For Silica Silica 0.25 - 4 mg/L SiO2 For Phosphate : Range : 0 - 2.5 mg/L For Hydrazine Range : 0 - 1.0 mg/L N2H4
3.		Color discs should have a continuous color gradient making it possible to achieve a direct color match No need to extrapolate the result between two color standards
4.	Application	Laboratory
5.	Cell	2 cells
6.	Operation	Automatic
7.	Material	Steel
8.	Voltage	220 V
9.	Training	Successful bidder shall provide training to Laboratory personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.
10.0	Accessories	
10.1	Operation/ maintenance manual	One set
10.2	Service manual	One set
10.3	Tool kit	One set of required tools
10.4	Other Accessories	Bidder shall offer all necessary cables, power cord etc. and any other component required making the instrument complete in all respect.
10.5	Technical Catalogues	Bidders shall submit technical catalogues in support of the technical parameters
11.	Warranty	The bidder shall provide the warrantee for their complete system for a period of 36 (Thirty six)

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		months from the date of successful commissioning.
12.	Supply, Installation, Demonstration, Commissioning& Performance	i) The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory. (ii) All consumables including standards required for successful installation and demonstration of performance shall be arranged by the bidder.

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4.8.2. Chemical Laboratory for DM Plant

4.8.2.1. Technical Parameters of DM Water is indicated below: -

- Turbidity,
- M- Alkalinity,
- Dissolved Oxygen/Carbon Dioxide,
- Chloride,
- Conductivity,
- pH,
- Sodium,
- Silica,
- Potassium,
- Phosphates,
- Hydrazine,
- Ammonia,
- Coagulant Dosage,
- Moisture content/Drying of Chemicals,
- Purified Water
- Iron,
- Copper,
- Free Chlorine,
- Suspended solids

Furnished below the list of Instruments/ Equipment and Chemicals to meet the requirement of aforesaid testing and analysis:-

Sr. No	Name of Instruments/Equipment	Determination Of
1	pH Meter	pH
2	Conductivity Meter	Conductivity
3	Turbidity Meter	Turbidity
4	Flame Photometer	Sodium, Potassium
5	UV-Vis Spectrophotometer	Silica, Phosphates, Hydrazine, Ammonia, Iron, Coper, Free Chlorine
6	Jar Test Apparatus	Coagulant Dosage
7	Filtration assembly with Vacuum Pump	Suspended Solids
8	Dissolved Oxygen meter	Oxygen Contain in Water
9	Analytical Balance	For Accurate Weighing
10	Rough Balance	General Weighing
11	Hot air oven/Drying oven	Moisture content of coal samples, for drying of chemicals, glassware etc
12	Ultra-Pure Water Purification System	To have purified water for analysis

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4.8.2.2. Technical Specification of Instruments

4.8.2.2.1. Bench Top pH Meter

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Standard bench type pH meter suitable for measurement of pH with temperature compensation, stability indicator, Hold & pH slope/off set display
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	pH Range	1.0 to 14.00 pH
2.2	Resolution & accuracy	0.01 & ± 0.01 pH
2.3	mv range	0 to ± 1999.9 MV
2.4	Resolution & Accuracy	0.1 mv & ± 0.2 mv (within 200 mv); 1 mv & ± 2 mv (Beyond 200 mv)
2.5	Resolution & Accuracy	0.1°C & ± 0.3°C
2.6	Nos. of calibration points	Up to 3 points push button calibration with auto buffer recognition for 4.00, 7.0 and 9.2 pH buffer
2.7	Temperature compensation	Automatic/ Manual (0 to 100°C)
2.8	Operating condition	Temperature - Ambient to 45°C Relative Humidity(RH) - 5 to 90% (Non-condensing)
2.9	Display	LCD.
2.10	Power requirement	9V DC & 220 volt AC both
3.0	Accessories	
3.1	Operation/ maintenance/ Service manual	One set Quick reference–slideout instruction and detailed operation manual shall be supplied with the equipment
3.2	Power Cable	To be supplied complete with power cable, plug and 220 VAC adapter
3.3	Other Accessories	pH meter shall be supplied with one set pH electrode and temperature probe, integral electrode holder. As required for operations, i.e. pH Buffer solution and others materials required for trouble free operation of Instruments shall be provided by the supplier at the time of commissioning.
4.0	Warranty	The bidder shall give the warrantee for their complete system covering all the components for a period of 36 (Thirty six) months from the date of successful commissioning.

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Sl. No.	Items	Technical Specification
5.0	Supply, Installation & Demonstration	The successful bidder shall complete supply, installation, demonstration and commissioning of the instrument in the designated laboratory.
6.0	Training	Successful bidder shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.2. Microprocessor Based Conductivity Meter

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	**Description**	Bench type Conductivity meter suitable to measure the Conductivity and Total Dissolved Solids (TDS) of water and waste water. The equipment should be a microprocessor-based conductivity meter with graphics display & electrodes for measurement of conductivity.
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Conductivity measuring range	Three Ranges 0 - 200 µS, 0 – 2 mS, 0 – 20 mS with a measurement accuracy of ± 0.5%
2.2	TDS Range	Three Ranges 0 - 200 mg/l, 0 – 2 gm/l, 0 – 20 gm/l with a measurement accuracy of ± 0.5%
2.3	Temperature Range	0 - 100° C
2.4	ISE Resolution and Accuracy	0.001 and 0.5 %
2.5	Memories	The equipment should have the memory for storing measured values
2.6	Software Programme	It should also have the provision to save the recorded data using suitable data management software and the equipment should have an interface to connect PC or Printer. The facility shall also be available to enter the sample ID for identification purpose.
2.7	Calibration	The equipment should have automatic calibration

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Sl. No.	Items	Technical Specification
		intervals to check the calibration due of conductivity cell. Certificate of calibration shall be supplied with the equipment.
2.8	Display	Graphic Display
2.9	Power requirement	9V DC & 220 volt AC both
3.0	Accessories	
3.1	Carrying Case	The system should also have a complete accessory case for outdoor use.
3.2	Operation/ maintenance/ Service manual	One set of detailed user/ technical/ operation / maintenance manual shall be supplied with the equipment
3.3	Other Accessories	The equipment should be provided along with all the necessary accessories required for conductivity, Temperature and TDS measurements (electrodes, calibration standards, batteries, carrying case, etc.).
4.0	Warranty	The bidder shall give the warranty for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory
6.0	Training	Successful bidder shall provide training to Lab. personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.3. Turbidity Meter

Sl. No.	Items	Required Specification
1.0	**Schedule of Requirement**	
1.1	**Description**	Turbidity meter for Nephelometric measurement, suitable for water analysis
1.2	Quantity	1 Set
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Measuring principle	Nephelometric (90o scatter)
	Light detector	Silicon photocell
2.2	Light source	Tungsten filament Lamp
2.3	Measuring range	0...1000 NTU
2.4	Resolution	0.01 NTU from 0.00 ... 9.99
		0.1 NTU from 10.0 ... 99.9

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Sl. No.	Items	Required Specification
		1 NTU from 100 ... 1000
2.5	Accuracy	± 2%
2.6	Reproducibility	± 1 % of value
2.7	Calibration	Automatic 1 ... 3 point calibration
2.8	Display	Digital display on LCD screen
2.9	Sample Cell	Made of Borosilicate glass with screw cap and Sample Cell Black Cover
2.10	Power Source	220 ± 10 volts 50 Hz AC
2.11	Accessories	Operation/ maintenance /service manual along with all accessories to make the system complete for trouble free operation. Equipment will be supplied with turbidity standards of 10, 20, 100, 400 NTU
2.12	Warranty	36 (Thirty six) months from the date of successful commissioning.
2.13	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory
2.14	Training	Successful bidder shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.4. Flame Photometer

Sl. No.	Items	Technical Specification
1.0 Schedule Of Requirement		
1.1	Description	Flame photometer shall be capable for analysing Sodium, Potassium, Lithium and Calcium in the water samples. Equipment should comprise of an aspirator unit, oil free compressor, burner unit, gas igniter and nebuliser cleaning wire etc. Equipment shall be microprocessor based with in-built Auto Gas Cutoff, Auto Flame Failure detection device and shall have printing facility.
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Flame photometer shall be capable for analysing Sodium, Potassium, Lithium	Equipment should comprise of an aspirator unit, oil free compressor, burner unit, gas igniter and nebuliser cleaning wire etc. Equipment shall be microprocessor

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Sl. No.	Items	Technical Specification
	and Calcium in the water samples.	based with in-built Auto Gas Cutoff, Auto Flame Failure Detection device and shall have printing facility. The Instrument should simultaneously analyse Sodium, Potassium, Lithium and Calcium in single aspiration of the sample
2.2	Flame System	Burner – Stainless Steel Fuel – LPG gas Regulator – SS needle type
2.3	Filters	Instruments should have inbuilt filters for Sodium, Potassium, Lithium and Calcium.
2.4	Detector	Photodiode
2.5	Limits of detection, ppm	Sodium : ≤ 0.2 ppm Potassium : ≤ 0.2 ppm Lithium : ≤ 0.25 ppm Calcium : ≤ 15 ppm
2.6	Instrument response/ sensitivity	Sodium : up to 100 units for 2 ppm or less Potassium : up to 100 units for 1 ppm or less
2.7	Accuracy and reproducibility	± 3 %
2.8	Calibration	Provision of auto calibration of the instrument using multiple standards (upto five)
2.9	Sample data storage	The instrument should have Sample data storage facility. Multiple calibration curve saving facility should be available
2.10	Safety	Auto ignition and automatic gas shut off facility should be available in case of power failure
2.11	Data Presentation	LCD Display
2.12	Key board	Alphanumerical key board should be available for easy data entry
2.13	Power requirement	220 ± 10 volts 50 Hz AC
2.14	Accessories	Oil free Air compressor, Necessary cables/cords for connecting sensors, suitable Rubber pipe connection for compressor to main instrument and any other component required to make the instrument complete in all respect. Silicon tube for aspiration, compatible with nebulizer -1 meter
2.15	Operation/ maintenance/ Service manual	One set of Operation/ maintenance/ Service manual with technical catalogue
2.16	Tool kit	One set of required tools including nebuliser cleaning wire
2.17	Warranty	36 (Thirty six) months from the date of successful commissioning.

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Sl. No.	Items	Technical Specification
2.18	Supply, Installation, Performance Demonstration & Training	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory and shall provide training to Lab personnel.

4.8.2.2.5. UV-Visible Spectrophotometer

Sl. No.	Items	Required Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	PC Controlled / Microprocessor based Double Beam UV-Vis Spectrophotometer. The minimum technical specification of Double Beam UV-Vis Spectrophotometer is given below:
1.2	Quantity Required	01 Set
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Principle	PC controlled/ Microprocessor based Double Beam UV-Vis Spectrophotometer along with built-in printer or with printing facility, required software, and all required accessories, consumables .such as printing paper etc.
2.2	Operating / Measuring Mode	Transmittance (%), Absorbance and Concentration by K-factor & multi standard
2.3	Source of light	Tungsten-Halogen (Visible) and Deuterium lamp for UV-region with automatic source change/xenon Flash Lamp
2.4	Measuring wavelength range	190-1100 nm
2.5	Wave Length accuracy	Better than or equal to ± 1 nm (full range 190 to 1100 nm)
2.6	Wave Length Reproducibility	Better than or equal to < 0.1 nm
2.7	Base Line Correction/ Wavelength selection	Automatic
2.8	Spectral Band width	Variable band width from 0.5 to 2.0 nm
2.9	Resolution	Ratio of absorbance at λmax (269 nm) and at λmin (266 nm) of 0.02 % v/v toluene in hexane (UV grade) should be greater than 1.5
2.10	Photometric range	- 0.4 to 3.5 Abs or better
2.11	Photometric accuracy	± 0.005 at 1A

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Sl. No.	Items	Required Technical Specification
2.12	Detector	Photo Multiplier Tube/ Solid State silicon photo diode
2.13	Scan Speed	900 nm/min(in 1nm steps)
2.14	Basline flatness	±0.001 Absorbance or better
2.15	Baseline Stablity or Drift	0.0002 A/hr or better
2.16	Stray Light	<0.05 % at 220 nm and 340 nm or better
2.17	Photometric system	Double beam
2.18	Monochromator	Diffraction Gratings with 1200 lines/mm or more
2.19	Sample Cell quartz (Cuvettes) -10 mm	5 nos. with 10 mm path length and shall be made of quartz or UV grade silica, fused together rather than cemented. 5 nos. with 10 mm path length and shall be made of Glass. Optical windows shall be highly polished, parallel and flat. Entrance & exit surfaces should be exactly parallel
2.20	One set NIST SRM (Optional) for: I. 4% Holmium Oxide in 10 % perchloric acid for checking wave length accuracy II. Metal on Quartz Filters for checking photometric accuracy II. 0.02 % v/v toluene in hexane and hexane blank (UV grade) for checking resolution V. KCl and water blank for checking Stray Light	Flame-sealed quartz cuvette liquid standards of 3ml capacity in 10mm path length cuvette Consisting 3 filters and a blank Flame-sealed quartz cuvette liquid standards of 3ml capacity in 10mm path length cuvette Flame-sealed quartz cuvette liquid standards of 3ml capacity in 10mm path length cuvette
2.21	Back up Memory	System should have backup memory to save minimum 10 sets of working curves with analytical conditions
2.22	Weight	kg or less
2.23	Power Requirement	220 ± 10 V ; 50-60 Hz AC
2.24	Accessories	Bidder shall offer all necessary cables, power cord etc. and any other component required making the instrument complete in all respect.
2.25	Printer Facility	Bidder shall supply the instrument along with built-in printer or with printing facility and consumables such as printing paper etc

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Sl. No.	Items	Required Technical Specification
3.0	Accessories	
3.1	Operation/ maintenance manual	One set
3.2	Service manual	One set
3.3	Tool kit	One set of required tools
3.4	Other Accessories	Bidder shall offer all necessary cables, power cord etc. and any other component required making the instrument complete in all respect.
3.5	Technical Catalogues	Bidders shall submit technical catalogues in support of the technical parameters
4.0	Warranty	The bidder shall provide the warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation, Demonstration, Commissioning& Performance	i) The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory. (ii) Performance tests shall be carried out by the successful bidder during demonstration & commissioning, for WAVE LENGTH ACCURACY, PHOTOMETRIC ACCURACY, RESOLUTION and STRAY LIGHT. (iii) All consumables including standards required for successful installation and demonstration of performance shall be arranged by the bidder.
6.0	Training	Successful bidder shall provide training to Laboratory personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.6. Jar Test Apparatus

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Jar Test Apparatus with Programmable Controller – To select the water treatment process and quantify the coagulants.
1.2	Quantity Required	01 Set.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	No. of Flocculation beakers/jars	6, cylindrical with 6 stirrer
2.2	Capacity of Beaker	500 ml /1000 ml

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Sl. No.	Items	Technical Specification
2.3	Individual paddle speed	25 to 300 RPM with 1 RPM increment
2.4	Programmable Stirrer Speed and stirring time	The Stirrer will be operated to run independently or continuously at a selected or variable speed. Stirring Time – 1 to 60 Minutes
2.5	Material of Construction of Stirrer shaft and Paddle	Stainless Steel
2.6	Paddle Height	Paddle Height shall be adjustable
2.7	Display	Digital display with LCD module with LED backlit panel.
2.8	Floc illuminator light	In built floc illuminator light shall be available with ON/OFF switch
2.9	Operating conditions	Indoor installation Operating Temperature-10°C - 45°C
2.10	Power supply	220 - 230 V AC supply
3.0	Accessories	
3.1	Beakers/ Jars and other accessories like tools & tackle	Bidder shall offer all necessary beakers/jars, cables, power cord and any other component required to make the instrument complete in all respect for smooth trouble free operation/ functioning at the time of commissioning. The list of same also to be furnished along with offer.
3.2	Operation/ maintenance/ Service manual	Instruction and detailed operation manual to be supplied with the equipment
4.0	Warranty	The bidder shall give the warrantee for their complete system covering all the components for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated lab.
6.0	Training	Successful bidder shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.7. Filtration Assembly with Vacuum Pump

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Filtration Assembly with Vacuum Pump suitable for measurement of Total Suspended Solids. Filtration System shall be complete with Filtration flask, funnel, filter holder with filtration base, spring clamp,

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Sl. No.	Items	Technical Specification
		vacuum pump and all other essential accessories.
1.2	Quantity Required	01 Set
1.3	Make and Model	Bidder to furnish
2.0 Technical Specification		
2.1	Filter Assembly	The filtration assembly shall be made of 100% borosilicate glass with fritted glass filter base with integral vacuum connection located above filtrate drip to prevent contamination of vacuum line with droplets.
2.2	Filter holder	All Glass filter holder-47mm filtration base
2.3	Receiving Flask Capacity	1000 ml
2.4	Filter Funnel Capacity	Glass; 300ml; perforated neoprene cork cover
2.5	Spring Clamp	Made of Aluminium and shall be suitable for clamping the filter holder
2.6	Operating Pressure	Vacuum
2.7	Air Vent Filter	50mm; 0.2µm; Hydrophobic, PTFE
2.8	Membrane Filter	47mm; 0.45µm; Cellulose Nitrate (CN) pack of 100 Nos.
3.0	Vacuum Pump for Filtration Assembly	Vacuum pump shall be for stable pumping throughout the operation, handy, pressure controlled and anti suck back device, low noise level and minimum vibration pump, moisture and solvent resistant to be fitted with pressure gauge. Auto cut to protect from overheating
3.1	Type of Vacuum pump	Diaphragm piston type, oil free with continuous heavy duty type. Adequate for smooth filtration of water/ waste water.
3.2	Motor power & Speed	0.25 HP & 1450 rpm
3.3	Flow rate/ rating	<25 LPM (Maximum)/ 60 W
3.4	Operating voltage	220-240 Volts, 50Hz, Single phase AC
3.5	Noise Level	< 60 dB
3.6	Security/Safety	Equipped with an overheating protection system
3.7	Special Feature	Contains a moisture trap/vacuum regulator
3.8	Vacuum system	Adequate for smooth filtration of water/waste water.
4.0	Accessories	

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Sl. No.	Items	Technical Specification
4.1	Operation manual of filter assembly and vacuum pump along with other accessories.	Bidder shall provide all the items mentioned below The operation manual -1 Flexible Silicone Tubing-Two meters ; Plastic Tweezers (forceps)-One No Power Cord – One No with plug Beside the above any other component required making the instrument complete
5.0	Warranty	The bidder shall give warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
6.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated lab.
7.0	Training	Successful bidder shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.8. Dissolved Oxygen Meter (DO Meter)

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Bench Type Dissolved Oxygen Meter (DO Meter) Electrode type DO Meter, suitable for routine measurement of Dissolved Oxygen in water
1.2	Quantity Required	01 Set
1.3	Make and Model	Bidder to furnish
2.0 Technical Specification		
2.1	Display	LCD (liquid crystal)
2.2	Measuring Ranges and Operating Temperature	mg O2/l - 0.5-20.0 mg/l 5 to 45°C
2.3	Accuracy O2	± 1% or 0.1 mg/l
2.4	Temperature	Automatically with dual thermistor system of Oxygen electrode, compensation range 5-45°C or 1.5% above
2.5	DO Sensor Electrode type	Polarographic / Galvanical sensor shall be a membrane covered oxygen electrode, suitable for the measurement of DO and pressure resistant. Electrode shall be provided with calibration and maintenance kit and clamp to hold the electrode with stand if necessary.

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Sl. No.	Items	Technical Specification
2.6	Energy control	Automatic display
2.7	Power Supply	Universal power supply 9V DC & 220 volt AC both
3.0	Accessories	
3.1	Operation / Service manual	Instruction and detail operation manual shall be supplied with the equipment
3.2	Power Cable and plug	To be supplied with water proof plug, power cable appx.10 feet and 220 V AC adapter
3.3	Other accessories	DO meter shall be supplied with one set DO sensor electrode, 1No. exchange membrane head, stand with electrode holder, electrolyte, cleaning solution, replacement cap and temperature probe, integral electrode holder, Beside above any other component required make the instrument complete will be supplied by the successful bidder.
4.0	Warranty	The bidder shall give warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
6.0	Training	Successful bidder shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.9. Analytical Top Loading Balance (Capacity 120 g)

Sl. No.	Item Description	MECON's Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Analytical Top Loading Balance with digital display capable of weighing up to 0.1 mg
1.2	Quantity Required	01 Set
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Capacity	120 gm
2.2	Readability	0.1 mg
2.3	Repeatability	0.1 mg
2.4	Tarring Facility	Entire range

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Sl. No.	Item Description	MECON's Technical Specification
2.5	Weighing pan diameter	80 - 85 mm
2.6	Display	Digital display and Overload protection
2.7	Calibration	Built-in
2.8	Operating temperature	0º C to 50ºC
2.9	Weighing chamber dimension	6" x 8" x 10" approx. The Glass chamber shall be with sliding glass door with fitted cap in both and top side door for easy sliding.
2.10	Power requirement	220 ±10 VAC, 50 Hz
2.11	Standard weights	A set of Standard weights box containing from 1 mg to 200 g shall be provided along with balance. The weights shall be supplied with calibration certificates from an NABL accredited laboratory with validity of one year from the date of supply.
3.0	Accessories	
3.1	Operation/ maintenance manual	One set
3.2	Tool kit and dust Cover	One set of required tools and dust cover
4.0	Availability of spares	The tenderer shall assure availability of all spare parts for the quoted model of the instrument for a minimum period of 10 (Ten) years from the date of commissioning and submit a certificate to that extent from the manufacturer/principal.
5.0	Warranty	The tenderer shall provide the warrantee for their complete system covering all the components for a period of 36 (Thirty six) months from the date of successful commissioning.
6.0	Supply, Installation, Demonstration & Performance	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
7.0	Technical Catalogues	Bidders shall submit technical catalogues in support of all the technical parameters mentioned above.

4.8.2.2.10. Precision Top Loading Balance (Capacity 500 g)

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Precision Top Loading Balance – for Specific weighing purposes in Laboratory.
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	

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Sl. No.	Items	Technical Specification
2.1	Weighing Capacity	500 g
2.2	Readability	0.001 g
2.3	Reproducibility	0.001 g
2.4	Display	Digital display with Overload protection
2.5	Linearity	± 0.002 g
2.6	Tarring facility	Entire range
2.7	Weighing pan diameter	Min. 100 mm
2.8	Weighing chamber	Weighing pan shall be under the suitable glass chamber with sliding glass door with fitted cap in both and top side door for easy sliding.
2.9	Calibration	Built in
2.10	Stabilization time	2 seconds (Approx)
2.11	Power requirement	220 ± 10 VAC 50 Hz
2.12	Other requirements:	Should be provided with glass draft shield, calibration weights, and dust cover
3.0	Accessories	
3.1	Operation Manual	1 set of Operation Manual should be provided with the balance
3.2	Standard weights	Standard weights of 50 gm, 100 gm and 200 gm should be provided along with balance.
3.3	Tool kit and dust Cover	One set of required tools and dust cover
4.0	Spares parts availability	The tenderer shall assure availability of all spare parts for the quoted model of the instrument for a minimum period of 10 (Ten) years from the date of commissioning and submit a certificate to that extent from their manufacturer/principal. .
5.0	Warranty	The tenderer shall give the warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
6.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
7.0	Training	Successful tenderer shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

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4.8.2.2.11. Hot Air Oven

Sl. No.	Items	Technical Specification
1.0 Schedule of Requirement		
1.1	Description	Hot Air Oven shall be used as general purposes for heating a sample under control conditions and for drying the glass vessel as well as for other analysis
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Capacity	200 to 250 Lts
2.2	Material of Construction	a. External: Stainless Steel Casing. Insulated stainless steel single door with locking and rear zinc-plated steel b. Interior - mirror finish, easy-to-clean interior, made of Double walled stainless steel sheet, with supports on the three sides for three perforated stainless steel shelves adjustable at any level.
2.3	Control System	With PID-temperature controller. Thermostatically controlled system
2.4	Air Circulation	Forced air circulation by quiet air turbine/Fan to ensure uniform temperature, thermostat indicators and on/off switch
2.5	Temperature Range & Control	Ambient to 250°C +/- 1° C. Thermostatic control built in L shaped thermometer-heating elements placed on both sides
2.6	Display	LCD/LED display
2.7	Safety system	Safety alarm for over temperature with indicator lamp.
2.8	Heating Power	2000 watt and above
2.9	Power requirement	220 ± 10 volts 50 Hz AC fitted with Indian plug
3.0	Accessories	
3.1	Operation/ maintenance/ Service manual	One set User/Technical/Maintenance manuals to be provided with instrument
3.2	Power Cable	To be supplied complete with power cable, mains on/off switch.
4.0	Spares parts availability	The tenderer will provide the list of important spare parts & accessories and shall assure availability of all spare parts for the quoted model of the instrument for a minimum period of 10 (Ten) years from the date of commissioning and submit a certificate to that extent.

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Sl. No.	Items	Technical Specification
5.0	Warranty	The tenderer shall give the warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
6.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
7.0	Training	Successful tenderer shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.12. Ultra Pure Water Purification System

Sl. No.	Items	Technical Specification
1.0 Schedule of Requirement		
1.1	Description	The instrument shall consists of pretreatment filter followed by R.O. membrane, combination of DI cartridge with mixed bed resin followed by dual wave length UV lamp with 185 & 254 nm and shall be capable of producing Ultra pure grade of water. System should have recirculation facility with storage tank capacity of 25 l equipped with level sensor and the output water pH value should be neutral.
1.2	Quantity Required	01 Set
1.3	Make and Model	Bidder to furnish
2.0 Technical Specification		
2.1	Quality of water produced	Inlet water quality of the system shall be Plant's water supply system with conductivity > 1500 µs/cm, Max.. The instrument should be able to purify it to Ultra pure grade confirming parameters as specified below:
2.2	TOC (ppb)	≤ 5 with TOC monitor
2.3	Bacteria (CFU/1000ml)	<1
2.4	Resistivity (M Ohm x cm)	18.2
2.5	Endotoxin (Eu/ml)	<0.001
2.6	185/254 nm UV lamp	The instrument shall be provided with dual wave length UV lamp with 185 & 254 nm to reduce bacterial content & to lower the TOC level.
2.7	Production capacity (litre/ hr)	1 or more
2.8	Power Source	220/230 volt AC, 50/60 Hz.
2.9	Accessories	All necessary components required to make the system

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Sl. No.	Items	Technical Specification
		complete in all respect
2.10	Manual	One set of Operation/ maintenance/service manual
2.11	Availability of spares	The tenderer shall assure availability of all spare parts for the quoted model of the instrument for a minimum period of 10 (Ten) years from the date of commissioning and submit a certificate to that extent from the manufacturer/principal
2.12	Warranty	36 (Thirty six) months from the date of successful commissioning. During the tenure of warranty period bidder shall replace consumables like DI cartiges, mixed bed resin or any component, if exhausted/damaged and shall completely replaced the same free of cost. Bidder may consider output water production of 200-300 litre/month.
2.13	Supply, Installation & Performance Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
2.14	Training	Successful tenderer shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation, demonstration and commissioning of the instrument.
2.15	Technical Catalogues	Bidders shall submit technical catalogues in support of all the technical parameters mentioned above.

4.8.2.2.13. Magnetic Stirrer

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	**Description**	**Magnetic stirrer suitable to mix solution with the help of magnetic bar**
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0	Technical Specification	
2.1	Stirring Volume	0 to 2000 ml
2.2	Stirring Speed	0 to ≥1250 RPM
2.3	Top Plate Size	135 x 135 mm
2.4	Construction Material of Top Plate	Stainless Steel

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Sl. No.	Items	Technical Specification
2.5	Timer	999 Minutes
2.6	Display	Display shall be available for speed.
2.7	Operating condition	Ambient to 45°C
2.8	Power requirement	230 ± 10 volt AC
3.0	Accessories	
3.1	Operation/ maintenance/ Service manual	One set detailed operation manual shall be supplied with the equipment
3.2	Other Accessories	Two Nos. Magnetic Bar of 20 mm and 40mm shall be supplied with the equipment As required for operations, all the accessories required for trouble free operation of Instruments shall be provided by the supplier
4.0	Warranty	The bidder shall give the warrantee for magnetic stirrer for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
6.0	Training	Successful bidder shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.14. Glass Desiccators

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	**Description**	**Glass Desiccators with Cover (Lid) and Porcelain Plate for use in laboratory for desiccation / drying / storage of moist products under atmospheric pressure.**
1.2	Quantity Required	02 Nos.
1.3	Make and Model	Bidder to furnish
2.0 Technical Specification		

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Sl. No.	Items	Technical Specification
2.1	Type and material of Glass Desiccator	1. Desiccators' body and cover shall be made of borosilicate glass. The internal side of the Desiccators shall be suitable for easy cleaning of used desiccant. 2. A Knob also shall be made on the top of cover to hold the same 3. The Desiccators shall have ground glass flanges to hold its cover. 4. To keep/ hold the samples a Porcelain Plate shall be positioned inside of Desiccators on an internal ledge made within the base.
2.2	Size	I.D. of Ground Flange shall be 200/250 mm.
2.3	Desiccant	The desiccators shall be supplied with 1 kg of silica gel and 1 kg of silica gel in air tight packet as desiccant
3.0	Supply & Installation	The successful bidder shall supply, install and demonstrate the same in the designated laboratory.

4.8.2.2.15. Hot Plate

Sl. No.	Item	Required Specification
1.0 Schedule Of Requirement		
1.1	**Description**	**Hot Plates with easy setting and digital display shall be provided for accurate temperature setting and control.**
1.2	Quantity Required	1 nos.
1.3	Make and Model	Bidder to furnish
2.0 Technical specification		
2.1	Size	25 cm x 25 cm approx.
2.2	Material of Top Plate	Ceramic corrosion/acid resistant
2.3	Temperature range	30°C to 400°C
2.4	Power	230 VAC, 50 Hz
2.5	Heating Maximum Load	2000 watts approx.
2.6	Spares parts availability	The tenderer shall assure availability of all spare parts for the quoted model of the instrument for a minimum period of 5 (five) years from the date of commissioning and submit a certificate to that extent.

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Sl. No.	Item	Required Specification
2.7	Warranty	The tenderer shall give the warrantee for their complete system covering all the components for a period of 36 (Twenty four) months from the date of successful commissioning.
2.8	Supply, Installation, & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
2.9	Technical Catalogues	Bidders shall submit technical catalogues in support of all the technical parameters mentioned above.

4.8.2.2.16. Laboratory Refrigerator

Sl. No.	Items	Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	Laboratory refrigerators for preserving water / waste water, standard reagents / solutions, etc. at <4•C.
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish
2.0 Technical Specifications		
2.1	Basic Information	It should be high efficiency and optimum energy saving by custom heat cooling system and should have all normal facilities such as de-freeze, thermostat auto defrost system. It shall be high stability with main double cascade cooling system and optimized design for maximum storage of samples
2.2	Capacity	350 to 400 Ltrs.
2.3	Door	Single door (double-layered)
2.4	Shelves	Shelves/Basket (height adjustable)
2.5	Ambient Temperature	10 - 45ºC
2.6	Operational temperature range	2 - 8ºC
2.7	Construction of Material	Sprayed steel plate in Inner and outer Material and Polyurethane (PU)
2.8	Cooling type	Forced Air Cooling System

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Sl. No.	Items	Technical Specification
2.9	Defrost	Auto
2.10	Refrigerant	Eco-friendly CFC free
2.11	Power requirement	220 ± 10 volts 50 Hz AC
3.0	Accessories	
3.1	Operation/ maintenance/ Service manual	One set User/Technical/Maintenance manuals to be supplied
3.2	Other accessorioes	Shall be supplied with compatible voltage stabilizer, Caster with Lock, Foot, Door Lock,
4.0	Spares parts availability	The tenderer will provide the list of important spare parts & accessories and shall assure availability of all spare parts for the quoted model of the instrument for a minimum period of 10 (Ten) years from the date of commissioning and submit a certificate to that extent.
5.0	Warranty	The tenderer shall provide the warrantee for their complete system covering all the components for a period of 36 (Thirty six) months from the date of successful commissioning.
6.0	Supply, Installation & Demonstration	The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory.
7.0	Training	Successful tenderer shall provide training to Lab personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

4.8.2.2.17. Online Silica Analyser

Sl. No.	Items	Required Technical Specification
1.0	**Schedule of Requirement**	
1.1	Description	On Line Silica Analyser The minimum technical specification is given below:
1.2	Quantity Required	01 No.
1.3	Make and Model	Bidder to furnish

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Sl. No.	Items	Required Technical Specification
2.0	Technical Specification	
2.1	Silica measurement range	0-5000 ppb, limit of detection as per ASTM Method D7126
2.2	Operating Range (Temp.)	Ambient – 60 °C 41 °F – 140 °F
2.3	Sample Flow rate	50 – 250 mL / min
2.4	Process Connection	Sample inlet: 6 mm or 1/4" OD tube SS compression fitting Drain hose: 19 x 25.4 mm (¾ x 1"), 2 m (6 ft) length included
2.5	Protection Rating	IP55
2.6	Ingress Protection	IP55 (Enclosure) IP66 / NEMA4X (Electronics)
2.7	Silica Measurement Accuracy	± 5 % of reading or ± 1 ppb, whichever is greater
2.8	Operator Interface	TFT color touchscreen Simultaneous display of silica concentration and measurement or auto-cal status
2.9	Zero calibration	Automatic, every measurement cycle
2.10	Analog Output	Powered 0 / 4 – 20 mA, 22 mA alarm, 500 ohm max load, not for use with externally powered circuit
2.11	Analog Output Scaling	Linear, bi-linear, logarithmic (1,2,3,4 decades), auto ranging
2.12	Power Supply	On power loss all settings are retained without batteries 100 – 240 VAC, 50 – 60 Hz, 100 W
2.13	Power Supply (AC/DC)	100 V – 240 V
2.14	Flow Rate	50 mL/min – 250 mL/min
2.15	Digital Input	Remote start / stop of measurement cycle
2.16	Measurement Parameter	Silica
2.17	Humidity	10 – 90 % non-condensing
2.18	Grab Sample Measurement	500 mL capacity
2.19	Sample Pressure	0.3 – 7 bar (5 – 100 psig)
2.20	Analog Output	± 0.05 mA

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Sl. No.	Items	Required Technical Specification
	Accuracy	
2.21	Measurement Cycle Time	20 min typical Adjustable ≥ 10 min
2.22	Sample Temperature	5 – 60 °C (41 – 140 °F)
2.23	EnclosureType	Full
2.24	Resolution	4 digits with decimal, autoranging 0.001 ppb in lowest range
2.25	Built-in sequencer	Yes
2.26	Ambient Operating Temperature	10 – 50 °C (50 – 122 °F)
2.27	Calibration	Automatic per schedule
3.0	**Accessories**	
3.1	Operation/ maintenance manual	One set
3.2	Service manual	One set
3.3	Tool kit	One set of required tools
3.4	Other Accessories	Bidder shall offer all necessary cables, power cord etc. and any other component required making the instrument complete in all respect.
3.5	Technical Catalogues	Bidders shall submit technical catalogues in support of the technical parameters
4.0	Warranty	The bidder shall provide the warrantee for their complete system for a period of 36 (Thirty six) months from the date of successful commissioning.
5.0	Supply, Installation, Demonstration, Commissioning& Performance	i) The successful bidder shall supply, install, demonstrate and commission the instrument in the designated laboratory/site. (ii) Performance tests shall be carried out by the successful bidder during demonstration & commissioning, (iii) All consumables including standards required for successful installation and demonstration of performance shall be arranged by the bidder.
6.0	Training	Successful bidder shall provide training to Laboratory personnel covering operation and preventive maintenance of the instrument after completion of installation & demonstration.

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4.8.2.3. Technical Specification of Glass Wares, Porcelain Ware and Plastic Wares

Indicated below Technical Specification of Glass ware, Porcelain ware and Plastic ware with capacity and quantities. The list provided is tentative and any additional items required for completeness of the system shall be provided by successful Tenderer.

Sl. No.	Name of the Glass Wares/ Plastic Wares	Capacity	Quantity Nos.
1	Glass Beakers(Graduated)	100 ml	5
2	Glass Beakers(Graduated)	250 ml	10
3	Glass Beakers(Graduated)	500 ml	5
4	Glass Beakers(Graduated)	1000ml	2
5	Burette, straight Bore with PTFE Stopcock - Class "A" with Certificate	25 ml	2
6	Burette, straight Bore with PTFE Stopcock - Class "A" with Certificate	50 ml	2
7	Burette, straight Bore with PTFE Stopcock - Class "B"	25 ml	5
8	Burette, straight Bore with PTFE Stopcock - Class "B"	50 ml	5
9	Bulb Pipette - Class "A"	2 ml	2
10	Bulb Pipette - Class "A"	5 ml	2
11	Bulb Pipette - Class "A"	10 ml	2
12	Bulb Pipette - Class "A"	25 ml	2
13	Bulb Pipette - Class "A"	50 ml	2
14	Graduated Pipette- Mohr Type (Graduation interval 0.02ml) - Class "B"	2 ml	10
15	Graduated Pipette- Mohr Type (Graduation interval 0.05ml) - Class "B"	5 ml	10
16	Graduated Pipette- Mohr Type (Graduation interval 0.1ml) - Class "B"	10 ml	5
17	Graduated Pipette- Mohr Type (Graduation interval 0.2 ml) - Class "B"	25 ml	5
18	Conical Flask Narrow Mouth	100 ml	10
19	Conical Flask Narrow Mouth	250 ml	10
20	Conical Flask Narrow Mouth	500 ml	10
21	Measuring Cylinder graduated (Class B)	50ml	5
22	Measuring Cylinder graduated (Class B)	100ml	5
23	Measuring Cylinder graduated (Class B)	500ml	2
24	Nessler Tube - Graduated in 25 ml and 50 ml	50 ml	25
25	Nessler Tube - Graduated in 25 ml & 50 ml	100 ml	10

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Sl. No.	Name of the Glass Wares/ Plastic Wares	Capacity	Quantity Nos.
26	Separating Funnel, Pear Shape with stopcock with PTFE key &Interchangeable Glass Stopper	125 ml	10
27	Separating Funnel, Pear Shape with stopcock with PTFE key &Interchangeable Glass Stopper	250 ml	10
28	Separating Funnel, Pear Shape with stopcock with PTFE key &Interchangeable Glass Stopper	500 ml	5
29	Filter funnel Plain	Dia - 50 mm	10
30	Filter funnel Plain	Dia - 65 mm	10
31	Volumetric Flask with Interchangeable Glass Stopper ”Class A”	100ml	10
32	Volumetric Flask with Interchangeable Glass Stopper ”Class A”	250ml	10
33	Volumetric Flask with Interchangeable PP Stopper” Class A”	500 ml	5
34	Volumetric Flask with Interchangeable PPStopper” Class A”	1000ml	5
35	Watch Glass –free of bubble	Dia-80mm	10
36	Watch Glass –free of bubble	Dia-100mm	10
37	Weighing bottles with glass stopper-25 ml	-	5
38	Weighing bottles with glass stopper-50 ml	-	5
39	Glass Weighing Scoop	2ml	2
40	Polythene weighing scoop	2ml	2
41	Silica Dishes- 55-85mm (OD)x25-35mm (H), Round with spout	50 ml	5
42	Silica Dishes- 85-100mm (OD)x35-45mm (H), Round with spout	100 ml	5
43	Silica Crucible -20/25 ml - Heat Resistance ≥350°C	-	5
44	Silica Crucible – 50/60 ml - Heat Resistance ≥350°C	-	2
45	Round bottom Test Tubes with Rim	30 ml	25
46	Round bottom Test Tubes with Rim	15 ml	25
47	LDPE Wash bottles, Squeeze Type, Narrow Mouth with screw cap fitted with Pointed Dispensing tube	250 ml	5
48	LDPE Wash bottles, Squeeze Type, Narrow Mouth with screw cap fitted with Pointed Dispensing tube	500 ml	5
49	Reagent Glass Bottles, Amber coloured, Narrow mouth with Glass stopper	250 ml	10
50	Reagent Glass Bottles, Amber coloured, Narrow mouth	500 ml	10

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Sl. No.	Name of the Glass Wares/ Plastic Wares	Capacity	Quantity Nos.
	with Glass stopper		
51	HDPE Reagent Bottles, Narrow mouth with leak proof Screw Cap	250 ml	5
52	HDPE Reagent Bottles, Narrow mouth with leak proof Screw Cap	500 ml	5
53	HDPE Reagent Bottles, Narrow mouth with leak proof Screw Cap	1000 ml	5
54	Sample bottles made of Polythene	1000 ml	50
55	LDPE Indicator dropping bottle (Narrow Mouth)	120 ml	10
56	Burette Stands Retort Stand Type fitted with Rod and double burette clamp made of Polypropylene (PP)	30(L)x20(B) Central	5
57	Burette Stands Retort Stand Type fitted with Rod and Separatory Funnel holder and double funnel holder made of Polypropylene (PP)	30(L)x20(B) side	5
58	Pipette Stands Rack Horizontal Type made of PP	12 groove	3
59	Pipette Stands vertical made of PP	>20 hole	2
60	Test Tube Stands made of PP, Tube dia -32mm	12 hole	5
61	Glassrod	Length -12"	10
62	Lab Spatula set made of HDPE one end flat & another spoony	12 -15 CM	5
63	Lab Spatula set made of SS one end flat & another spoony	12-15 CM	5
64	Gas collection Bulb made of PP (Sauces tube)	250 ml	5
65	Gas collection Bulb made of PP(Sauces tube)	500 ml	5
66	Bubblers three ways mouth with valve, made of natural rubber suitable to fit in gas collection bulb tips for gas sampling	100 ml	5
67	Bubblers three ways mouth with valve, made of natural rubber suitable to fit in gas collection bulb tips for gas sampling	250 ml	5
68	Handy pipette controller made of PP /Silicon	1-100 ml	5
69	Pestle and Mortar - shall be made of natural agate (silicate with a main composition of SiO_2) The grinding surface shall be polished, non reactive to detergent and will be suitable for preparing laboratory samples and pure chemicals. The thermal endurance shall will be ≥350°C .	Depth- 20-25 mm ID – 80 mm OD – 95 mm	1 Set
70	Tongs for Crucible made of Stainless Steel	8 inches	6
71	Glass Marker Pen –Suitable to write on glass & Polythene surface	Red, Blue, Green, Black Colour	One each

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Note:- **1. All glass ware shall be made of Borosilicate Glass and Plastic wares will be made as mentioned in all items**

2. All Class 'A' glass wares shall be supplied with Class 'A' Certificate

4.8.2.4. List of Chemicals

Indicated below list of chemicals envisaged for designated DM lab. The list provided is tentative and any additional items required for completeness of the system shall be provided by successful tenderer.

Sl. No.	Name of Chemicals
1	Ammonium Chloride (AR)
2	Ammonium Hydroxide -30% (AR)
3	Magnesium Salt of EDTA (AR)
4	Disodium Salt of ethylenediaminetatra acetic acid dehydrate (AR)
5	Magnesium Sulfate ($MgSO_4.7H_2O$) (AR)
6	Magnesium Chloride ($MgCl_2.6H_2O$) (AR)
7	Sodium Hydroxide (AR)
8	Conc. Hydrochloric Acid
9	Murexide (Ammonium Purpurate) (AR)
10	EDTA – Disodium Ethylenediaminetetraacetate dehydrate (AR)
11	EBT – Erichrome Black T (AR)
12	pH 4 – Buffer Solution (Potassium hydrogen phthalate) - CRM
13	pH 7 - Buffer Solution (Potassium di-hydrogen phosphate / di-Sodium hydrogen phosphate) -CRM
14	pH 9.22 - Buffer Solution (Di-Sodium tetraborate) -CRM
15	Maganous Sulphate ($MnSO_4.4H2O$) AR
16	Potassium Hydroxide – AR
17	Sodium Iodide -AR
18	Potassium Iodide - AR
19	Sodium Azide - AR
20	Conc. Sulfuric Acid
21	Sodium thiosulfate -AR
22	Potassium Dichromate -Secondary reference standard for volumetric titration
23	Potassium Dichromate -AR
24	Starch - AR
25	Potassium chloride - CRM
26	Conc. Nitric acid
27	Sodium Chloride - CRM
28	Sodium Chloride
29	Ferrous Ammonium Sulphate -AR
30	Mercuric Thiocyanate-AR

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Sl. No.	Name of Chemicals
31	Methanol -AR
32	1-amino, 2-napthol, 4-sulphonic acid - Extra Pure
33	Sodium hydrogen Sulphite ($NaHSO_3$) - AR
34	Ammonium Molybdate $(NH_4)_6$, Mo_7O_{24}, $4H_2O$ -AR
35	Oxalic Acid – ($H_2C_2O_4.2H_2O$) -AR
36	Sodium Metasilicate – ($Na_2SiO_2.\ 9H_2O$) -AR
37	Potassium Dihydrogen Phosphate -AR
38	Anhydrous Potassium Carbonate – AR
39	Sodium Sulphite Heptahydrate (Na2SO3.7H2O)-AR
40	Hydroquinone – AR
41	Stannous Chloride -AR
42	Hydrazine Dihydrochloride -AR
43	p-Dimethylaminobenzaldehyde – AR
44	Potassium Sodium Tartrate – AR
45	Mercuric Chloride – AR
46	Cupric Sulfate – AR
47	Zinc Sulfate – AR
48	Sodium Nitrite – AR
49	Chlorophorm (CHCl3)
50	Sulphanilic Acid – AR
51	Glacial Acetic Acid – AR
52	1- Naphthylamine – AR
53	Isopropyle ether – AR
54	Di-isopropyl Alcohol
55	Phenonthroline (1-10 Phenonthroline monohydrate -$C_{12}H_8N_2$, H_2O)-AR
56	Hydroxylamine – Hydrochloricle (NH_2OH. HCl) - AR
57	N-Hexyle Alcohol (HEXAN-1-OL) or iso-amyl alcohol-AR
58	Ammonium acetate ($NH_4C_2H_3O_2$) - AR
59	Sodium Acetate trihydrate ($NaC_2H_3O_2$, $3H_2O$) – AR
60	Ferrous Amonium Sulfate – $Fe(NH_4)_2(SO_4)2.\ 6H_2O$ - AR
61	Potassium Permagnate ($KMNO_4$) -AR
62	Ethyl Alcohol -AR
63	Bathophenanthroline -AR
64	Iron Standard Solution -1000 mg/l (Single element solution) - CRM
65	Copper Standard Solution -1000 mg/l (Single element solution) - CRM
66	Conc. Sulphuric Acid
67	Sodium Citrate ($Na_3C_6H_5O_7.2H_2O$) -AR
68	2,9 Dimethyl, 1, 10 Phenonthroline Hemitrydrate (Neocuproine)-AR
69	Free Chlorine Text Kit with Chart Range – 0 - 2 mg/lt
70	Hydrazine Sulfate $(NH_2)_2.\ H_2SO_4$ -AR
71	Hexamethyleneteramine $(CH_2)N_4$ – AR
72	Sodium Carbonate anhydrous -AR

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Sl. No.	Name of Chemicals
73	Bromocresol Green Indicator Powder
74	Metacresol Purple Indicator Powder
75	Phenolphthalein Indicator Powder
76	Potassium Chromate (K_2CrO_4) - AR
77	Silver Nitrate - AR
78	Fused Calcium Chloride - LR
79	Qualitative Filter Paper equivalent to Whatman Grade -1, Size-125 mm
80	Quantitative Filter Paper - equivalent to Whatman Grade -41, Size-125 mm
81	Quantitative Filter Paper - equivalent to Whatman Grade -42, Size-125 mm
82	Quantitative Filter Paper - equivalent to Whatman Grade -42, Size-70 mm
83	Cellulose Nitrate Membranes Filter Paper - 47 mm /0.45µm

**** End of Clauses ****

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4.9. STRUCTURAL WORKS

4.9.1. General

Purchaser will get the steel structural works executed for which the detailed engineering drawings will be prepared by the Consultant based on the input data/ assignment drawings of the Tenderer. It will be the responsibility of the Tenderer to ensure the correctness and completeness of the data/drawings supplied to the Purchaser so that drawings prepared by the consultant shall not undergo changes. However, any change felt necessary in the basic engineering data/assignment drawings issued by the Tenderer to the Purchaser, in course of detailed engineering by the Tenderer, shall be immediately and specifically informed in writing to the Purchaser. Since total responsibility of testing and commissioning of the entire complex lies on the Tenderer, one set of all steel structural design drawings prepared by the Consultant will be sent to the Tenderer for concurrence within an agreed time schedule. During detailed engineering any clarifications sought by Purchaser shall be replied promptly by the Tenderer.

The scope of input for steel structures shall be as follows but not limited to these.

Supply of basic input design data/assignment drawings as detailed further in this chapter, for designing steel structures pertaining to buildings, supports for pipelines etc. which Purchaser will procure through indigenous design and supply for the units listed in this specification.

4.9.2. Scope of the Tenderer

The Tenderer shall furnish the basic input data/ basic engg. Drawing/ assignment drawings indicating the following information along with any other special design consideration for designing the building structures, supports for pipelines etc. required within the battery limits.

4.9.2.1. For Building and Other Structures

The scope of work shall cover providing the layout, data and other parameters required for design/ engineering of the structures for which the structural detailed engineering is beyond the scope of the technological supplier.

a) Submission of layout / cross section drawings of individual buildings with basic dimensions, column spacing, column leg spacing, levels, clearances considering statutory and safety requirements, locations of expansion joints, column vertical bracings and provision of future expansion, if any, etc.

b) Crane capacities and their numbers in each bay of the building, crane spans, rail levels, requirement of walkway along crane long-travel top and end clearances, working condition of cranes in a particular bay i.e. in tandem or not, class / duty cycles, all load data pertaining to cranes along with rail size, crane wheel configuration with load data,

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clearance diagram, etc.

c) Location, routing, level and capacities of hoists for maintenance of cranes and other equipments. Projection of monorail beam beyond the building, if any, shall be indicated.

d) Location, general arrangement, type of construction of all floors, platforms, walkways, staircases, ladders, etc. with due considerations of their feasibility and safety requirements, along with the design superimposed load and technological loads with dynamic effect, if any

e) Dust load on roof/floors of the buildings, if any

f) Type of roofing material and side cladding

g) Requirement of natural ventilation on roof and side walling of the buildings – Monitor throat opening and length, size and number of louvers.

h) Requirement of natural lighting on roof and side walling of the buildings.

i) Location and loading from water supply and utility pipelines, cables, ducts and other service lines, which may be required to be supported from the building structures.

j) Location and loading from adjacent buildings, lean to buildings, etc. if any, which may be supported from the building structures.

k) Requirement of heat shield and its type to protect the building structures, if any.

l) Corrosion protection system with special requirement, if any.

m) Floor live loads to be considered, extent of floor and floor cut outs.

n) Location and size of erection opening.

o) Equipment location, load data, fixing details.

p) Size and location of duct opening, load from ducting and supporting arrangement required.

q) Other technological requirements and equipment loads.

s) For other utilities like pipe, cable and conveyor galleries the layout, elevations and cross sections, walkways, type of roof and side covering, location of take-up, location of trestles etc. shall be furnished.

t) All loads, spillage loads, loads due to service pipelines, if any, belt tensions, belt speed etc. shall be furnished.

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u) For steel bunkers and silos, capacity of bunkers, profile of bunkers, major dimensions, size and location of openings at bunker top and bottom, type of supports (load cell or ordinary) of bunker / silo, characteristics of storage material, requirement and type of liners including its fixing details, details of any vibrating equipments and loading on bunker walls, maintenance platforms, access to platforms, requirement of load indications, if any, etc.

v) For steel chimneys, height, diameter of chimney at top and bottom, thickness of lining, if any, density of lining, temperature of flue gas, number of platforms, access to platforms, location of flue duct connection, doors etc.

w) For gas/ water/ cable galleries, layout of pipes/ conveyors, elevations and cross sections indicating type of supports (sliding, pendulum and fixed supports), type and extent of walkways, if any, etc. Loads from pipelines (empty, operating and testing), load from walkways, temperature and technological loads from pipelines, etc

x) Any other data/ parameters necessary for structural design not specified above shall be furnished.

4.9.2.2. For All Technological Structures

a) The scope of work shall cover providing the layout, data and other parameters including structural design-engineering/ supply/ erection of structures within the scope of the technological supplier.

b) General Instructions

All structural design/ engineering of structures shall be carried out in accordance with IS codes. Some of the IS Codes to be followed for design of structures shall be as follows.
IS 800: 2007- For Design of Steel Structures
IS 875 (Pt 1&2) - For Dead and Live Loads
IS 875 (Pt 3): 2015 - For Wind Loads
IS 1893 (Pt 4 and Pt 1): 2015/ 2016 - For Seismic Loads
IS 6533: 1989- For Design of Chimney
IS: 9178 (Part 1) 1979 – For Design of Steel Bins

c) For conveyor/ pipe/ duct bridge structures, vertical deflection of gallery shall be limited to Span/400 and horizontal traverse deflection of trestle top shall be limited to height/1000.

d) The design drawings shall be submitted in complete for a unit along with design calculations both in hard copy and soft copy indicating formulae used. Design shall be done using STAAD.

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4.10. CIVIL WORKS

4.10.1. Civil works (both design & execution) are excluded from the scope of the package Tenderer. However, package Tenderer shall indicate the space requirement in composite layout including load data of individual foundations as required for package completion well in advance so as to design and construct the same suiting to project requirements.

All foundation bolts, embedded bolts with templates, anchor box, sleeve, machined inserts, etc. shall be in the scope of the Tenderer.

4.10.2. The Tenderer shall submit all the information required in the form of drawings based on which the civil engineering detail drawings will be prepared by the purchaser / his consultant. The Tenderer shall submit the integrated general layout with sectional views with all necessary dimensions for preparation of civil drawings. The civil engineering assignment drawings to be prepared by the Tenderer shall include the following:

- Load data for all technological structures including erection loads
- Details of foundation bolts showing location of pockets, projection above concrete, threaded length, diameter, etc.
- Area & thickness of grouting, type of grout recommended
- Environmental details like temperature, pressure, corrosion prevailing over or around the structures
- Process drainage / waste disposal requirements, if any
- Sequence of erection of structures / equipment and basic information on the sequence of construction of civil structures required (within battery limits).

4.10.3. Machine and Equipment foundations

- Foundation plan and sections / elevations
- Details of foundation bolts showing bolt plan, location of pockets, projection above concrete, threaded length, diameter, etc.
- Details of anchor box / sleeve
- Details of all inserts, conduits to be embedded in concrete / brick work
- Complete load data and their point of application including dynamic loads wherever applicable. Operating speed, permissible amplitude, Characteristic curves (frequency /speed vs time), Unbalanced forces etc for machine (fan ID/ FD, pump, turbine, generator etc as applicable etc).
- Area and thickness of grouting, type of grout, strength of grout recommended
- Protection requirements, if any, against heat, temperature, corrosion, pollution, etc.
- Process drainage / waste disposal requirements
- Sequence of erection of equipment and details of erection openings, if any.

4.10.4. All other units for which basic & detail engineering of technological item / units are to be done by Tenderer. All relevant necessary data for preparation of civil working

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drawings shall be provided by the Tenderer.

Floor loadings to be considered in designing of foundations / structures. Clear height required for the equipment inside the cellars, ECR buildings, etc.

4.10.5. The Tenderer shall provide all other necessary drawings, specifications and information not covered under the above scope of basic engineering but is essential for completeness of civil design and execution of project.

4.10.5. The Tenderer shall participate in inspection and checking of the completed civil works.

**** End of Clauses ****

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5. ELECTRICS

5.1. Special Instructions to Bidder

5.1.1. Compliance with Specification

All equipment and accessories covered under this specification shall conform to 'Technical Specifications' given in this document.

In case alternative type of equipment is offered, all technical particulars of equipment offered, number of such equipment supplied in India, reference list of installations where such equipment is in operation as per qualifying requirements, type test certificates of their collaborators, type test certificates of indigenously made equipment, extent of import content and availability of spares indigenously, along with any other data for considering the alternative equipment shall be furnished with the offer. The purchaser, however, reserves the right to accept or reject the proposal without assigning any reason.

All equipment shall be suitable for voltage/frequency variations and other data given in Electrical System Design.

The bidder shall be responsible for satisfactory working of system with guaranteed parameters. All the equipments under the scope of the bidder shall be installed/erected, tested and commissioned by the bidder and/or bidder assigned representatives of respective OEM/Sub-vendor.
For erection, testing and commissioning, the details furnished in separate chapter of this tender specification shall also be referred by the bidder for proper compliance.

In case of any contradiction between the data given elsewhere in overall Technical Specification (TS) and this specification, in general, the stringent of the two will be followed. However, in all such cases, bidder shall refer the same to the purchaser/consultant for necessary review and finalization.

5.1.2. Standards and Regulations

The design, manufacture, performance, testing and installation (including safety, earthing and other essential provisions) of equipment and accessories covered under this specification shall, in general, comply with the latest issue of the following:

- Applicable Standards and Codes of Practices published by Bureau of Indian Standards.
- Central Board of Irrigation and Power
- Indian Electricity Act, 2003
- Central Electricity Authority
- Indian Electricity Rules
- Equipment specific statutory regulations
- Indian Factory Act

Equipment complying with other recognized Standards such as IEC, BS, VDE, DIN etc. will also be considered if it ensures performance equivalent to or superior to Indian Standards.

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Equipment and accessories for which Indian Standards are not available, shall be designed, manufactured and tested in accordance with the latest issues of recognized Standards such as IEC, BS, VDE, DIN etc.

In case of conflict between applicable Standards referred to in this part and technical specifications, bidder shall intimate the purchaser all such differences for review and resolve. However, in general, the Technical Specifications shall govern to the extent possibility for all such differences.

5.1.3. Make & Interchangeability

This specification is issued for procurement of specified equipment and system preferably from indigenous suppliers who may make use of imported systems / sub-systems / equipment / parts and who have valid collaboration agreement with reputed foreign suppliers with experience in design and supply of similar systems as specified. The Bidder shall furnish division list of supplies from foreign and Indian sources indicating the name of the agency or make against the respective items. It shall be the responsibility of the successful bidder to arrange the import license for the imported items offered and to co-ordinate the supply of equipment from foreign and Indian sources and execute the contract within the agreed time schedule.

The make of major equipment shall be limited to preferred makes indicated this document under 'List of preferred makes'. Makes of all other equipment and accessories are subject to prior approval by the purchaser. The make of equipment not covered in the TS shall be considered after the approval of purchaser/consultant during the detailed engineering stage.

Similar equipment and components shall be of same make; equipment of same type and rating shall be interchangeable.

The purchaser has the option of selecting the manufacturer of electrical equipment, instruments and controls and any other specialized items in the interest of standardization and the successful bidder shall have to supply equipment of particular make, if so required.

5.1.4. Safety

All equipment shall be complete with approved safety devices wherever a potential hazard exists and with provision for safe access of personnel to and around equipment for operational and maintenance functions.

The design shall include not only those usually furnished with elements of machinery but also the additional covers, stairways, ladders, steel structural platforms for operator's control panels, handrails, partitions etc. which are necessary for safe operation of the plant. In addition, maintenance platform, wherever required, shall be included in the design.

All danger and caution notice boards shall be in Hindi, English and Bengali.

When the work is carried out at night or in the obscure day light, adequate arrangements

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for flood lighting in the working area shall be made by the bidder at his own cost and got approved by the purchaser.

The safely postures/regulations for the prevention of accidents shall be displayed by the bidder at appropriate places. Notices and warning signs shall be displayed for all sources of dangers.

All electrical drives and equipment must be equipped with safety devices. The safety provisions shall conform to the recognized standards, safety codes and statutory regulations.

All safety measures as required to be adopted as per the statutory regulations and the safety rules of the plant shall be strictly followed by the Bidder during the execution of the Contract.

Adequate number of first aid boxes as defined in the State Factory Rules shall be provided and maintained at all the work sites.

5.1.5. Coding/Numbering Scheme

Bidder shall adopt the coding scheme to be provided by the purchaser during engineering stage, for identifying the drawings, plant and equipment, structures, spares and shipping documents in a sequential manner.

5.1.6. Bidder's License

The bidder shall possess a valid and competent bidder's license of specified voltages issued by the electrical licensing authorities of the Govt. of West Bengal or other States for carrying out electrical installation work of the type and magnitude covered in this document, in the state of West Bengal. The bidder shall also be required to obtain labour license from Statutory Authority.

Copy of the license shall be made available to the owner/consultant for verifications during the execution of contract.

All linemen, wiremen, electricians, supervisors and engineers engaged by the bidder or his sub-bidder shall possess necessary valid license issued by the statutory authority and the same shall be submitted for verification, if called for.

5.1.7. Compliance with rules, regulations, and obtaining statutory approval

All equipment/materials shall be installed in accordance with the requirements of relevant standards, Indian electricity Rules, Indian Electricity Act, 2003 and also the Factory Act. It is the responsibility of the bidder to see that the electrical installation supplied and erected by him shall be to the entire satisfaction of Chief Electrical Inspector, Central Electricity Authority or any other statutory body having jurisdiction in the area and also to the owner/ consultant.

The responsibility for obtaining all statutory approvals for the installation to be carried out rests entirely with the bidder. It shall be the responsibility of the bidder to prepare and submit all necessary drawings, calculations, test certificates and relevant details

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(other than those given by the owner/consultant) to the Electrical Inspector and obtain prior approval for commencing the work and for the complete installation work done.

The inspection fee for statutory approvals shall be reimbursed by the owner on submission of documentary evidence.

5.1.8. Type test certificate from CPRI or Govt. institute (conducted with in 7 years before the date of LOI) for all the equipment shall be submitted , other wise Type test of the equipment shall be carried out by the supplier at CPRI or Govt. institute without any cost implication to the purchaser.

5.2. Scope and Brief Description of Work and Electrical System Design Criteria

5.2.1. General

The scope of work includes design, engineering, procurement, manufacturing, inspection/testing at manufacturer's works, supply, ,unloading, storage at site, erection, testing and commissioning of all equipment/system including preliminary acceptance test, performance guarantee and post commissioning services, insurance cover during transit, storage, erection and commissioning for total electrical system for the entire Captive Power Plant with the following units along with the auxiliaries.

- 3 x 300 t/hr Mixed Fuel Fired Boilers.
- 3 x 40 MW Steam Turbine Generators
- 3 nos. Steam Turbine driven Blowers

The bidder shall note that in this project (4.08MTPA expansion), there will be one TRT Generator which will be supplied by purchaser/other vendor and shall be located near Blast Furnace complex. Power generated in TRT shall be evacuated to standalone 33kV GIS in TRT (TRT 33kV GIS is under the scope of purchaser/others), located in TRT area. This TRT 33kV GIS shall be connected to 33kV GIS in CPP, (33kV CPP GIS is under the scope of this bidder), located in CPP area. All cabling from CPP GIS and CPP Control system to Purchaser's TRT (GIS and Control system) is in CPP Bidder scope. Facility for synchronization of TRT shall be from both TRT control room and CPP control room. For this, one set of TRT synchronization panel to be supplied by TRT supplier shall be located in CPP control room. For this, further engineering/methodology shall be finalized during detail engineering stage once inputs from both TRT and CPP vendors are available.

The job shall be done on turnkey basis including supply of Commissioning Spares and Special Tools and Tackles.
For two years O&M spares, bidder shall supply List of items for two years O&M spares along with item wise price list.

After successful commissioning, the commissioning spares not used, will be the property of the owner

5.2.2. Emergency Power Supply to Category-1 / Emergency Loads

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Emergency LBSS envisaged under CPP scope shall cater to the category-1 / emergency loads of blast furnace LBSS, coke oven and by-product LBSS, HSM LBSS, SMS LBSS, plant emergency lighting and plant common facilities like water system, compressed air station.

5.2.3. 33 kV, 6.6 kV and 415 V power will be carried through XLPE insulated aluminium conductor, armoured cable. The cables will be laid on cable trays in cable gallery / Cable Trestles / Supporting Structures, wherever applicable connecting to various load centres, Equipment, LBSS/LCSS of plant units.

5.2.4. All civil and structural works for the electrical premises e.g. Substation building, MCC room, control room , cable trench, cable trestle etc. and for all the electrical equipment foundations shall be carried out by purchaser/others. However, bidder shall submit civil assignment drawings and engineering inputs/details for all buildings and equipment foundations. Bidder shall take into consideration of the following while submitting the civil assignments and/or drawings:

Static and dynamic loading of the equipment
Clearances, approach, safety exits required
Recommended height of electrical rooms/buildings considering busduct height, ventilation ducts and civil beams height etc.
Future provision of electrical equipment.

Bidder shall have to build all above aspects in his offer whether specifically mentioned in civil part or not.

Clearances from all the four sides of the walls shall be maintained as per TS/applicable standards / good design practice.

Providing all input informations related to civil and structural works and all sorts of co-ordination with the purchaser/purchaser assigned other vendors (Civil and Structural), shall be undertaken by the bidder to avoid any difficulty and/or adversity during erection and commissioning of the entire electrics at site to be carried out by this bidder.

5.2.5. **The major equipment covered under scope of work shall be as follows:**

1. Complete generator sets and their auxiliaries consisting of the following major equipment/systems
   - Generator sets
   - Equipment/systems/mechanisms like acoustic enclosure, etc to meet pollution norms like noise level, vibration level, etc.
   - Generator cooling systems
   - Generator lubricating oil systems
   - Complete excitation systems (brushless type),dual channel(i.e. double auto and double manual channel) latest digital AVR (thyristors controlled with dual channels and associated electrical equipment having data interface with DDCMIS)
   - Generator line side terminal cubicles consisting of Surge Arrestors, PT, CT, Capacitor, Link etc.
   - Generator neutral cubicles with neutral side CTs.

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- Generator neutral grounding transformers (NGTs) with isolator and secondary loading resistor
- CO_2 / Suitable extinguishing system for the Generators.
- Any other equipment/systems required for smooth running of generator sets

2. Generator Transformer (rating to be selected as per design requirement of the bidder) 11/34.5 kV, ONAN Type for STGs along with NIFPS (nitrogen injection fire protection system) and necessary piping/ring with sprinklers, On-Off valves etc. around each of the transformers having connecting facility with isolation valve to the fire water supply line (MVWS) to be supplied separately by purchaser/other vendors.
3. Phase segregated generator bus ducts from generator to generator transformer for each of the Generators including all supporting structures and required number of bends and accessories (along with suitable canopy with proper slope for outdoor portion).
4. Control, monitoring, interlocking, annunciation and synchronising panels, desks for all the generators, the upstream MRS interconnector and bus coupler
5. Relay and Protection Panel for all the Generating units
6. 33 kV GIS (Double bus bar) along with separate relay and control panel.
7. Synchronising panel(s) (separate supply by TRT supplier) for Power evacuation of TRT (TRT supply by purchaser/others) to 33kV GIS in CPP area for necessary synchronization along with required equipment/instruments
8. Islanding & Load Shedding Panel for Grid Islanding due to the Grid Fault and disturbance
9. All Power Transformers, 33/6.9 kV, ONAN/ONAF type (individual ratings to be selected as per design requirement of the bidder) for Boiler, TG, auxiliaries wherever applicable along with NIFPS (nitrogen injection fire protection system) and necessary piping/ring with sprinklers, On-Off valves etc. around each of the transformers having connecting facility with isolation valve to the fire water supply line (MVWS - to be supplied separately by purchaser/other vendors).
10. Emergency LBSS comprising of 6.6 kV Switchboard, Two nos. of Power Transformers etc., each of rating 25/31.5 MVA (Approx.), 33/6.9 kV, ONAN/ONAF type along with NIFPS (nitrogen injection fire protection system) and necessary piping/ring with sprinklers, On-Off valves etc. around each of the transformers having connecting facility with isolation valve to the fire water supply line (MVWS to be supplied separately by purchaser/other vendors).
11. Auxiliary Transformers, each of rating 2.5 MVA/2 MVA/1.6MVA (individual ratings to be selected as per design requirement of the bidder), 6.6/0.433 kV, ONAN type. However, depending upon the load of individual load centres, capacity and quantity of distribution transformers which will be selected by the bidder shall be clearly specified in their offer for review / finalization by the purchaser.
12. Design details of Individual oil collecting pits for all the transformer and common sump pit along with interconnection of individual pits to sump pits.
13. Design details for foundations and all civil works including fire wall between transformers for all transformers, fencing & gate.
14. All 6.6 kV Switch Boards including that for Emergency LBSS.
15. SAS (Substation Automation System) upto 6.6 kV level
16. 415V Power cum Motor Control Centers (PMCCs) for Boiler and TG.

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17. 415V Motor Control Centers individually for all the Boilers.
18. 415V Motor Control Centers individually for all the Steam Turbine Generator.
19. 415V Motor Control Centers individually for all the three Steam Turbine Blowers.
20. 415V Emergency MCC to which DG power will be connected as one of the incomers
21. 415V Motor Control Centers for DM Plant (DM plant MCC shall be of thermoplastic poly carbonate material)
22. 415V Motor Control Center for Cooling Water system.
23. 415V Motor Control Center for BOP/Common system.
24. 415V Motor Control Center for the AC and Ventilation system.(ACVS MCC)
25. 415V Motor Control Center / Local Starter Box for Compressed Air station MCC (CAS)
26. 415V Power Distribution Boards.
27. Soft starter with DOL bypass for motors rated above 75kW. Soft starter shall also be considered for barring gear motors.
28. A Remote Control, metering & annunciation panel for the centralized control desk, metering and annunciation for all the 33 kV, 6.6 kV and 415 V feeders shall be provided.
29. Hooking up for control, monitoring and protection of generators and power distribution equipment/systems, HT & LT Boards, Motors, UPS, DC system, with DDCMIS. Transducer panels for inputs/outputs from/to electrical equipment to/from DDCMIS shall be in the scope of the bidder.
30. One set of redundant DC System including two nos. rectifier, two sets of battery, two nos. of FCBC, One DCDB, for DC motor loads and emergency lighting of the plant. Bidder shall provide 30% extra capacity for use by purchaser/others
31. One set of redundant DC System including two nos. rectifier, two sets of battery, two nos. of FCBC , One DCDB, for generator control and protection as well as for HT/LT substation requirement. Bidder shall provide 30% extra capacity for use by purchaser/others
32. Dual Redundant UPS system complete in all respects for all UPS power requirements for items/equipment/system under the scope of this bidder. Bidder shall provide 30% extra capacity for use by purchaser/others
33. HT & LT motors including DC motors and actuators.
34. Motorized control/isolation valves with integral starters with manual operating handles. In addition to the Make list provided by ISP for motorised actuator, Antrieb Make may also be considered by the bidder'.
35. All HT & LT power and control cables
36. All Signal and instrumentation cables, special cables, screened cables, fibre optic cables, etc
37. Plant earthing system including main plant earthing mat and other system/safety/equipment earthing, electronic earthing, etc.
38. Plant lightning protection.
39. Suitable surge protection against lightning and switching surges for all electrical and electronic equipment.
40. Plant road, area and building illumination within battery limit with Lighting Transformers, MLDB and sufficient numbers of LDBs /SLDBs, lighting poles, lighting fixtures.
41. DC starter panels for DC motors.

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42. Fire Detection and Alarm System for the complete plant , NIFPS and emulsifier system for generator transformers and unit power and auxiliary transformers
43. Telecommunication
44. CCTV
45. Local Push button stations.
46. Welding sockets, Power receptacles, etc.
47. Complete electrics of material handling equipment like cranes, hoists, elevators as required for all the equipments/items, Monorail for HT/LT motors
48. Complete electrics of DG (for electrics of DG, separate chapter to be referred)
49. All erection materials / hardwares, required during erection of Generator and auxiliaries, Electrics of Boiler and auxiliaries, Electrics of Turbine and auxiliaries, Electrics of Blower and Auxiliaries, GIS and all types of electrical equipment/system under bidder's scope within the battery limit of CPP.
50. Transformer handling rail track. This shall be extended upto the road. Design details and associated drawings shall be submitted
51. Complete electrics of air-conditioning and ventilation systems in all the premises under battery limit.
52. Water drainage pumps/sump pumps in required numbers with complete electrics including source feeders, pumps/motors etc.
53. Fire Detection and Alarm System with associated Panel for the cable gallery/cable cellar, electrical buildings/equipment/rooms, control rooms and other premises within battery limit
54. HVWS/Emulsifier (for Transformers rated above 10MVA or having oil quantity 2000 litre or above), NIFPS system for generator transformers, power transformers and unit auxiliary transformers etc.
55. Portable pumps for taking oil/water from transformer sump pit with suitable sockets near oil sump pits.
56. Safety items.

5.2.6. Installation/Erection, Testing and Commissioning

The scope of the bidder shall also include the following:

- Erection, testing, commissioning including transportation of all equipment and material, associated controls and electrics which are in the scope of supply of bidder..
- Necessary coordination work required for erection, testing & commissioning and resolving problems of all equipment.
- Installation & testing of cabling system, including cable, trays/supports etc.

- Laying and termination of all interconnecting cabling required for completeness and commissioning of the plant.

All equipment, components, erection accessories or consumables required for the completion of the electrical job shall be in the scope of the bidder.

5.2.7. Scope of Miscellaneous Activities

Following miscellaneous works shall also be included in the scope of bidder;

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- Obtaining certificate from Chief Electrical Inspectorate of the state and CEA required for installation and energising the complete electrical system and equipment covered under the package.

- Any modification or additional requirements by Statutory Authorities shall have to be carried out without time and cost implication to the purchaser.

- Arranging any other statutory approval, if required.

- Along with the offer, bidder shall submit proposed layout diagram for all electrical equipment, panels, GIS, Transformers etc. indicating approximate dimensions for each item. Bidder shall also cross-check the proposed positions/placements of each item and confirm that the space indicated in preliminary building/equipment layout is adequate or the same needs some modification. However, this layout shall be finalized during detail engineering stage
- The bidder shall provide cable routing diagram indicating GI cable trays (with 30% spare trays) of different types and sizes, as required for laying all cables under the scope of the bidder
- Bidder shall also submit cable schedule, cable termination details for connection/termination of all cables under the scope of bidder.
- Along with the offer, bidder shall submit details of (approximate I/O Count) inputs/outputs for all electrical equipment, panels, SAS, SCADA including those signals to be connected to/from DDCMIS. Actual list of all I/Os shall be submitted and subsequently finalised during detailed engineering stage
- Along with the offer bidder shall submit heat load for individual equipment/panel and/or floor-wise heat load of PBS building for designing ACVS by purchaser/others. For each electrical building/premises/rooms/equipment/Cable cellar/Cable vault, bidder shall submit the requirement of Air Conditioning or Ventilation or exhaust fans
- For construction power supply, 415V power supply shall be provided by the purchaser/others within a distance of 300 meters. Bidder shall have to make their own arrangement for feeding to various load centers. This shall include supply, laying and termination of required power and control cables, associated distribution boards, if required, breakers etc.

5.2.8. Electrical system design criteria

General

The design, manufacture, assembly and testing as well as performance of the equipment shall conform to the relevant IS specifications (latest revision) and other relevant standards.

In case the bidder is not in a position to comply fully with certain IS specifications, or in respect of certain items for which there are no IS specifications, the bidder may base his proposals on IEC/BS/VDE/DIN recommendations or other reputed national or international standards subject to the approval of the purchaser.

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All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the Government of India and the Government of West Bengal.

Climatic Conditions

Electrical Equipment selection and derating shall generally be based on ambient temperature of 50^0C. For specific hot areas the ambient temperature conditions shall be taken into consideration and equipment suitably derated where necessary. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

Room temperature of control rooms with electronic equipments shall be maintained as 21-24 degree C.

The equipment offered shall be suitable for smooth, efficient and trouble free service in the climate prevailing at site.

Where explosion hazard due to fuel gas/oil is present, dust proof and flame proof/ increased safety type apparatus shall be used. All such equipment shall be certified by recognized statutory authority as fit for use that in particular location.

Standard Voltage levels

Following power utilization standard voltage levels shall be adopted for various systems:

1.	Generation voltage	11 kV, 3 phase, 3 wire, 50 Hz, non effective earthed.
2.	Evacuation & transmission voltage	33 kV, 3 phase, 3 wire, 50 Hz, non effectively earthed.
3.	Auxiliary supply	6600 V, 3 phase, 3 wire, non effective earthed.
		415 V, 3 phase, 4 wire, solidly earthed.
4.	A.C. drive motors	6600 V, 3 phase, 3 wire, non effective earthed.
		415 V, 3 phase, 4 wire, solidly earthed.
5.	Higher rated EOT cranes	690V
6.	DC drive motors	220 V, 2 wire, unearthed D.C.
7	Instrumentation and control including protection interlocking system	240 V, 1 phase, A.C. (from UPS)
8.	Control and protection of HT and LT switchgears including ACBs of MCCs	220 V, 2 wire, unearthed D.C.
9.	Control and indication for MCC feeders (other than ACBs)	240 V, 1 phase, line & neutral (through control transformers)
10.	UPS	240 V, 1 phase, 2 wire
11.	Metering	110 V, AC, PT supply
12.	Plant illumination	240 V, 1 phase, line & neutral
13.	Emergency illumination	220 V, 2 wire, unearthed D.C.

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14.	Panel lighting and space heaters	240 V, 1 phase, 2 wire, 50 Hz, A.C. with one point earthed
15.	DDCMIS/PLC power supply	240 V, 1 phase, 2 wire, 50 Hz, A.C. (UPS supply)
16.	Welding socket / power receptacles	415 V, 3 phase, 50 Hz, A.C. outlets 240 V, 1 phase, 2 wire, 50 Hz, A.C. with one point earthed
17.	Special socket outlets for portable lamps for maintenance	24 V, 1 phase, 2 wire, 50 Hz, A.C. through suitable transformers
18.	Sockets for electrical tools, etc.	240 V, 1 phase, 2 wire, 50 Hz, with one point earthed

Permissible variations

The system/ unit/ plant/ equipment shall be designed suitably for following variation in voltage and frequency;

	Voltage	**Freq.**
Permissible variation with rated performance and control effectiveness maintained	+10% to -10% (for LT) +10% to -10% (for HT)	+5% to -5%
Permissible variation for control and regulation equipment with rated performance and control quality maintained	± 10 %	+5% to -5%
Permissible voltage dip at HT switchgear bus during starting of HT motor	± 10 %	------
Permissible voltage dip at LT switchgear bus during starting of LT motor	- 15 %	------

Symmetrical short circuit ratings

The three phase symmetrical short circuit ratings of the switchgear at different voltage levels envisaged are as follows:

	Breaking Capacity	Making Capacity
33 kV	2200MVA (40KA)	78.75 kA
11 kV	760MVA(40KA)	100 kA
6.6 kV	450MVA(40KA)	100 kA
415 V	50 kA	105 kA
220 V DC	10 kA	--------

The rated short circuit withstand duration for 33kV, 11kV and 6.6kV switchgears will be 3.0 secs, whereas for 415 V switchgears including MCCs, it will be 1.0 sec.

Criteria for selection of voltage levels for drive motors

AC squirrel cage induction motors of ratings up to 200 kW will be fed at 415 V, 3 phase 50 Hz. AC motors of ratings larger than 200 kW shall be connected to the 6.6 kV system. IGBT based variable speed drive (constant V/F control) will be

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considered for higher rated pumps like BFPs and fans/blowers like ID fans, where output is variable based on process requirements.

All LT motors shall be fed from the respective MCCs. Feeders catering to motors less than 75 kW capacity shall be consisting of MCCB/MPCB, power contactor and O/L relay, whereas, motors of 75 kW and above capacity shall have soft starter with DOL bypass and will be fed through air circuit breakers (ACBs) directly from LT switch board. O/L relay, wherever applicable, shall be electronic type. For incoming and outgoing power feeders and outgoing motor feeders having ACB, Micro processor based Numerical protection relay shall be provided.

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All AC drives shall be designed for ambient temperature of 45 degC.

Separate starter panels shall be provided for DC motors.

5.2.9. Electrical auxiliary power distribution & Evacuation scheme

The tentative electrical scheme shall be in line with preliminary single line diagram (MEC/11/E4/M/0033/CPP1/01, Rev.01).The power supply system for the proposed plant has been envisaged through three number 40 MW STG, and one no. Top Recovery TG (TRT) generator set along with inter connection with 33KV CPP GIS.

All the TGs will generate at 11 kV and then step up to 33 kV through 11/34.5 kV step up transformers, where TG's will be synchronized with 33KV CPP GIS . 33kV CPP GIS shall be further connected to upstream 33kV GIS of MRS. (33kV GIS of MRS shall be by purchaser/others)

To have a better flexibility of Generator Synchronisation operation, 33kV double bus bar switchgear (GIS) shall be provided.

The electrical auxiliary power for the Power and Blowing Station will derive through 33/6.9 kV power transformers.

Bidder shall provide DG set based on the sizing calculation to be submitted by the bidder for safe shutdown and emergency load of the power plant including emergency illumination system. DG shall be preferably in a separate building at Power and Blowing station for feeding emergency load / safe shut down of the Power and Blowing station. Details of emergency loads for the offered system shall be submitted by the bidder along with the offer.

5.2.10. Synchronising Scheme

All incoming, bus-coupler, sectionalizing and tie feeder circuit breakers will be provided with synchro-check feature for closing. The CPP will have synchronising facility at 33 kV. Provision will also be there for reverse synchronisation of the grid power supply on restoration following a successful islanding. TRT generator will be connected to one no. of standalone 33 kV GIS of TRT located in electrical room of TRT building. The TRT generator will have synchronising facility at 33 kV GIS of TRT. Additional synchronising facility of TRT Generator shall also be provided in CPP control room.

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5.2.11. Islanding Scheme

In case of grid failure, the grid system will be isolated from the plant power system so that total power failure can be avoided and the critical loads may be operated with the in-plant generators only. Subsequently, automatic load shedding system shall be installed to control shedding of non-essential loads, matching the in-plant generation. Implementation of Islanding scheme with necessary relays, panels shall be under the scope of the bidder. Bidder to submit the details of islanding scheme which will be reviewed and finalized during detail engineering stage.

5.2.12. Load Shedding Scheme

In case of inadequate in-house power generation due to tripping of any generators after islanding that fails to support all category-1 / emergency loads connected to 33kV GIS at CPP, under frequency-based automatic load-shedding will be effected to maintain the load - generation balance. Plant loads will be shed in stages, starting from non-critical ones, to achieve stabilized operation of the islanded power system at least with the critical loads. Implementation of Load shedding scheme with necessary relays, panels shall be under the scope of the bidder. Bidder to submit the details of load shedding scheme which will be reviewed and finalized during detail engineering stage.

5.2.13. Energy Saving Scheme - V/F Control

AC variable speed IGBT based drive (constant V/F control) over open loop control with digital regulation system, instead of conventional DOL starting, will be considered for higher rated pumps and fans/blowers where output is variable based on the process requirements. Based on the requirement and load, unit type drive system fed from 415 V systems may be used. All drives will be designed for ambient temperature of 45°C.

5.2.14. Layout of electrical plant

The layout of plant will be in line with the good and state of the art engineering practice with consideration of safety, ease of movement and with standard clearances stipulated in IS / IE rules.
Bidder shall refer to Layout drawings for Power House Buildings (Drg. Nos. MEC/11/S3/M/0033/CPP1/01,02.03,04,05,06,07, Rev.00) for preliminary assessment and for further development of Bidder's own Layout drawings accommodating all electrical items/equipment/panels/GIS/Transformers etc. suiting their offered system.

Accordingly, Bidder shall submit their layout drawing. Bidder's layout drawing shall cover the requirements of cable routing, levels of floor, clearances, entry/exit points, cable structure details etc. to understand the offer clearly.

5.3. Performance Requirement and Guarantee

The bidder shall study the specification and satisfy themselves thoroughly regarding the workability of the plant, equipment and systems offered and also take full responsibility for the guaranteed operation and performance of the same as well as for their smooth, safe and reliable working.

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All equipment shall be guaranteed for workmanship, materials design and satisfactory performance to the parameters in accordance with the specification document and relevant clauses of the General Conditions of Contract. The guarantee for performance shall cover individual items and systems for their ratings/outputs.

Bidder shall also guarantee the integrated operation of all the systems and equipment covered in his scope as a whole including interfaces required to be established with other related systems and equipment.

The supplier shall conduct performance/acceptance tests on each of the major items of equipment supplied to demonstrate that the equipment and system supplied are capable of achieving the performance parameters specified. The total system performance shall also be guaranteed and demonstrated.

Should the tests specified show that the unit has failed to achieve the guaranteed parameters, the supplier shall carry out necessary modifications or part replacements to achieve the guaranteed parameters and for successful demonstration the tests shall be repeated, without any cost implications to purchaser.

Loading of the various system and their performance shall be demonstrated to the maximum possible extent.

5.4. Technical Specification

5.4.1. Technical Specification for Synchronous Generators & Accessories

5.4.1.1. Type

The synchronous generators shall be totally enclosed directly driven by the steam turbine at 1500 rpm.

The generator shall be three phase, four pole/OEM Standard, laminated round rotor, wye connected machine with phase and neutral terminals brought out for connection to bus duct.

5.4.1.2. Rating

The generator shall have following technical parameters:

1.	Maximum Continuous Rating	:	**STG**
i.	Active output	:	40 MW
ii.	Apparent output	:	50 MVA
2.	Rated terminal voltage	:	11 kV
3.	Rated power factor	:	0.8 (Lag)
4.	Rated frequency	:	50 Hz $\pm$ 6 %
5.	Phases	:	3
6.	Phase connection	:	Star
7.	Line terminals brought out	:	3
8.	Neutral terminals brought out	:	3
9.	Rated speed	:	1500 RPM/OEM Standard

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10.	Short circuit ratio	:	0.6
11.	Class of insulation (stator/rotor)	:	F (Temperature rise limited to class B)
12.	Cooling for stator/rotor	:	CACW cooled
13.	Type of generator earthing	:	Earthed through NGT

The generator parameters listed above shall be guaranteed on the basis of continuous operation without exceeding the temperature limits listed below.

5.4.1.3. Insulation and Temperature Limits

The generator stator and rotor windings inclusive of main and neutral leads shall be provided with Class F insulation but temperature rise shall be limited to class B.

The maximum permissible temperature rise of different parts of the generator shall be as per latest IS standard/as follows:

1.	Stator Winding (By RTD)	:	84^0C
2.	Rotor Winding	:	79^0C
3.	Magnetic Cores	:	84^0C
4.	Exciter	:	84^0C

Ambient temperature to be referred shall be 50 deg C.

5.4.1.4. System Operation

The turbine-generator will be connected to the network through step up Delta-star transformer. The generator will be non-effectively earthed through a single phase distribution transformer provided along with secondary loading resistor.

The generator shall be capable of operating alone or in parallel with existing generators and/or grid.

5.4.1.5. Voltage & Frequency Variation

The generator shall be capable of continuous operation at rated output and at rated power factor under any of the following conditions:

a. Terminal voltage variation $\pm$10% of the rated value
b. Frequency variation of -5 % to 3 % of the rated value
c. Absolute sum of combined voltage and frequency variation of $\pm$ 10%.

The bidder shall indicate the voltage and frequency variations related to change of load in steps (sudden loading and load throw-off conditions) for +50%, +75%, +100%, -25%, -50% and -75% after conducting the system study during detail engineering.

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5.4.1.6. 3 - Phase Short Circuit withstand

The generator shall also be capable of withstanding, without injury, a three phase short circuit at the terminals for there (3) seconds when operating at rated output and power factor, at 5% over voltage with fixed excitation.

5.4.1.7. Capacity with one Cooler out of Service

In the event of one cooler being out of service, and other cooler tubes 10 % choked, the generator shall be capable of carrying the rated load continuously, without the permissible temperature of the machine being exceeded.

5.4.1.8. Stator Housing

The stator housing shall be of totally enclosed, having sufficient mechanical strength and rigidity deformation. Stator frame shall be of fabricated steel only

The housing shall have suitable provision for handling, lifting and/or jacking. Manholes with sealing arrangement shall be provided to facilitate inspection of terminals, internals etc.

All leads, including power, control and instrumentation cable shall be brought out of the generator housing through tight seals.

5.4.1.9. Stator core

The stator core shall be fabricated out of best quality silicon steel so that losses are minimum.

The core assembly and mounting arrangement shall be such that the transmission of the forced vibration of the core to the housing and foundation is effectively restricted.

The core assembly shall have adequate ventilation. Magnetic screens shall be provided, if required, to reduce the zone heating by leakage flux.

5.4.1.10. Stator Winding

The windings and all connections inclusive of phase and neutral leads shall be insulated for full voltage to ground.

In order to reduce the corona in the slot and where the stator bar leaves the stator core, a surface treatment corona grading system shall be applied which shall be carried into the end turn area.

Firm sitting of the stator bar in the slot shall be ensured by proper wedging fillers and refill springs (or as applicable). Adequate arrangement shall be provided for the slot wedges to compensate for any future shrinkages and ensure permanent firm seating of the bars in the slot during operation. The end turns shall be suitably braced and supported to withstand the forces during normal operation and sudden short circuit at generator terminals.

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5.4.1.11. Terminal Connection

All phase and neutral terminals shall be brought out from the bottom of the generator (non-driving end) and located in a non-magnetic steel terminal box. Phase terminal bushings shall be spaced to permit connection to phase segregated bus duct to provide complete phase isolation directly upto the generator housing. Adequate spacing shall be provided between phase and neutral bushings to permit connection of the neutral enclosure.

The bushing shall be high glass laminated fibre (HGL) type complete with silver plated terminal connectors.

5.4.1.12. Rotor

The rotor shall be forged in one piece from alloy steel to ensure required mechanical strength and magnetic properties.

The forging shall be subjected to elaborate ultrasonic and mechanical tests to ensure freedom from any internal defect.

After assembly, the rotor shall be dynamically balanced and subject to 20% over speed for 2 minutes.

5.4.1.13. Rotor Winding

Rotor winding shall be made of silver bearing solid copper conductors. Winding insulation shall correspond to Class-F, i.e. glass, mica nomex etc. with temperature limited to Class-B. Rotor winding shall be secured in the slots by suitable slot wedges and fillers. The overhung portion of rotor winding shall be held in position against centrifugal force by retaining rings.

The retaining rings shall be machined from high strength, non-magnetic alloy steel forging. The retaining rings shall be floating type, shrunk on rotor body and prevented from axial movement by snap rings/locknuts.

Suitable damper winding shall be provided on the rotor to permit increased asymmetrical electrical loading.

5.4.1.14. Bearing

The generator shall be provided with journal bearings. The bearings shall be of split construction and forced lubricated from turbine oil system. Oil buffers shall be provided to prevent leakage of oil along the shaft.

Provision shall be made for hydraulic jacking of the shaft during start up and turning gear operation. Each bearing shall be provided with a well for thermometer in the return line and a sight glass with illumination to observe bearing oil flow.

Bearing shall be insulated from stator frame and foundation plate to prevent shaft current. Provision shall be made for bearing insulation measurement while the machine is in operation.

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5.4.1.15. Fans

Air shall be circulated in the generator in closed circuit by the radial fans located on rotor shaft at either end. The fans shall be shrunk on to their seats on the rotor shaft and locked against tangential or axial movement.

5.4.1.16. Temperature Measurement

Embedded temperature detectors, resistance or thermocouple type shall be built into the machine for measurement of temperatures of various active parts, bearings and cooling medium etc. The minimum requirements are listed below. Twelve (12) detectors, uniformly distributed around stator, located between insulated coil sides in stator slots.

- 6+1(spare)X2=14nos. simplex RTDs on stator winding.
- 6 nos tooth RTD.
- 4nos core RTD to be provided.

Two (2) detectors each generator bearings located on the lower bearing sleeve. All temperature detector leads shall be brought out to a terminal box suitably located on the outside of the generator frame for easy access. The leads shall be suitably fastened to the frame to prevent movement and shielded against stray field.

In addition to the ETD'S temperature switches shall be provided as required for alarm interlocks.
Temperature scanner shall be hooked up with DDCMIS through soft communication. Necessary provision shall be provided in all types of temperature scanners.

All the above temperature detectors shall be duplex type.

5.4.1.17 Generator Excitation System

a) Type

The excitation system shall be brushless type dual auto-dual manual type, bearing less PMG, Stroboscope with exciter to monitor rotating diode to meet the performance requirements specified hereinafter.

b) Performance Requirements

Main excitation system should have Two Regulator Channels with independent thyristors bridges for controlling the field power in which one acts as main and another one is hot standby, Field Breaker for disconnecting machine form excitation source, Field discharge resistor to discharge stored energy in the field, PMG o/p voltage will be used to meet excitation voltage.

The equipment shall confirm to the latest applicable standards. The AVR shall permit continuous stable operation of the concerned generators under Auto/Manual excitation control mode control for all conditions of operation.

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Dual auto Dual manual digital AVR with bump less transfer between all modes. Fully configurable I/Os and measuring inputs with user configurable field bus interface.

Advanced microprocessor technology with IGBT semiconductor technology.
Fiber optic connection between the controller's PCBs for redundant 10 Mbit/s data exchange, for maximum EMC immunity and for galvanic isolation.

Data acquisition of analog input signals (U_G, I_G & U_{syn}) with a processing accuracy better than 0.5%.

Multi-channel data recorder by 2'000 points per channel with 1.5 ms sample time (max 2.25 s records).

Event Logger with the last 2'000 entries with 1 ms accuracy including date - and time stamp.

Easy monitoring and operation by local or remote Excitation Control Terminal (ECT)
Easy time synchronization by Simple Network Time Protocol (SNTP) via Ethernet (option).

Serial interface with several protocols: MODBUS TCP, MODBUS RTU, PROFIBUS DP or IEC61850 (option), On-line maintenance of converters.

Provision for remote diagnostic via Internet (Additional service contract required to activate this feature) (option).

Each excitation controller/DVR should have following main control modes for necessary operation as per plant requirement.

i. Auto/Voltage Control Mode
ii. Manual/Field Current Regulator mode
iii. Reactive power control mode
iv. Power Factor control mode
v. Open loop/Firing Angle control mode

There should not be any hardware scaling/settings in any of the electronic boards like resistor, capacitor, jumpers & dip Switches for easy maintenance and trouble shooting and to avoid confusion during replacement of spares wherever required test the spares or to replacement during failure.

All the settings required for excitation to be done by soft settings only in the controller.

DVR Controller and I/O Boards should have dual auxiliary power supply ports and this supply should be monitored. Disconnection/Failure of one supply should not affect the operation of entire system.

Both the Controller/DVRs should have independent facility to measure generator voltage and current for feedback from 3 phase measuring PTs provided by end user.

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In the absence of two measuring PTs and two measuring CTs for above point only one available PT and CT should be used for both the DVRs. Each DVR should have self-diagnostic facility and watchdog in panel mounted HMI for checking healthiness of the DVR controller always. Each DVR should have independent disturbance/transient recording facility to store the disturbance trends independently during trip automatically. Requirement of minimum signals for disturbance recorder will be provided during detail engineering stage.

Each controller/DVR channel should have followings limiter function in Auto /FCR mode of operation

i) Over Excitation Limiter (Two stage Max Field current limiter, Reactive Stator current limiter, lag)

ii) Under Excitation Limiter (PQ/load angle limiter, Reactive Stator current limiter (lead), minimum excitation current limiter)

iii) V/Hz limiter,

iv) Load angle limiter

All the above-mentioned limiter should have wide range of settings to meet the plant requirement.
HMI on the excitation panel should have facility to modify the above-mentioned limiter settings.
Each controller/DVR channel should have minimum of following protection function in Auto/Manual Mode of operation.

Rotation diode monitoring.

Ripple monitoring, Thyristors bridges over current monitoring and input voltage monitoring.

Control circuit supplies monitoring.

Generator voltage & current monitoring.

Each Controller/DVR channel should have independent PSS function for damping active power oscillations.

All I/O's should be independent for both Controller/DVR's and failure of any one I/O board/group should not affect the operation of the system such that standby system should take over the operation without tripping the system.

All the components of the both controller/DVR should be identical and independent.
Each controller/DVR should be designed considering following operation conditions

i) Isolated operating mode (Feeding independent load)

ii) Parallel operating with Grid

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iii) Parallel operation along with other generators (Plant bus operation)

The excitation system shall have components to restrict harmonics in the supplied sources by user end and must operate stable.

Technical Data

Voltage regulation should be ≤0.25%.

Generator voltage adjustment range setting should be 90 to 110% of nominal value.

Reactive power compensation range of adjustment < ±20%.

All limiters setting range of adjustment 0 to 110% of nominal, Response time should be less than 20ms, Cross current compensation for parallel operation.

5.4.1.18. Generator cooling system

Bidder shall include complete generator cooling systems including all associated equipment like piping, valves, air to water coolers, instruments, etc in his contract. Complete status and annunciations including all critical parameters shall be available in the control room in DDCMIS.

5.4.2. Generator Control Equipment

5.4.2.1. Generator Current Transformer

To provide protection and metering for generator, suitable current transformers shall be provided in the separate panels after generator bushings. Separate cores of CTs shall be used for differential protection, over current protection and measurement purposes. CTs shall be bar primary type . Generally the measurement CTs shall have accuracy class as 0.2 whereas protection class shall be 5P20 and for differential CTs the class shall be PS with minimum burden of 50VA. The knee point characteristics of differential CTs shall be matched with the relays. The technical parameters are elaborated below:

Type	:	Epoxy cast resin
No. of cores	:	As per requirement
Power frequency withstand voltage	:	As per IS
Impulse withstand voltage	:	As per IS

Short time rating of CTs shall be 3 secs.

5.4.2.2. Generator Voltage Transformer

To provide power supply for metering, synchronisation, AVR and protection purposes voltage transformer shall be provided. These will be connected after the generator outgoing terminals. VTs shall be of dry type cast resin design mounted in separate panels. High voltage side of VTs shall have fuses with fuse monitoring relays on low voltage side. Low voltage star winding shall have all three phases and neutral connections brought out to terminals. Accuracy class of this shall be 0.2.

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The technical parameters shall be as follows:

Rated continuous voltage	:	11 kV
Ratio	:	$\frac{11}{\sqrt{3}} / \frac{0.11kV}{\sqrt{3}} / \frac{0.11kV}{\sqrt{3}}$
Burden	:	As per requirement Minimum 100 VA
Power frequency withstand voltage generator current trafo.	:	As applicable for
Impulse withstand voltage generator current trafo.	:	As applicable for
Over voltage factor	:	1.9 for eight hours.

5.4.2.3. Surge Protection Equipment

The surge protection cubicle shall comprise of surge diverter and protective capacitor on each phase to protect the generator from the effect of transient over voltages. Surge protection equipment and VTs as described above shall be mounted in dust proof phase segregated compartment with provision for entry of main bus tap off into the compartments.

Protective capacitors shall be single pole units i.e. one per phase, non inflammable synthetic liquid impregnated type connected between each phase terminals and ground. Each capacitor shall be provided with a built in discharge resistor to drain the residual charge after being de-energized.

Surge diverters shall be of station class type and shall be of design specifically meant for protection of rotating machines, other salient particulars of surge diverters should be chosen in accordance with relevant IS-3070,Part-I, 1974.

Technical Particulars

Surge diverter/Lightning Arrestor

1.	Type	:	Station class
2.	Service	:	Indoor
3.	Rated voltage	:	15 kV (rms)
4.	Nominal discharge current	:	10 KA
5.	No. of surge arrestor per phase	:	One
6.	Built in discharge resistor	:	Provided
5.	Power frequency dry withstand test voltage	:	As per IS

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Surge Capacitor

1.	Type	:	Single pole, non-inflammable
2.	Service	:	Indoor
3.	Rated Voltage (maximum)	:	17.5 kV
4.	Capacitance to earth	:	0.25 µF
5.	No. of capacitor per phase	:	One

5.4.2.4. Technical Specification of Generator Neutral Earthing

Resistance grounding system shall be adopted for Generator Neutral to limit the stator earth fault current within specified limit. Neutral Grounding. Transformer shall be connected between the Neutral of Generator and the ground. NGR shall be connected to the secondary of NGT.

The high resistance grounding of a generator neutral will be adopted by connecting the primary of a single phase distribution type grounding transformer between generator neutral and ground with the transformer secondary being shunted by either resistance with a voltage relay. The voltage relay shall be connected across the secondary. This will reduce transient over voltage limit at the point of fault and contribute to a positive selective relaying in the event of generator stator E/F.

The value of resistance shall be so chosen that the energy loss in the resistor equals the capacitive kVA of the generator windings, the generator surge capacitance, the capacitance of the phase segregated bus duct and the associated generator transformer with respect to earth during ground fault conditions.

The neural grounding transformers shall be dry type for indoor installation. The generator neutral grounding equipment shall be housed in a metal enclosed cubicle. The metal enclosed neutral grounding cubicle shall be connected to the neutral compartment of the star point of the generator through a fully enclosed bus duct. The value shall be minimum of 5 minutes rated.

The NGR shall be suitable for indoor installation and shall be housed in a sheet steel metal enclosed cubicle. The NGR cubicle shall be suitable to be connected with secondary terminals of the NGT.

Resistor elements shall be made of unbreakable, corrosion proof, joint less stainless steel grids conforming to ASTM-A240-304 or Ferro-chrome aluminum alloy conforming to ASTM-A-240-405. The grids shall be in punched fans. It shall be suitable for use in monsoon tropical climate.

Resistor shall be able to carry the specified current for 5 minutes with temperature rise not exceeding 350^0C at the maximum specified ambient temperature. The resistor shall also be able to carry at least 10% of its rated current continuously.

5.4.3. Generator Bus Duct

Bidder shall include the Generator bus ducts consisting of following minimum items;

1. Generator main Bus duct from generator terminals to generator transformers

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2. Generator neutral bus duct to the neutral grounding transformer.
3. Generator bus duct tap off to surge protection & VT cubicle.
4. Neutral grounding transformer, neutral grounding resistor.
5. All associated equipment/items like flexible/rigid joints, required no. of bends, silica gel breather, space heater, etc.
6. Set of maintenance tools and tackles as required.
7. Earthing of bus ducts with continuous run of conductors.
8. Necessary support structures, wall frame assembly erection hardwires.
9. Suitable canopy with proper slope for outdoor portion of the busduct.

The busduct and associated equipment shall conform to the applicable latest IEC/IS standards.

Electrical Design

Electric power supply

Rated voltage shall be 11 kV, 3 phase, 50 Hz which is non-effective grounded.

Insulation level

Rated insulation voltage shall be 12 kV. One minute power frequency voltage shall be 28 kV.

Short circuit strength

Rated short time withstand current not less than the system short circuit level specified for 3 sec for 11 kV bus ducts. Rated peak withstand current not less than 2.1 times the system short circuit level.

Rated current

Rated continuous current as specified while in enclosure and at specified ambient 50^0C temperature with maximum temperature of bus bars limited to 85^0C.

Neutral bus in LT with rating not less than half the rating of phase bus.

General Arrangement

1. 11 kV generator busduct shall be phase segregated with tubular/ rectangular shaped enclosure. Enclosure shall be continuous type.

2. Comprising of following sections, as applicable, to make the installation complete and to match with the terminal equipment:
   - Generator lead-in section with flexible hood and links.
   - Straight section in standard length.
   - Matching section (length as required).
   - Generator transformer lead-in section with flexible links
   - Corner sections (horizontal and vertical)
   - Phase cross-over section (If required to match phase sequence of the board).

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- Link section.

3. Silica gel breathers at appropriate locations.

4. Space heaters and power supply arrangement for the space heaters

5. Earthing of busducts with continuous run of conductors

6. Generator neutral bus duct along with all the generator CTs, LAPT, NGT and loading resistor, all associated accessories, etc

Construction Details

1. Degree of protection for enclosure IP 52 or better inside machine hall/substations and IP 55 for semi-outdoor and outdoor installation.

2. Enclosure material: Aluminium of minimum thickness 3 mm. Bidder shall include enclosure with the thickness required for the shape and mechanical/ electrical strength point of view.

3. Maximum temperature of enclosure under rated operating conditions limited to 70^0C

4. Bolted covers with gaskets for easy inspection and access to insulators and bus bar joints.

5. Rubber bellows at transformer end to take care of vibration (Flange on which rubber bellow shall be seated shall seam welded to avoid ingress of water into the transformer).

6. Hinged and gasketed inspection access cover at suitable intervals.

7. Seal off bushings and frames complete with bolts

8. Provision for draining moisture.

9. Provision for mounting on brackets.

10. Supply of GI supporting structures with necessary hardwares. Supporting structures shall be fabricated from standard steel sections and shall be hot dipped galvanised after fabrication.

11. Supporting structures shall cater to various static and dynamic loading such as weight of the bus duct, short circuit forces, wind load and seismic forces. Problem of induced magnetic heating and circulating current shall be avoided in isolated busducts.

12. For termination at generator end, suitable seal off bushings shall be provided, if required for air cooled generators.

13. Necessary supporting foundation details to be provided

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Surface treatment

Two coats of epoxy paint for outdoor and synthetic enamel paint for indoor application, preceded by de-rusting, cleaning chemically, degreasing, pickling in acid, cold rinsing, phosphating, passivating and spraying with two coats of zinc oxide primer.

Shade of paint

Interior : Black/white/light yellow

Exterior : Light grey shade 631 of IS - 5
1978 (unless otherwise specified) and further stoved.

Busbars and Connections

1. Material EC grade aluminium alloy equivalent to E91E WP conforming to IS 5082-1981.
2. Final operating temperature of both bus bars and joints under continuous operation in enclosure limited to 85^0C by thermometer method.
3. Bus bar arrangement as per IS 5578 (1991).
4. Phase identification by colour at ends and at regular intervals.
5. Busbars shall be of welded construction.
6. Copper flexible busbars surface shall be tinned
7. Contact surfaces shall be silver plated.
8. Flexible connections for termination on equipment.
9. Expansion joints on straight runs with joints staggered in adjacent phases.
10. Bimetallic joints for jointing between dissimilar metals.
11. Busbar conductors shall be given coat of black mat.
12. Busbar support insulators of non-hygroscopic material having high impact and di-electric strength with an anti-tracking contour.
13. Enclosures shall be connected to each other by low resistance path adequate to carry rated current of the busbar at both ends.

Protective Earthing

1. Aluminium earth bus of size 50 x 10 mm running throughout the length of the busduct, positively connected to the body of the busduct.

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2. Provision at each end of busduct for terminating external earth conductor.

Insulators

In isolated bus ducts, the magnitude of the short circuit forces expected on the bus conductors is calculated with pen bus arrangement (without enclosures). The type of insulators shall be selected in such a way that load on insulators shall be within it's safe strength with adequate factor of safety.

Space Heaters

Space heaters shall be provided near the insulators in adequate nos. Complete system including all the equipment and associated electrical power supply arrangement shall be provided by the bidder.

Technical Particulars of Generator Busducts

1.	Applicable Standard	IS : 8084
2.	Rated system voltage and frequency	11 kV, 50 Hz
3.	System earthing	Non effectively earthed
4.	System short-circuit level, kA (rms)	40 kA (for 3 sec)
5.	Type of busduct	Phase Segregated (Indoor+outdoor)
6.	Maximum voltage at which the busduct can operate continuously	12 kV
7.	Busbar material – Conductor Busbar Encloser	Aluminium Alloy Aluminium Sheet(3 mm. min.)
8.	Busduct support structure required	To be provided
9.	Rated continuous current	As per Bkr. rating
11.	Rated short time withstand duration	3 secs
12	Insulation level	
a)	Rated Voltage	11 kV
b)	Rated insulation voltage	18 kV
c)	Insulation class	
d)	One min. dry power frequency withstand voltage	As required/applicable
e)	Impulse withstand voltage	As required/applicable
13.	Supporting insulator	
a)	Type	Porcelain
b)	Max. distance between supports	To be worked out based on short circuit calculation
14.	Earth Bus	
a)	Material	Al
b)	Size	As per requirement
15.	Enclosure	
a)	Type	Continuous
b)	Degree of Protection	IP 52/IP55
c)	Material of Enclosure	Al
d)	Thickness	3 mm min.
16.	Accessories	

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a)	Seal-off bushings	As per requirement
b)	Silica gel breather	To be provided

Length of the busduct shall be calculated by the bidder based on approved layout and location of the generators and generator transformers.

Generator bus duct shall be suitable for air and water tightness test as per IS : 8084

Rating, type and detailed technical particulars of the generator neutral bus duct shall be as per requirement and as per standards prevailing.

5.4.4. Protection System

The protection required for all the generators, generator transformers has been listed below. Selection of protective scheme will be based mainly on reliability (main & standby), sensitivity, selectivity. All main protections shall be fast acting type in order to clear the faulty system from the healthy system in earliest possible time to minimise damage to equipment and ensure continuity of power supply, if possible. Bidder shall suitably design tripping system covering different protection under different class of trippings of generator and turbine.

The relays shall be of composite microprocessor based with communication System at control room through DDCMIS. The indications shall be provided in the Generator C/R Panel also.

The details of major protections are elaborated below.

Generator Protection

- Generator differential protection
- Over all Generator and Transformer Differential protection
- Generator stator earth fault protection
- Generator standby stator earth fault protection
- Generator field winding earth fault protection
- Generator negative sequence protection
- Generator low forward power protection
- Generator reverse power protection
- Loss of excitation protection
- Generator pole slipping protection
- Generator under frequency protection
- Generator over-voltage protection
- Generator backup impedance protection
- Generator stator over-current protection
- Generator VT fuse failure protection

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- Generator field over voltage protection
- Over fluxing protection

Protection for Generator Transformer

a) Generator transformer differential protection
b) Over current and earth fault protection on HV & LV side
c) Backup over current and earth fault protection on HV & LV side
d) Back-up earth fault protection on GT HV neutral
e) Restricted earth fault protection on HT side for GT
f) Buchholz relay (alarm & trip)
g) Winding temperature protection (alarm & trip)
h) Oil temperature Protection (alarm & trip)
i) Oil level alarm and trip
j) Auxiliary relays for generator transformer for receiving transformer alarm and trip.
k) Pressure Relief Device (alarm/trip)
l) Over fluxing protection

Electrical Inputs/Outputs of DDCMIS

Bidder shall consider all the electrical inputs/outputs for DDCMIS. The transducers shall be mounted in the switchgears or in separate panels.

Required transducers and wirings to hook up analog and digital inputs and outputs shall be included in the scope of the bidder.

Actual number of inputs/outputs to/from DDCMIS shall be finalized during detailed engineering stage.

5.4.5. Technical Specification for Generator Control, Mimic & Annunciation Desk

Generator control, mimic cum annunciation desk shall be provided for controlling, monitoring and annunciation of each generator, 33KV GIS inter-connector & bus coupler breakers. The synchronizing facility between the generators with 33KV GIS shall be done through this desk at 33kV level.

The main purpose of the control desk is as follows:

- Synchronization and on/off of 33 kV breakers for generator, 33KV GIS, connectors & bus coupler breaker in Auto/manual/Dead bus /Off mode.
- Synchronisation and on/off of 33 kV breakers connecting to TRT generator
- Control of generator excitation system including AVR.

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- Indications of circuit breaker position (ON/OFF) by semaphore as well as LED lamps. Circuit breaker other status like trip/trip circuit healthy/breaker readiness/spring charge etc. Shall be through LED lamps.
- Generators and Feeders metering.
- Fault annunciation for generators, generator transformers, excitation system etc.
- Temperature scanner for generators. Temperature scanner shall be hooked up with DDCMIS through soft communication.
- Load controller for export of power (MW and Mvar) to upstream MRS 33kV GIS.
- One dedicated HMI station (in control room) specific for monitoring electrical parameters.
- Two nos. digital display units shall be considered
  (i) state for generated power of three generators and TRT
  (ii) Input power received from upstream MRS (through four 33kV Tie Lines)

  Additional one energy meter for tariff purpose from approved meter list of West Bengal State Electricity Board shall be provided. Approval shall be taken before first charging from Electricity Authority of West Bengal

List of Equipment to be mounted on Generator Control Desk for each Generators.

(This list is tentative only and shall be finalised during detail engineering stage).

For Generator Exciter field;

- Ammeter for Exciter field; transducer operated digital type.
- Voltmeter for Exciter field; transducer operated digital type
- Null voltmeter; transducer operated digital type.
- Exciter field - Ammeter and Voltmeter; transducer operated digital type.
- Voltmeter ; transducer operated, digital type.
- Selector switch for voltmeter.
- 3 position bkr. Control switch Trip-Neutral Close for exciter field circuit breakers.
- Exciter field circuit bkr. ON/OFF indication lamps.
- Speed raise / speed lower Push buttons.
- Excitation ON/OFF, illuminated push buttons.
- AVR Auto regulation ON, illuminated push buttons.
- AMR manual regulation ON, illuminated push button.
- AVR Auto ref. Raise, Push button.
- AVR Auto ref. Lower , Push button.
- AVR manual ref. Raise, Push button.
- AVR manual ref. Lower , Push button.
- AVR Auto Ref. Maximum , lamps.
- AVR Auto Ref. Minimum , lamps.
- AVR manual Ref. Maximum , lamps.
- AVR manual Ref. Minimum , lamps.

For Generator/ MRS/ Bus Coupler feeder Metering Instruments:

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- Ammeters for generator line current in R, Y, B phases; transducer operated digital type.
- Voltmeter for generator line voltage, transducer operated, digital type, range –0-12 kV.
- PT phase selector switch for generator voltmeter dial engraved OFF-RY-YB-BR.
- Megawatt meter ; transducer operated digital type
- MegaVar meter ; transducer operated digital type,
- MVA meter ; transducer operated digital type,
- Power factor meter ; transducer operated digital type, range : 0.5 lag-1-0.5 each
- Generator frequency meter, transducer operated digital type range ; 45-50-55 Hz.
- Solid state multi function poly vector energy meter.
- Line frequency monitor transducer operated.
- Summation meter.

For Circuit breaker control/indication

- CB open lamp
- CB close lamp.
- CB trip ckt. Healthy lamp.
- CB auto trip lamp.
- 4 Position lockable synchronising selector switch (off/Auto-Dead bus Manual)
- 3 Position Breaker Control Switch Trip – Neutral-close.
- Semaphore Indicator for bkr. Position.

For Isolator control/indication

- open lamp
- close lamp.
- Open/ Close Switch .
- Semaphore Indicator for Isolator Position.

For Synchronising Equipment.

- Double voltmeter – 144 sq. mm AC moving iron, Digital Type
- Double frequency meter – 144 sq. mm vibrating reed type, Digital Type
- Synchronoscope – 144 sq. mm, Digital Type
- Synchronising selector switch, 3 position, Auto-off-manual.
- Check synchronising relay (Static/microprocessor type).
- Guard relay for check synchronising relay.
- Synchronoscope cut off switches (on/off).
- Reversing PT for bright lamp Synchronising.
- Indication lamp for check syn. Relay permissive,
- Synchronising lamp, white.
- Other aux. Equipment.

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Other System for each generator

- CO_2 release into Generator, lamps.
- CO_2 Panel under test, lamps.
- Emergency trip Push buttons.
- Temperature scanner.
- Indicating lamp test Push buttons.
- Annunciation with accept, Reset, lamp test, first up reset push buttons.
- Auto synchronizer along with control multiplication relays.
- Load Controller .
- Watch (digital type)

Constructional Features for Protection Panel as well as Control Desk

- Control desk shall be upright, floor mounted and dead front and made of cold rolled sheet steel thickness 2.5 mm . it shall be provided with 75 mm base channel & 15 mm anti vibration pad.
- Will have bottom cable entry Double compression cable glands, lugs and gland plates.
- Provided with space heater and interior illumination lamp with switches.
- Anodised aluminium inscription plate both at back and front side of size to enable a person to read from 5 meter shall be provided.
- Painted after proper degreasing, pickling and chemical phosphatising
- Lamp test facility to test all indicating lamps of the panel simultaneously.
- Earth bus securely fixed. 50 x 6 Aluminium ground bus for all panels
- Control desk will have mosaic type construction for both the horizontal and vertical plan and for relay panel rack type construction shall also be acceptable.

Wiring

- Wired with 1100 volt grade multi-stranded copper wire PVC insulation having area 2.5 sq.mm .The CT & PT wiring shall be done with color coded wires.
- Wire shall not be joined or tied between the terminal points. All wire termination shall be made with insulated sleeved crimping type lugs.
- No bunch will contain more than 12 wires.
- Wire end shall be fitted with moisture and oil resistant insulating material having glass finish with identification number clearly engraved in black.

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Terminal Blocks

- Stud type terminal blocks vertically mounted.
- Stud type terminal blocks shall be provided with brass studs of not less than 6 mm in diameter.
- In each terminal block 20% spare terminals shall be provided.
- CT terminal shall be suitable to terminate 4 sq.mm cable and shall be link type to facilitate shorting of CT wires during testing etc.

Control Supply

- The control voltage shall be 220V DC
- For switching off supply disconnecting devices with auxiliary contacts for indication of control supply.
- One number 240 V single phase 5 A point in all panels for testing purpose.
- AC supply shall have single feeder
- DC supply shall have duplicate feeders

Mimic

- Mimic diagram shall present comprehensive picture of the process/single line diagram, to denote different voltages.
- Mimic shall be painted on metal strip having thickness not less than 10 mm.The mimic representation, colour and size of diagram are subject to approval.

Annunciators

- Static type alarm annunciators as described under control scheme chapter shall be provided in common aux. panel, charger panels, compressor panels etc.

Technical Particulars

a)	Panel	:	Sheet steel 2.5 mm thick
b)	Enclosure	:	IP 54
c)	Extendable feature	:	Yes
d)	Illumination with door switch	:	Yes
e)	Provision of cable glands	:	Yes
f)	Inscription	:	Both sides, front and rear
g)	Control supply	:	220 V DC

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h) Signalling bus isolation	:	ON/OFF switch (stay put type)
i) Signalling supply isolation	:	By switch
j) Base channel provision	:	Yes
k) Control buses	:	As per circuit requirement
l) Relays	:	All relays shall be of microprocessor based Generator management type with self diagnostic feature and communication facilities at control room along with necessary PCs and software.
- Protective relays	:	Drawout type
- Auxiliary relays	:	Non-drawout
m) Hand reset contact with mechanical flag	:	Yes
- Master trip relay	:	Yes
- Auxiliary relays	:	As per circuit requirement
n) 5 kV test on relays	:	Yes
o) Instrument size	:	96 mm square
p) Provision of test block for CT and PT circuit	:	Yes
q) PT secondary voltage	:	110 V
r) CT secondary current	:	1A

Transducers

Various transducers (4-20 mA range) shall be provided either in separate transducer panels or mounted in control panels to facilitate remote monitoring of the parameters and to hook up with DDCMIS. All transducer shall be of duplex type.

Specification of Items

Indication lamps

- Shall be panel mounted with rear terminal connection
- Shall withstand 120% of rated voltage on continuous basis.
- Bulbs and lenses shall be replaceable from the front.
- Shall be LED type, with low voltage glow protection.

Semaphore indicators

- Shall rotate $\pm$ 45 deg. on energisation.
- Shall be mounted in such a way that it forms part of mimic.
- Shall withstand 120% of rated voltage on continuous basis.

Control switches

- Shall have four position viz. Trip, Close, Neutral after trip and neutral after close.

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- Type of operation handles of switches shall be spring return pistol grip type.
- All switches shall be provided with inscription labels.
- All switches shall have a rating 10A/500V.

- Switches shall be dust protected, heavy duty switch board type
  - Contacts shall be silver surfaced

Relays

- Shall be contained in dust and moisture proof cases.
- Protective relays shall be drawout type.
- All timers, under voltage frequency and differential relays shall be microprocessor based numerical type.
- Close/trip circuit supervision relays shall be suitable for connection in series with close and trip coil of breaker and trip supervision relay shall be suitable for monitoring the healthiness of tripping circuit on both breaker open and close conditions.
- All protective relays shall have provision for testing. The facilities provided shall be specifically stated in the offer.
- DC relays shall be suitable for operation between 70-110% of rated voltage.

- All protective relays, trip and timer relays, shall be provided with external hand reset positive action operation indicators with inscription.
- All protective relays which do not have built in hand reset operation indicators shall have additional aux. relays with operation indicators, for this purpose.
- All protective aux. and timer relays except lockout and interlocking relays shall be provided with self reset type of contacts.
- Short time delays in terms of milliseconds may be obtained by using copper slugs on aux. relays. Time delay in terms of milliseconds obtained by external capacitor resistor combination is not preferred.
- Tripping shall be initiated always by energization of relays.

Meters and Recorders

- Indicating meters shall be of 96 sq.mm size.
- Indicating meters shall have accuracy class of 1.0 or better.
- Shall withstand 120% of rated current continuously and 10 times rated current for 0.5 sec.
- Shall withstand 120% rated voltage for 0.5 sec. without loss of accuracy.
- MVAR meter shall have zero in the center of the scale. Watt hour and var hour meters shall be of three phase, two element type shall be drawout type and suitable for flush mounting.
- Separate 3 phase 4 wire type test blocks shall be provided for testing of energy meter without disturbing the CT-PT secondary connection.
- Recorders and summation meters etc. shall be supplied as a composite unit including transducers etc. so that same can be connected directly to CT PT circuits.
- All meters and recorders shall be enclosed in dust proof, moisture resistant black finished cases and shall be suitable for tropical use and flush mounting.
- Shall have means of calibration checking and adjustment at site.

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- Shall be suitable for connection with instrument transformers having technical particulars given in single line diagram.
- Shall have reverse running stops.
- Shall be compensated for temperature errors.
- Shall be calibrated to read directly primary quantities without any multiplying factor.
- Multiplying factor if unavoidable shall be multiple of 10 and shall be subject to purchaser's approval.
- Shall have sensitivity of 0.5%.
- Energy meters for unit aux. and excitation transformer and generator shall be digital type with 0.5 acc. class.
- Disturbance recorder with auto printing facility for pre configured set value(V/F/I) with eight configurable digital input.
- All MFM, wherever provided, shall be TFT display, touch screen feature type.

Alarm Annunciation

- Shall be of static type with first in & first out arrangement.
- Shall be suitable to work on 220V DC
- All important parameters shall be annunciated
- Warning and emergency points shall be as per the list approved during detail engg. stage. In general all tripping points and alarm points of transformer, battery system, UPS system, etc. shall be annunciated.
- Test, accept and reset facilities (with push button) shall be provided on each panel.

- Test facility include simultaneous testing of audio-visual indications.
- Shall be normally from one DC supply with manual changeover facility from one to another shall be provided on failure of one.
- Suitable audio - visual indication shall be provided on DC failure. Audio alarm with reset facility shall be provided. Visual indication shall be panelwise.
- Spare annunciation points shall be wired upto terminal blocks. 20% spare facias shall be provided.

- Each point shall have two bunch LEDs in parallel.
- The cover plate of facia shall be flush with panel.
- Shall be capable to receive simultaneous signals.
- Shall be capable to receive signal during testing mode.
- Bidder shall ensure the non-appearance of spurious signals due to the influence of external electromagnetic/electro static interferences on the annunciation wiring, and switching disturbances from neighboring circuits within the panels.
- Scope of supply includes all interconnections, bell hooter, buzzer, alarm facility, push button etc. required to achieve complete function of above scheme.
- Sequence shall be as follows:

Visual Audio

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On occurring of fault	Lamp flashing	ON
On accepting	Lamp steady ON	OFF
On reset	OFF	OFF
On test	Lamp flashing	ON

- All electrical annunciations connected with generator, generator systems and unit system shall be displayed in generator desk in line with boiler and turbine desks.

5.4.6. Generator, Power & Distribution Transformers

Design

Design shall be generally as per IS 2026. Transformer shall be suitable for rated frequency 50 Hz, -5%, +5%. Insulation level shall be designed according to the voltages specified below.

	Nominal system voltage =>		**6.6 kV**	**11 kV**	**33 kV**
1.	Max. system voltage (kV)	:	7.2	12	36
2.	One minute power frequency withstand voltage (kV)	:	20	28	75
3.	Peak impulse test withstand voltage (kV)	:	60	75	170

Transformers shall be capable of delivering rated current at an applied voltage up to 105% rated voltage without exceeding the temperature limits specified below. Overload capacity shall be as per IS 6600. Transformers shall be operable at its rated capacity at any voltage within $\pm$ 10% of rated voltage of the particular tap.

Permissible maximum temperature at rated output and principal tap over an ambient temperature of 50^0C.

- Top oil (by thermometer) : 45^0C
- Windings (by resistance method) : 50^0C
- Maximum Hot spot temperature : 55^0C

Transformers shall be designed to withstand the thermal and dynamic stresses due to short circuits at its terminals. Unless otherwise specified the duration of short circuit shall be 5 seconds.

Disconnecting chamber at the cable and bus duct terminal box shall be provided.

Magnetic Circuit shall be made of low loss CRGO silicon steel shall be used. Laminations shall be annealed in a non-oxidising atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets after the cutting and punching operations.

Flux density at normal over voltage or frequency shall be such that under 10% over voltage condition it shall not exceed 1.6 tesla.

OLTC shall be provided with AVR and LDC in Auto mode.

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Frequency response analysis shall be done on each of the Transfomer during routine testing.

Over voltage capability of the transformers shall be as per IS and shall match with the connected equipment.

Windings

Material shall be electrolytic grade work hardened copper of high proof stress with more numbers of radial supports. Completed core and winding shall be vacuum dried in full vacuum and impregnated immediately.

Insulating materials shall be compatible with transformer liquid under all service conditions. Leads to the terminal board and bushings shall be rigidly supported.

Insulation

Interturn and inter coil insulation shall be designed such that dielectric stress is uniformly distributed throughout the windings under all operating conditions.

Tank

Fully assembled transformer with its radiators, conservator and other fittings shall withstand for one hour a pressure corresponding to twice the normal head of liquid or to the normal pressure plus 35 KN/sq. m, whichever is lower, measured at the base of the tank. Tank shall be provided with inspection opening and cover/with handling equipment) to provide access to bushing connections. Form of cover shall be such as to prevent any stagnant water deposit and to drain gas bubbles towards the buchholz relay. Tank shall be capable of withstanding of 600 mm of mercury.

Conservator and Breather

Conservator mounted on frame, integral with tank in such a manner that under all conditions and the lowest oil level the bushings remain under the head of liquid. Conservator volume shall be sufficient to maintain oil seal from ambient to oil temp. of 90^0C.

Auto de-hydrating type Breathers shall be considered.

Silica gel breather with inspection window and oil level shall be mounted at 1.4 m from ground level and connected to conservator.

Prismatic type oil level gauge shall be provided with max. and min. levels marked on it. Tap and valves shall not be fitted to oil gauge. 150 mm diameter dial type magnetic level gauge with alarm and trip contacts shall also be provided.

Breather shall be connected with rubber bellow inside the conservator tank for expansion and contraction of oil.

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Buchholz Relay

Buchholz relays shall be double float relay as per IS 3677. Shut off valves shall be provided on either sides of the buchholz relay.

Potential free, self reset independent alarm and trip contacts rated to make, break and carry 2 amps at 220 V DC shall be provided. No auxiliary relay shall be used to multiply the contacts. Contacts are to be wired to the marshalling box.

Cooling

The cooling system provided shall be as per the data sheet.

Radiators shall be detachable type directly mounted and shall have flexible earthing arrangement. Bolted, gasketted and flanged connections shall be used for connecting the radiators to the tank.

Additional spare radiator fins shall be provided along with isolation valves.

The following accessories shall be provided for each radiator/radiator bank.

- Top and bottom shut off valves and blanking plates
- Bottom drain plug and top filling plug, air release plug
- Lifting lugs
- Neutral bushing CTs
- Thermometer pockets with thermometers in the inlet and outlet pipes (for separately mounted radiator banks).
- Top and bottom filter valves for each separately mounted radiator bank.
- Pressure reducing devices with alarm and trip .
- Air release devices
- Earthing arrangement
- Bi-directional rollers/rails
- Rail for transportation with provision for extension for HT station transformer
- Spare radiator fins along with isolation valves
- Any other accessories required.

Valves and connections

Valves shall be of sluice type with hand wheels. They shall be made of gun metal and shall be provided with padlocking facility to lock in closed/open position, blanking plates or screwed plugs and clear indication of open and closed position.

Terminations

It shall be possible to withdraw the transformer easily after disconnecting the connections without disturbing the OH line/cable/busduct terminations. For cable termination, air insulated cable box shall be provided which shall be suitable for the type and number of cables specified. Cable end box shall be self-supporting. For OH line termination, proper bushing shall be provided. For bus duct termination, proper matching flange arrangement shall be provided.

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Bushings

Bushing shall conform to IS 3347 and 2099. Clamps and fittings shall be made of steel or malleable iron shall be hot dip galvanized. Neutral bushings shall be provided as required for earthing of neutral point. All the HT bushings shall be provided with suitable connectors and clamps.

Minimum rated current of line bushings shall be 1.5 times rated current of the corresponding windings. Bushing rated 400A and above shall have non-magnetic clamps and fittings only.

Creepage distance for the bushing shall not be less than 25.4mm/kV of the higher system voltage.

Bushing Current Transformers

Bushing CT shall be removable at site without opening transformer tank cover/active part. Secondary leads of $4mm^2$ shall be brought to a weatherproof terminal box and from there to the marshalling box.

Oil temperature Indicator (OTI) / Winding Temperature Indicator (WTI)

Digital display type thermometer shall be provided with alarm and trip settings, manual reset and maximum reading display. There shall also be two independent potential free contacts for alarm and trip signals.

Also analog signals for WTI, OTI for hook-up to DDCMIS shall be provided.

Marshalling box

All outgoing connections from the transformer i.e. buchholz relay, temp. indicators, level indicators, CT secondary, alarm contacts for annunciations, etc. shall be wired to a marshalling box. Degree of protection of enclosure shall be IP 55 class.

All other standard fittings and accessories like name plate, first fill of oil as per IS - 335 with 10% excess in drums, cooling system complete with accessories including detachable radiators, drain and sampling devices, air release device, lifting lugs, conservator with sump, drain valve and detachable end plate, dehydrating breather, etc shall be provided along with the transformer.

In addition, bidder shall supply all the accessories like bidirectional rollers, radiators, etc so as to complete the transformer in all respect.

Bidder shall also provide dedicated remote tap changer control panel for all the transformers with all indications, control, annunciations, etc.

Off-Circuit Tap Switch (Wherever Applicable)

- Externally hand operated

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- Designed for sustained over current of at least 150% of the rated current of the winding.

- Shall not occupy any intermediate position between clearly marked tap position.

- Capable of repeated operation and withstanding short circuit forces.

- Integral handle with pad locking facility at every tap position.

- Tap position indicator

- Inspection and/or repair shall not require removal of transformer from tank nor major draining.

On Load Tap Changer

A. Electrical Design

- Generally as per IS 8468
- Automatic motor operated, resistive transition impedance type.
- Tap changer shall change the effective transformation ratio without providing phase displacement.
- The tap changer shall have the same rating as the associated transformer with respect to rated current, rated voltage, no. of phases, insulation level, over loading capability and short circuit withstand capacity.
- No. of steps and rated step voltage shall be as per Technical Particulars.
- Shall be suitable for connection to line end of neutral and of the winding as specified.
- DC control supply voltage shall be 220V DC.

B. General Arrangement

- Diverter switch contacts shall be housed in a separate oil chamber not communicating with the oil in the main tank of the transformer.
- The oil used shall be transformer oil conforming to IS 355.
- The OLTC oil chamber shall have oil filling and drain plug, relief vent and glass window for seeing the level. A oil surge relay (hand reset type) also shall be filtted, the outlet of which shall be connected to a separate conservation.
- A mechanical tap position indicator shall be provided locally.
- A mechanical operation counter shall be provided to indicate the number of operations completed.
- The main contacts, switching contacts and transition contacts shall be of copper with maximum temperature rise of contacts at 150% of rated current of transformer limited to 20° C.

C. Control Features.
- The OLTC shall have the following control regimes,

a) Local manual operation
b) Local electrical operation

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- In manual regime, the OLTC shall be operable by a person standing at ground level. The electrical operation shall be inhibited automatically once manual operation is restored to.
- For electrical operation, a suitable 3 phase, 415V AC motor and associated starter with thermal O/L relays, fuses, etc. shall be provided.
- The manual electrical operation, either local or remote shall cause one tap movement only. The control switch is to be returned to the OFF position between successive operations.
- Once a switching sequence has started, it shall always be completed. The tap changer shall not stop in an intermediate position even in the event of control power failure.
- Mechanical stop shall be provided to prevent overrunning beyond the extreme tap positions. An electrical interlock through limit switches shall also be provided to cut off power for electrical operation.
- A reverse tap change signal during an operation shall be ignored till the mechanisms comes to rest and resets the circuit for a fresh operation.
- Emergency stopping provision shall be provided both at the local and remote control panels.
- An indication 'tap change in progress' shall be available at the remote control panel.
- Power and control circuit of motor shall be inter-locked.
- If control is set to 'automatic', it shall not be possible to operate the OLTC by manual electric or hand operating gear.

D. Local OLTC Control Cabinet

- Dust vermin and weather proof outdoor type with lockable door.
- Shall house the drive motor for OLTC, starter, local control equipment, indicators for tap position, counters, etc.

E. List of accessories for OLTC.

- Operation counter
- Local tap position indicator
- Conservator
- Dehydrating breather
- Drain plug and oil filling plug
- Local OLTC control cubicle

F. One number (common) portable automatic Transformer Oil Filtration Unit (2000 litre capacity) shall be provided

Technical requirement of Generator transformers

1.	Rated capacity	:	* MVA (bidder to select)
2.	Cooling	:	ONAN
3.	Voltage LV/HV	:	11 kV / 34.5 kV
4.	Duty	:	Outdoor
5.	Specification to be complied with	:	IS 2026
6.	Winding connection	:	Delta/Star
7.	Vector group	:	Ynd11

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8.	Termination	:	HV : Cable LV : Busduct
9.	Tap changer	:	OLTC (17 steps)
10.	Impedance	:	10 % (with no-tolerance)
11.	Withstand time without injury for 3 ph. short ckt	:	5 secs
12.	Overload capacity	:	As per IS
13.	Radiator	:	Detachable
14.	Transformer Losses		
	No load losses	:	To be specified
	Load losses	:	To be specified

Technical requirement of Power transformers

1.	Rated capacity	:	*MVA (bidder to select for each category)
2.	Cooling	:	ONAN/ONAF
3.	Voltage HV/LV	:	33kV / 6.9 kV
4.	Duty	:	Outdoor
5.	Specification to be complied with	:	IS 2026
6.	Winding connection	:	Delta/Star
7.	Vector group	:	Dyn11
8.	Termination	:	HV : Cable LV : Cable
9.	Tap changer	:	OLTC (17 steps)
10.	Impedance	:	10 %
11.	Withstand time without injury for 3 ph. short ckt	:	5 secs
12.	Overload capacity	:	As per IS
13.	Radiator	:	Detachable
14.	Transformer Losses		
	No load losses	:	To be specified
	Load losses	:	To be specified

Technical requirement of Distribution transformers

1.	Rated capacity	:	* MVA (bidder to select for each area/load centre)
2.	Cooling	:	ONAN
3.	Voltage HV/LV	:	6.6 kV / 0.433 kV
4.	Duty	:	Outdoor
5.	Specification to be complied with	:	IS 2026
6.	Winding connection	:	Delta/Star(HV/LV)
7.	Vector group	:	Dyn1
8.	Termination	:	HV : Cable LV : Busduct
9.	Tap changer	:	Off Load Type
10.	Impedance	:	6.25 %
11.	Withstand time without injury for 3 ph. short ckt	:	5 secs

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12.	Overload capacity	:	As per IS
13.	Radiator	:	Detachable
14.	Transformer Losses		
	No load losses	:	To be specified
	Load losses	:	To be specified

[Note : Transformer sizing calculation for Generator, Power and distribution Transformers shall be submitted by the bidder and same shall be reviewed and approved by the purchaser during detail engineering stage. Vector Group shall also be indicated which shall be finalized during detail engineering stage. All transformers shall be supplied based on above considerations.]

5.4.7. 33 kV GAS INSULATED SWITCHGEAR (GIS) BASED SYSTEM

General

This specification covers the technical requirements for 33kV SF6 Gas Insulated double busbar indoor cubicle type switchgear, separately mounted free standing CRP/LCU suitable for terminating incoming and outgoing 33 kV cables complete with all accessories for trouble free and efficient operation & performance.

Standards

Following standards, amended up to date, as on the date of drawing approval shall be applicable:

Sl/No.	Description	Standard No
1	Circuit Breaker	IEC 62271-100
2	Disconnector & Earth Switch	IEC 62271-102
3	Switchboard	IEC 62271-1, IEC 62271-200
4	Current Transformer	IEC 60044-1
5	Voltage Transformer	IEC 60044-2
6	Ingress Protection (IP)	IEC 60529

General Description

The SF6 insulated switchgear shall be type-tested and of pre-fabricated metal enclosed construction.

The system shall be of two bus system with adequate numbers of disconnectors/sectionalizes in each bus. Number of breakers, isolators/disconnectors, CTs, PTs, LAs, etc shall be in line with Single Line Diagram ..Additional 20 % spares with minimum 1 of each type shall be provided .

Bus differential protection shall be considered for four zone considering four section (02 nos B/c and 02 nos Sectionalizers).

The offered Indoor GIS shall have Vacuum Circuit Breaker, Three Position

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Disconnecting Switch in combination with Earth Switch and Bus Bars enclosed in SF6 Gas. Instrument Chamber shall be Air Insulated.

Each single panel shall be built up from the modular range of separate functional units and combined to produce the specified single panel switchgear configuration. Separate power and control compartment per panel for each bay shall be considered. Circuit-breaker and three-position switch drives are to be designed with mechanical interrogation interlocks and shall include all necessary auxiliary devices (auxiliary switches, releases etc.).

The three-position disconnector (ON-OFF-EARTH) shall be designed with separate manual and motorized drives for the disconnector and earth switch functions.

All drives for switching devices shall be located outside of the gas compartments.

The panels are to be delivered to site as factory assembled and routine tested units. After linking the panels (or panel assemblies) by the busbar connection system and connection of the power and control cables, the system should be ready for operation.

Functional Compartments

i) Circuit-breaker & Disconnector compartment - Gas insulated

ii) Busbar compartment - Gas insulated

iii) Cable connection / transformer clad compartment.

iv) Control Compartment

Switchgear Operator Interfaces Requirements

i) A standard mechanical user interface, ergonomically positioned at a convenient height. It shall be visible directly without opening of doors etc.

ii) The user interface comprises all the mechanical, panel- related interfaces and continuous interrogating interlocks.

iii) All the basic mechanical ON/OFF of CB, Disconnector & earth switch operation, manual spring charge of CB must be possible without opening the door to ensure the operator safety.

iv) Mechanical mimic directly linked to mechanism should be provided at the panel front door.

v) The basic switchgear unit is to be designed for suitable free-standing installation within a switch room.

vi) The Interlocking shall be as per IEC.

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vii) The mechanical control panel shall be located at an optimum height for operation and arranged in a recessed position on the switchgear front. Thus, the operating area is clearly visible while no control elements protrude from the switchgear front. The position of the individual elements shall be selected according to their function, i.e. according to their allocation to the corresponding device functions. The elements which form part of a switching device, such as position indicators, crank ports or mechanical push buttons, are visually linked by a specific pattern and integrated in a mimic diagram. Mechanical operation is performed the same way as with the habitual operation with stationary switching devices. Separate control elements and mechanical switch position indicators shall be available for the following functions:

a) Circuit-breaker ON - OFF

b) Disconnector ON - OFF-EARTH

Busbar / Panel Connections:

The busbar shall be three phase encapsulated type, whereas, feeders may be single phase encapsulated. The enclosure shall be made of aluminium / steel with adequate thickness and mechanical strength to have minimum corrosion and lesser weights. All the individual modules shall be connected with flanges to make a common bus bar system. The gas-insulated busbar sections of the single panels shall be connected via elements which allows for easy exchange of a cubicle. Busbar connection to be designed in such a way that no adjacent panels shall be moved or opened for exchange of a panel.

Gas Compartment Technology:

Each SF6 gas filled compartment shall have independent temperature compensated continuous density /pressure monitoring and alarm & tripping system with visual display of SF 6 gas pressure and alarm (red) /normal (green) zone markings.

By design there should be no need for gas works during the whole time on site, e.g. no gas handling shall be necessary during the anticipated service life of the switchgear, under normal operating conditions. (The gas-filled clad compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200).

The switchgear panels shall be filled with gas and checked for leakage in the factory. For a proper recycling / emergency replacement, a gas valve in each gas compartment has to be provided

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Each gas compartment shall have provision for independent sampling and topping up of SF 6 gas without disturbing other compartments with provision for monitoring SF6 gas pressure by external hand held manometers. Individual feeder bays shall also be segregated from each other .

Desiccators shall be provided for each SF 6 gas segregated compartment . Electrical connection amongst compartments shall be by means of bushing insulators to ensure proper sealing . Solid insulating materials used in the switchgear shall be impervious to deterioration due to contact with SF 6 gas and its decomposed product .

The switchgear shall be able to withstand rated voltage even if SF 6 gas pressure in any compartment falls to atmospheric pressure.

All the live parts including the VCB, Three position Disconnector, and main busbar shall be encapsulated in type tested stainless steel/ AL alloy enclosures filled with SF6 gas.

Circuit Breakers

The three-pole vacuum circuit breaker with its maintenance-free vacuum interrupters shall be installed in the gas compartment. The CB shall be spring operated, motor charged, and manually/ electrically released spring closing mechanism with three pole simultaneous operations. The speed of closing operation shall be independent of the hand-operating lever. The indicating device shall be **mechanical type directly linked to the mechanism & shall show the OPEN and CLOSE position of breaker visible from front of the cubicle.**

The Breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of IEC 62271-100 and latest amendment thereof.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. **Three stage gas density** alarm and lockout system with local and remote indication shall be provided.

Emergency **mechanical trip push button on each CB shall be provided on panel front & shall be accessible with front door closed.**

Spring charged indication to be provided. Manual Spring charging provision shall be provided for circuit breaker.

The vacuum circuit-breakers are to be equipped with

a) Spring-stored-energy operating mechanism with motor, auto-reclosing

b) Mechanical OPEN and CLOSE buttons

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c) 1 closing coil

d) 2 numbers of trip coil

e) Operating cycle counter

f) Auxiliary switch with at least 12NO + 11NC available

g) Auxiliary switch for "spring charged" signal

The circuit-breaker has to control at least 10,000 Make-Break cycles (One operating cycle of making & Breaking) operations at rated current or 100 breaking operations at rated short-circuit breaking current without maintenance. The mechanical life of the vacuum interrupter has to comprise at least **20,000** operating cycles.

The operating mechanism must be maintenance-free without time limit up to 10,000 operating cycles.

The breaker shall ensure Continuous operation at rated current at specified ambient conditions i.e. 50^0C.

Disconnector and Earthing Switches:

Disconnector combined with earthing switches (3 position switch) shall be motor operated. In cases of emergency, provision for manual operation shall be provided.

The earthing position for all 3 phases must be visible via a mechanical position indicator directly connected to the drive shaft on panel front Fascia.

Position of the earth switch shall be in line with SLD or the scheme The mechanical operation of 3 position disconnector switch mustbe possible with door closed for operator safety.

Instrument Transformers:

Only Conventional inductive voltage and current transformers according to IEC 60044-1 and IEC 60044-2 or electronic current and voltage transformers to IEC 60044-7 and IEC60044-8 or a combination of both are acceptable. Current & voltage Sensors are **not** acceptable.

The **current transformers** shall be toroidal core type. The Current Transformers shall be located outside the Gas Compartment. The transformer ratio, the accuracy class and the performance load to be selected to suit the application requirements.

PT shall be inductive type, cast resin insulated voltage transformers in metal enclosed safe to touch design. PT shall be located outside the gas compartments. Bus PT shall be connected to bus through 3 position disconnector switch. Line PT can be plugged directly on the cable connection or connected through separate cable. PT shall have

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one or more secondary windings as per requirement. Plug in type Line PT with isolator in HT side shall be considered.

(Preliminary ratio of the CT/PT shall be furnished. However actual rating shall be finalized during detailed engineering. No commercial implication shall be entertained in this regards. CT burden shall be provided as per relay and metering requirement and bidder to substantiate this with suitable calculations during detail engineering with CT/ PT Burden calculation)

Mechanical Safety Interlocking Features:

Following Internal mechanical interlocks shall be provided for the panel

a) With the circuit-breaker closed, the interrogation slide is locked for the disconnector and the earthing switch. (Restriction to the insertion of Hand Crank for Disconnector-Earth Switch when CB is ON)

b) The interrogation slide always releases one insertion opening only (disconnector or earthing switch), or both of them are locked. (To ensure that either Disconnector- or Earth Switch operating at a time)

c) The crank for the disconnector and earthing switches can only be removed in its appropriate end position.

d) When the crank on the disconnector or earthing switch is still in place, or when the interrogation slide is open, the following components are locked:

   i) ON push button of circuit breaker

   ii) ON pulse is interrupted

Power Cable Termination Modules

Termination modules shall be for cables only. Cable connections shall be accessible from the beneath through the cable duct, cable trench or the cable basement. Cable connections shall be either inner cone/outer cone type as specified in technical particular. The termination module shall be suitable for 3 – core or 1 –core cable per phase, multiple runs as per the size N number as per the system requirement shall be considered.

Termination kit shall be fully insulated type and shall be supplied along with the GIS. Test plug shall also be provided for each feeder. Minimum 3 numbers dummy plugs (1 Set) shall be provided along with each feeder.

The cable module in each outgoing feeder shall be provided with suitable station class surge arrestor. Calculation for finalization of the size of the surge arrestor shall be submitted during detailed engineering.Gland plate shall be 5mm Aluminium for 1

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core or 3 core cable entry.

Protection Requirement

i) All Protection relays shall be provided as indicated in the specification or in line with single line diagram / scheme. All relays shall conform to the requirements of IS:3231 / IEC-60255 / IEC 61000 or other applicable standards.

Busbar differential protection shall be provided considering four zones/sections

ii) All main protective relays shall be of fully microprocessor based numerical type and shall comply as per IEC 61850 standard for communication. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable. The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking and also to ensure interoperability with third party relays. Each relay should also generate an ICD file in EXCEL format for engineering/ integration to a vendor independent SAS/ SCADA system.

iii) All the protective relays shall be mounted on the control cubical of the GIS switchgear along with other control elements e.g meters, lamps, switches, aux relays, Push buttons etc.

iv) **For numerical relays, the scope shall include the following**:

a) Necessary software and hardware to up load /down load the data to/from the relay from/to the PC installed in the substation. Laptop(s) with necessary licensed software along with associated components/items for all numerical relays shall be provided.The relays should have two type of communication ports e.g. Front network port for local communication for relay settings, modifications, extraction and analysis of fault/event/ disturbance records from a laptop and Rear fiber optic port on IEC61850 standard for remote communication to Automation system.

b) The relays shall have the following tools for fault diagnostics

- Fault record: The relay shall have the facility to store fault records with information on cause of trip, date, time, trip values of electrical parameters.
- Event record: The relay shall have the facility to store at least 1000 time stamped event records with 1ms resolution.
- Disturbance records: At least 60 sec of disturbance records with 12 recording shall be provided in the offered Numerical relays. Each record shall store data from all the analogue channels, at least 10, used in the relay for protection and at least 32 digital channels. The data from DR function shall be available in IEEE format and shall be compatible with the relay test kit being supplied under this contract.

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c) All relays shall be flush mounted in dust proof cases and shall be mounted on front side of cubicle.

d) All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in bidder's scope of supply.

e) Signals from / to SAS/SCADA shall be routed through numerical relay. Relay shall be selected accordingly so that Number of IO's confirm to this requirement. Scheme shall be suitable for complete remote operation / control through relay.

f) Numerical relay shall have facility to filter out inrush currents so that lower setting for short circuit protection could be utilized

v) The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided.

vi) Relay and meter ranges, exact type, number of aux. relays, timers shall be finalized during drawing approval stage during detailed engineering. Further:

a) All timers and protection relays shall have flag indicators. Numerical relays shall also have LED indicating lamp/LCD to indicate operation of relay and type of fault

b) All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self –reset type contacts.

c) Master trip relay shall be hand reset and shall have 2 NO and 2 NC contacts in addition to those required by the protection/control scheme.

d) All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.

e) VAA type aux. relays shall be provided for each transformer fault / external signal interface. Connection of the relay shall be through links to facilitate maintenance.

f) The circuits of various protections (coming from other panels/ field) shall be connected to master trip relays through aux. relays (flag indicated) only.

vii) All AC operated relays shall be suitable for operation at 50 Hz AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage applicable for the project and shall operate satisfactorily between 80% and

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110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

a) Independent timers, if applicable, shall be of solid state type.

b) Contact arrangement, number of poles/ways in control/selector switches shall be as per the requirement/approved scheme.

c) All instantaneous / IDMT current protection relays shall be of 3 pole type.

d) ICTs whenever considered necessary shall be included in the scope

e) For control supply distribution, panel to panel separate set of terminal blocks shall be provided at top of the panel. All items/accessories required for above in each panel and in incoming panels shall be provided by the supplier.

f) Annunciation fascia shall be mounted on individual switchgear panels and details shall be finalized during drawing approval stage.

Control Compartment

i) **Enclosure-**The Control compartment shall be made of 2.0 mm CRCA sheet and shall be integral part of the GIS switchgear. All the relays, meters, selector switches, lamps, PBs etc shall be mounted on this compartment. The position of various control switches, push buttons, levers etc requiring manual operation shall be at a height not less than 450mm and shall not exceed 1850 mm from the finished floor level.

ii) **Control Wiring** -Control wiring shall be carried out by 1100V grade FRLS PVC insulated, single core multi stranded copper wire of minimum cross section 2.5sq. mm. Flexible multi strand wire of 4 sq.mm shall be used from CT to control chamber. Interconnection between panels of adjacent shipping sections to be brought out to a separate terminal block. Not more than two connections shall be provided on any one terminal. All spare contacts shall be wired to TB. All internal wiring shall be terminated with **round lugs** only.

iii) **Terminal Block - 800V grade** multi-way terminal blocks of non-tracking moulded plastic complete with insulated barriers, stud type terminals of polyamide material **(STH4 of connectwell or OAT6 of Elmex or Equivalent)**, washers, nuts and lock nuts and identification strips shall be provided. All CT and PT wires shall be first brought to disconnecting type TBs. 20% spare terminals in each control terminal block. Terminal Blocks shall be separately grouped as per their functional requirement.
Distinct identification labels (stickers and name plates) shall be provided on terminal blocks used for CT circuits, PT circuits, AC power supply circuits, DC power supply circuits, CB closing circuits, CB tripping circuits. Name plates for devices shall have brief description and tag No. of the device.

All plastic ferrules shall have engraved numbering and shall be interlocking type.

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iv) **Analogue Instruments** - All analogue indicating instruments shall be taut band, flush mounting, back connection type. Minimum size 96 x 96mm. Accuracy class of the analogue meters shall be 1.0. All analogue indicating Instruments shall have square flush case, non-reflecting type, clearly divided and indelibly marked scales, sharply out lined pointers and zero adjusting device.

v) **MFM** - Digital multi function meter with TFT display having touch screen feature type shall be provided with Modbus RTU or TCP/IP communication port for connection to SAS/SCADA. The MFM shall be true rms type, have accuracy class of 0.5 for all the parameters. The MFM shall be 3 line 7 segment, 31/2 digit LED display, external powered, site configurable for CT/PT ration, 3 Phase measurements. Display-Current, Voltage, Active & Reactive power, PF, frequency, four quadrant active, reactive and apparent energies, THD & Individual voltage & current harmonics indications.

vi) **Annunciator** - Microprocessor based facia window type annunciator, programmable and suitable for NO/NC potential free contacts shall be provided for each panel. Hooter and bell for trip and alarm indication respectively shall be configured. 20% spare fascias shall be provided. All trip points facia shall have red color and non trip points white color. The cover plate of facia shall be flush with panel.

vii) **Control Supply** - Control supply buses shall run throughout the switchgear. Two feeders of DC feeder shall be taken in board controlled by MCB's. In each panel for controlling of its DC supply MCB (DC duty) shall be used. Failure of each DC supply shall be monitored in the switchboard as well as at remote. Two feeders of 240V AC supply shall be fed from a AC distribution board. Each panel shall have one MCB for controlling its AC supply. Sub circuits shall be protected with MCB in each panel for indication lamps, closing circuit and tripping circuits separately. Other manual changeover option, auto changeover feature should be there for both AC & DC supply using timers and contactors and auto-manual changeover selector switch.

viii) **Earth Bus -** Continuous earth bus of minimum size 50x6 and meeting requirement as per IEC 62771-200 cl 5.3.2 made of copper, designed to carry the peak short circuit and short time fault current as specified shall be provided. All non-current carrying metal work (including metallic cases of instruments and other panel mounted components effectively) bonded to the earth bus directly.

ix) **Labels –** Switchboard designation nameplate at the center of the board with letters not less than 25 mm high. Panel designation number on each panel, both in front and rear. Component labels (minimum 3 mm high) below each component. Label shall be made of non-rusting metal with engraved inscription of black letters on white background and shall be riveted at the outer surface of the cubical. Labels for

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equipment/component inside the cubicle shall be painted at base and sticker on equipment. Label designation and size of lettering subject to approval.

Changeover Scheme

All the HT switchboards with sectionalized buses will be normally operated with the bus coupler breakers in open condition.

Manual changeover between the two normal incomers and their bus-coupler will be provided with the `following features.

Manual changeover from one incomer to another with momentary paralleling of the two supplies after checking through synchrocheck relay.

Manual live changeover facility will be provided for all the switchgears. When planned outage of one of the normal incoming supplies is required, the respective incomers will be tripped automatically after the bus section breaker is closed manually. For this purpose, a trip selector shall be provided for selecting the incomer to be tripped. Thus, depending on the selection made, incomer to bus section – A or to bus section – B will be tripped once bus section breaker is closed manually, thus maintaining continuity of supply.

Manual dead bus closing of a bus-coupler after an intentional manual trip/outage due to under voltage of any one incomer will be possible. However, restoration to normal will be manual.

A timer with a time delay on pick up of 0.5. - 5 sec. for annunciation of the running breaker failing to trip within a preset time, (i.e. If the two sources remain paralleled for more than a preset time) will be provided. Latest breaker tripping provision will be included in the changeover scheme in addition to annunciation.

When the normal supply is to be brought back into operation, the incomer breaker will be closed whereupon the bus coupler will trip automatically.

Technical particulars:

Sl. No	Particulars	33 kV GIS
1.	Type (Model No.)	To be specified by the Bidder.
2.	Service	Indoor
3.	Nominal System Voltage	33 kV
4.	Highest System Voltage	36 kV
5.	No. of phases and frequency	3ph. 50 Hz
6.	Busbar material & size	Electrolytic grade copper, size as per type tested design
7.	Bus Color code	RYB

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Sl. No	Particulars	33 kV GIS
8.	System Earthing	Earthed through NGT
9.	Circuit Breaker Rating	
9.1	Continuous Current Rating at 50^0C	As per design requirement/ SLD
9.2	Short Circuit Rating	40 kA
9.3	Short Circuit duration	3 sec
10.	Rated making Current	100 kA
11.	Operating duty	O-0.3sec-CO-3 min –CO
12.	Leakage rate per year in gas compartment	< 0.1%
13.	Busbar rating	In line with the scheme / SLD
14.	Outgoing feeder rating	In line with the scheme / SLD
15.	Power Frequency Withstand voltage	70 kV for 1 minute
16.	Impulse withstand voltage (1.2/50 micro sec)	170 kVp
17.	Control Voltage	220 V DC
18.	Spring charge motor voltage	240V AC
19.	CT Ratio	Secondary Current 1A (Ratio during detail engineering)
20.	PT ratio - STAR/ STAR/ OPEN DELTA	(33/√3) / (0.11/√3) / (0.11/√3) / (0.11/3)
21.	Aux. Contacts (Min)	For disconnector switch - 3CO, 5NO + 5NC For Earthing Switch - 6CO, 3NO + 4NC For Breaker contact - 12NO + 11NC
22.	Termination	
22.1	Incomers	XLPE AL Cables
22.2	Outgoings	XLPE AL Cables
22.3	Termination Kits	Shall be supplied along with the panel
22.4	Cable termination type(Inner cone/ Outer cone)	**Inner cone**
23.	Degree of protection SF6 filled compartment	IP – 67 or better

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Sl. No	Particulars	33 kV GIS
	LV equipment Cable compartment Drives	IP – 4X or better IP – 3X or better IP – 3X or better
24.1	Internal Arc rating of the switchboard	Rated fault current for 1 Sec
24.2	Internal Arc Classification	AFL for panels with no rear access required. AFLR for panels with rear access required.
25.1	Enclosure – Gas Tank	Stainless steel, Thickness as per the type tested design
25.2	Enclosure – Panel	CRCA, min 2.0mm
25.3	Gland Plate	5mm AL

Testing of Equipment

Testing

i) Tests of all equipment shall be conducted as per latest ISS/IPSS. Tests shall also confirm to International Standards IEC/VDE/DIN/BS (in case corresponding test are not mentioned in ISS/IPSS).

ii) No equipment or part items shall be dispatched without final acceptance certificate and dispatch instructions issued by purchaser and/or their authorized representatives.

iii) All routine tests shall be carried out as per relevant ISS / IPSS / Other Standards during inspection at manufacturer's works in presence of purchaser or his representative.

iv) Quality Assurance Plan (QAP) shall be submitted by the successful bidder / supplier for all the equipment as per the QAP format given during detail engineering for approval by the purchase or his representative. Inspection shall be carried out as per the approval drgs/ spec. and QAP.

v) Inspection call shall be given by the successful bidder / supplier for association of purchaser or his representative during inspection in line with the inspection call proforma which will be given during detail engineering . Inspection call shall be given minimum 15 days in advance from the proposed date of inspection. Four sets of relevant manufacturer test certificates, test certificate for major bought out components, internal inspection report of bidder (if applicable) etc. as per the approved QAP shall be enclosed with each inspection call.

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vi) The bidder shall submit type test certificates for similar rating & design of equipment supplied by him elsewhere earlier. In case type test certificates for similar rating & design of equipment is not available, the same shall be conducted in presence of Purchaser or his representative if Purchaser so desires, without any financial implications to purchaser.

vii) Manufacture test certificate for major bought out components shall be submitted during inspection.

viii) All the equipment shall be tested at site to know their condition and to prove suitability for required performance.

ix) The bidder shall be responsible for satisfactorily working of complete integrated system and guaranteed performance.

Spares

The bidder shall furnish list of 2 yrs. maintenance spares and quote item wise price for 2 years maintenance spares in their offer. Order for same may be placed by purchaser separately. The purchaser reserves the right to buy any recommended spare. Any variation in quantity of spares based on contracted unit rates, if desired by purchaser, shall be acceptable to the bidder.

All spares supplied shall be interchangeable physically, functionally and operationally on one to one basis with the parts for which they are intended for replacement.

Bidder shall guarantee for supply of spares for their equipment for at least 10 years.

Guarantee

The bidder shall stand guarantee for the trouble free operation and satisfactory performance of all the equipment supplied by him. The material used shall be new and best of its kind available and shall conform to relevant latest Indian standards, IPSS and international standards.

The guarantee shall also cover faculty design or materials or workmanship. The supplier shall do all rectification or replacement under the guarantee free of cost.
The supplier will replace equipment/component without any cost implication to purchaser in case of any failure during testing and commissioning.

The supplier shall replace the wrong/defective equipment supplied by them, missing items (observed during inspection at site after receipt of materials) or any damages caused to equipment during transportation free of cost after receipt of information from the Purchaser. In case of any dispute, decision of purchaser shall be final. The supplier shall depute his representative to site for replacement/rectification work without any extra cost to purchaser.

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Accessories:

SF6 gas filling and evacuation unit with pressure tank, vacuum compressor , vacuum pump, evaporator, filters/ dehumidifier , pressure reducer , rubber hoses , wire braided hoses, tubings, meters, switches, alarm indication , indicators and other fittings and accessories all mounted on trolley and suitable for 2 4 0 V , 5 0 Hz power supply.

Tools & tackles in suitable carrying cases for fitters , electricians, SF 6 gas work including monitoring & measuring , electrical measurements.

Handheld SF 6 gas pressure/ density /leakage and moisture measuring devices and partial discharge measurement device .

33 kV GIS supplier shall supply special embedments for GIS /LCU well in advance for fixing the same during civil construction.

Erection Testing & Commissioning

All equipment supplied by bidder shall have erection, testing, & commissioning of entire supplied 33kV GIS & LCU/Control unit. However successful bidder shall depute their/OEM expert to site and shall be responsible to perform all initial checks/tests including simulated checks, calibration setting adjustment etc., erection and commission the equipments satisfactorily and for stable commercial operation.

5.4.8. 6.6 kV Switchgear (Indoor)

5.4.8.1. Constructional and other features

The switchgear shall be of metal clad, single busbar for 6.6 kV switchgear, self standing, dust proof construction, indoor cubicle type fitted with vacuum breakers, in fully draw out execution. Degree of protection shall be IP4X.

The circuit breakers shall be suitable for following duties:

i) To withstand in rush magnetizing currents of transformers.

ii) To withstand switching off over voltages caused due to break of lightly loaded low capacity cage type induction motors. It shall also withstand DOL starting of motors with large starting time, and repeated starting like one hot start and two successive cold starts.

iii) Transients surge produced by one CB due to severe chopping during rapid interruption of inductive currents, e.g, motors, shall be within the limits allowable for overhauled motors according to IEC34 pt. 1 for that suitable surge absorber shall be provided.

- The controls, indicating lamps, relays and meters shall be mounted on breaker cubicle itself.

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- Operation counter, close/open mechanical indications spring charged/discharged indication shall be provided.

- All circuit breakers shall have 240V AC motor operated spring charging and 220V DC independent closing and shunt tripping . Closing coil shall be suitable to operate between 85-110% of voltage and tripping coil between 60-110% of rated voltage. Spring charging motor shall operate between 80-110%.

- A manually operated device to enable charging of closing springs.

- All circuit breaker trucks shall have service, test and draw out positions. Test position shall engage only the auxiliary (control) contacts to close the CB during testing.

- Anti pumping features shall be provided.

- All live parts shall be insulated by tapping supported by suitably designed insulators. Proper insulation of bus bars upper and lower contacts of breakers, vacuum bottles (for VCB) and sealing of opening of bushings shall be provided to eliminate accidental contacts. Switchboard busbars shall be tapped by proper grade of insulating tape.

- Each cubicle shall have mimic diagram with metal/PVC strip.

- Each cubicle shall be of compartmentalized construction and shall have separate compartments for busbars, CTs and outgoing cables, metering protection devices.

- All circuit breaker trucks of same rating shall be identical in all respects (except metering and protective devices) and shall be interchangeable with similar breaker panel.

- Continuous earth bus shall be provided throughout the board.

5.4.8.2. Auxiliary buses for control & protection

- Buses shall be formed by Cu wire looping.

- Control supply buses for AC and DC

- Signaling supply

- PT secondary voltage

- Under voltage bus-1 for tripping of motors not meant for automatic restarting

- Separate buses shall be provided for control, indication and metering.

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5.4.8.3. Provision of surge suppressor

- In case of breakers that give rise to over-voltage surges due to current chopping phenomenon, surge suppressors to be provided at the load side terminals of the breakers to limit the switching surges to value limited for as per IEC.

5.4.8.4. Annunciation scheme

- Flag indications for all faults for which individual protective relays have been specified.
- 'Warning' signalling (as applicable) on individual panels :

a) All transformer warning/signalling conditions (group signal from corresponding transformer control panel/substation)
b) Loss of trip circuit supply
c) Earthfault
d) Control supply failure
e) PT fuse failure/MCB tripping

- 'Emergency' signalling for tripping of HT breakers on fault
- One common signal for warning and one signal for emergency from each panel to be wired to a common annunciation panel of the switchboard, where specified.
- Annunciators for warning and emergency signalling conditions on individual panels of solid state facia window type. Common audio signalling with Accept, 'Reset' and 'Test' push buttons for the switchboard where common annunciation panel not specified. Audio signalling to have distinct tones for 'warning' and 'emergency'.

5.4.8.5. Busbar and connections

- The main buses and connections shall be of high conductivity aluminum/ aluminum alloy
- Control and auxiliary buses of electrolytic grade copper
- The continuous rating of the main horizontal bus not less than the rating of the incomer specified, where not specified, the rating to be selected for at least 125% of the maximum demand of the switchboard taking into account spare feeders.
- The vertical bus rating :

. For incomer : Not less than that of horizontal bus
. For outgoing : not less than that of the outgoing breaker,

- Final operating temperature under continuous operation in enclosure limited to 90 deg. C by thermometer method.
- Cross section of main horizontal bus to be uniform throughout the switchboard and continuous in one transport unit.
- Bus bar arrangement as per IS-11353 - 1985, IS-5578 - 1985.
- Phase identification by colour in each panel.
- Busbar joints and tap off connections of bolted type with zinc bichromated high tensile steel bolts, nuts and spring washers, fish plates with accessories at the end of a transport unit for site connections.

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- Busbar support insulators of non-hygroscopic material having high impact and dielectric strength with an anti tracking contour.
- Busbar shall be insulated by Raychem sleeving with full voltage sleeving.

5.4.8.6. Internal control wiring

- Control wiring by 1100V grade PVC insulated, single core copper wire of minimum cross section 2.5 sq. mm
- Flexible wires protected against mechanical damage for wiring to door mounted devices.
- Wires identified at each and in accordance with schematic diagrams by interlocked type ferrules.
- Colour code for control wiring : AC - black ; DC - ligh grey
- All connections external to a feeder, all the auxiliary contacts of the HV breaker and at least 1 NO + 1 NC spare contacts of the relays, brought on to terminal blocks.
- Interconnection between panels of adjacent shipping sections to be brought out to a separate terminal block.
- Control wires shall be run in earthed metallic flexible conduits when laid in HV bus chamber.
- Not more than two connections on any one terminal.
- All telemetering signals wired to terminal strips.

5.4.8.7. External Terminations

- Control Terminations
- 650V grade multi-way terminal blocks of non-tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
- Control terminals of minimum rating 10 amps and suitable to receive 2.5 sq. mm copper conductor.
- Terminal blocks in separate groups shall be provided for DDCMIS, remote control panels, transformer marshalling boxes, local push button station etc.
- 20% spare terminals in each control terminal block.

5.4.8.8. Power Terminations

- Suitable for accepting cable/bus trunking as specified.
- Sufficient space and support arrangement inside each panel to accommodate HT cable termination kits and sealing kits suitable for the type, size and number of cables to be terminated.
- The size of HT cable shall be decided during detail engineering
- Dummy panels to be provided adjacent to the switch panel, where the required number of cable terminations can not be accommodated in the cabling chamber of the main panel.
- Where more than one cable have to be terminated per unit, the arrangement shall permit connection and disconnection of cables separately without disturbing other cables.

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- Where specified, the following cable termination accessories, suitable for the type, size and number of cables to be terminated, to be supplied with the switchboard. :
- Cable sockets with all HT terminals. (socket set at such an angle that cable tails can be brought up for termination with minimum bending and setting.)
- HT cable termination and sealing kits.
- Double compression type, brass cable glands and crimping type tinned heavy duty copper lugs for HT, LT power and control cables.

5.4.8.9. Current Transformers

- Separate sets of current transformers shall be used for differential protection, over current protection and measurement purposes.
- Short time rating and insulation levels of CTs shall be similar to the rating of associated breakers.
- CT ratios specified are provisional. Where outputs and accuracies are not specified, these shall be such as may be required by the circuits in which they are used. Generally the protection CTs and metering CTs shall have 5P20 and 1.0 class respectively.
- CTs shall be window/bar primary type
- CTs shall have shorting link on secondary side to facilitate insertion of meters on secondary side without opening CT circuits.

5.4.8.10. Voltage Transformers

- Voltage transformers shall be provided in incomer panel of the switchboard.
- High voltage side of VTs shall have fuses and low voltage side shall be provided with MCCBs.
- Low voltage star winding shal have all three phase and neutral connections brought out to terminals and one phase shall be earthed.
- Insulation levels shall be similar to the rating of associated board.
- ACC class 1.0 shall be used.
- Shall be mounted on withdrawable truck.
- Preferred VA burden 100.

5.4.8.11. Relays

- All relays shall be flush mounted in dust proof cases and shall be mounted on rear side of cubicle.
- All protective relays shall be drawout type and micro processor based numerical type with communication system at control room.
- All timers and protection relays shall have flag indicators.
- Master trip relay shall be hand reset type and shall have 3 NO and 3 NC contacts in addition to those required by the protection/control scheme.

5.4.8.12. Indicating instruments

- All indicating instruments shall conform to IS : 1248 - 1983 and IS - 2419 – 1973.
- Shall be capable of withstanding system fault current taking account CT saturation.

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- Shall be back connected.
- Shall be located in the upper part of the panel.
- Shall have 144 sq. mm square flush case, non-reflecting bezels, clearly divided and indelibly marked scales, sharply out lined pointers and zero adjusting devices.
- The full load reading of each ammeter shall occur at the most prominent part of the scale. The minimum scale reading shall not be more than 10%. Maximum reading shall be 15% full load for transformers panels and 600% full load for motor panels.

5.4.8.13. Annunciators

- Solid state facia window type with white heat resistant plastic material, inscriptions, engraved in black.
- Lighting unit with dual LED lamps in parallel.
- Facia window and lighting unit in `plugin' type assembly.
- Control circuits of individual channels on glass epoxy coated plug in type PCBs in bin assembly, plug/sockets mechanically coaded, to avoid wrong insertion.
- Falut ACCEPT, system RESET and TEST push buttons common for the system.
- Sequence of operation
- On incidence of fault - hooter ON, lamp FLASH
. On pressing ACCEPT PB - Hooter OFF, lamp STEADY
. On pressing RESET PB LAMP OFF if fault has been cleared. Otherwise LAMP Persists

5.4.8.14. Control Supply

- Control supply buses shall run through OUT the switchgear.
- Two DC feeders shall be taken in each board controlled by MCBs.
- In each panel for controlling of its DC supply MCCB shall be used.
- 240V AC supply shall be taken from a substation aux. board.
- Each section shall have separate feed with automatic changeover scheme.
- Each panel shall have one MCB for controlling its AC supply.
- Sub circuits shall be protected with HRC fuses.

5.4.8.15. Voltage Selection Circuit

- Voltage selection circuit shall be formed to ensure that only one PT feeds the entire load of PT consumers. This shall be necessary to avoid paralleling of PTs, when more than one voltage source in 'ON'.

5.4.8.16. Earthing Devices

- Either integral earthing switch or a separate earthing switch shall be provided to facilitate earthing of busbars and any feeder circuit. Earthing truck shall have PT and alarm provision.
- One number earthing truck shall be provided for each type of feeder panel.
- Rating of earthing device shall be in line with associated board.

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5.4.8.17. Terminal Blocks

- Stud type suitable to accommodate 2 cores of 2.5 sq. mm copper control cables.
- Size of terminals for bus wires - AC/DC incoming supplies shall be as per requirements.
- 20% spare terminals shall be provided in each panel.
- All terminals going out of the switchboard shall be brought to a separate terminal board marked 'External Connections'.

5.4.8.18. Small wiring and ferrules

- All small wiring shall be carried out with 650 V grade single core cable having copper conductor, preferably stranded, of not less than 1.5 sq. mm cross section. However, wires going outside the switchboard shall have minimum 2.5 sq. mm cross section.
- Wiring across the hinges shall be through flexible cables.
- The wires shall be identified by numbered ferrules at each and, all in accordance with connection diagram.
- All ferrules shall be made of non-deteriorating materials.
- The ferrules shall be firmly located on each wire so that they cannot move freely on the wire.

5.4.8.19. Indicating Lamps

- LED indication shall be provided. The lamps shall be LED industrial duty with low voltage glow protection.

5. 4.8.20. Control and selector switches

- Control switches for circuit breaker ON/OFF control-3 position spring return to neutral with lost motion device and pistol grip handle.
- Other control and selector switches - stay put type with wing type knobs.
- Ammeter selector switches - 4 position, make before break
- Voltmeter selector switches - 4 or 7 position as required.
- Rating: continuous - 10 amps
  AC - 4 amps, 240V
  DC 11 - 0.5A, 220V, L/R - 40 ms
- Colour : Black

5.4.8.21. Push Buttons

- Rating: continuous - 10 amps
  AC - 1.5 amps, at 240V
  DC 11 - 0.5A, 220V, L/R - 40 ms
- Color : ACCEPT - BLUE
  RESET - BLACK
  TEST - YELLOW

5.4.8.22. Control Circuit Protection

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- Preferably with MCBs, alternatively HRC link type conforming to IS 9224.

5.4.8.23. Protective Earthing

- Continuous earth bus of minimum size 50 x6 mm copper or equivalent aluminium/galvanised steel section, designed to carry the peak short circuit and short time fault current as specified.
- Provided at the bottom extending throughout the length of the board, bolted/brazed to the frame work of each panel, with an earthing terminal at each end, for terminal at each end for terminating external earth conductor.
- Vertical earth bus for earthing individual functional units.
- All non-current carrying metal work (including metallic cases of instruments and other panel mounted compoents) efectively bonded to the earth bus.
- Hinged doors earthed through flexible earthing braid.
- Looping of earth connection resulting in loss of earth connection to other devices when the loop is broken, not permitted.
- Withdrawable units provided with self aligning, spring loaded, silver plated copper, scrapping earth contacts, of make before/break after type, ensuring earth continuity from service to the test position.

5.4.8.24. Test and maintenance equipment

- Each board to be supplied with
. 1 set of test plugs
. Three earthing Truck (1 no. for Bus earthing & 2 nos. for Feeder earthing), if integral earth switch is not provided in the board.
. 1 common transport trolley for interchanging withdrawable units, height of the trolley lifting arm adjustable for raising/lowering the units.
. Any other special purpose tools for maintenance.

5.4.8.25. Auto- Changeover Scheme (applicable for 6.6 kV switch board)

In case of failure of any of the incoming supplies, to be sensed by under voltage relay the incoming breaker of the de-energised section shall be triped after a pre-set time delay. Through the normally closed auxiliary contacts of the tripped incoming breakers, the bus tie breaker shall close provided the other section is healthy.

The automatic transfer scheme shall be such that the automatic closing of the bus section can be done only once and in case that bus tie breaker trips during auto-changeover, no further auto closing shall be permitted. Auto changeover shall not take place if the incomer breaker trips on fault. The restoration of power shall be manual.

The scheme shall include facility for trip selection type manual transfer with momentary paralleling of the incomers and bus-coupler through check synchronising relay and Guard relay.

The automatic transfer circuit shall be controlled by an auto manual change over switch.

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5.4.8.26. Technical particulars and design parameters

6.6 kV Switch Board

1.	Type	:	Indoor, metal clad.
2.	Enclosure	:	IP-4X
3.	Thickness of sheet for Enclosure	:	MS 2 mm for cold rolled 2.5 mm for hot rolled
5.	Nominal system voltage	:	6.6 kV $\pm$ 10%
6.	Highest system voltage	:	7.2 kV
7.	No. of phases and frequency	:	3, 50 Hz + 3% to -5%
8.	Minimum current rating	:	Incomer-3150/2500Amps Outgoing- 1250 Amps
7.	System earthing	:	Resistance - earthed
8.	Circuit breaker rating	:	
a)	Continuous current rating at 45 deg. C	:	As per requirement
b)	Short circuit rating for 3 sec.	:	40 kA
c)	Dynamic system stability	:	100 kA
9.	Busbar rating	:	40kA (3 sec)
10.	Power frequency with-stand voltage	:	20 kV rms for 1 min.
11.	Impulse withstand voltage	:	60 kV
12.	Control voltage	:	220V DC 240V AC
13.	Termination	:	XLPE cables
14.	CT ratio	:	Secondary current 1A
15	PT ratio	:	$\frac{6600}{\sqrt{3}} / \frac{110}{\sqrt{3}} / \frac{110}{3}$
16.	No. of aux. contacts for purchaser's use.	:	4 NO & 4 NC.
17.	Aux CT	:	All motor feeders to have Aux

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			CT for remote metering
18.	Paint	:	Shade RAL-7032 : Powder Coated
19.	Details and type of feeders	:	As per customer requirement minimum 20% spare

5.4.8.27. For DDCMIS **interfacing**

The control, metering and indications of all the 33kV and 6.6 kV breakers / panels shall be carried out from the DDCMIS.

Following digital/analog input/output to/form shall be provided for DDCMIS hook up.

INCOMER	:	MW, MVAR, MVA I, V, ON/OFF/TRIPPED SATATUS & AVAILABILITY OF BREAKER.
LINE PT	:	V. UNDERVOLTAGE
BUS PT (R, Y, B)	:	V. UNDERVOLTAGE, VOLTAGEAVAILABLE

OUTGOING

a) Transformer	:	I, MW, ON/OFF/TRIPPED STATUS & AVAILABILITY OF BREAKER BUCH/OTI/WTI/OIL LEVEL LOW ALARM & TRIP POINTS
b) Motor	:	I, MW, ON/OFF/TRIPPED/ READY TO START STATUS
a) Buscoupler	:	I, MW ON/OFF/TRIPPED SATATUS & AVAILABILITY OF BREAKER.

Adequate numbers of CT- PT outputs and potential free contacts including aux. relays and aux. CTs shall be provided for this purpose.

Total running hours for all the HT motors shall be made available in DDCMIS.

Local/remote section shall be realized in DDCMIS for all the HT motors and big critical LT motors.

Above list is for guidance purpose and shall be finalized during detailed engineering stage. Bidder shall include complete wiring from breaker contacts, contacts of aux. relays, and contacts of trip relays for all the HT/LT motor feeders to provide control & annunciation in DDCMIS as well as to control panels for TGs.

It shall be possible to know tripping of all the 33kV/ 6.6 kV feeders and status of voltage, frequency, current, etc. prior and just after the tripping. Scanning time shall be selected between 0 and 3 seconds. It shall also be possible to take a print out of above parameters and recording of disturbances. It shall be possible to generate report

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for weekly, monthly and yearly generation and shiftwise alarm/trip events with date and time display.
Analog signals for WTI, OTI for hook-up to DDCMIS shall be considered. MOG shall be standard one without analog output signal.

Required transducers and wirings to hook up all above analog and digital inputs and outputs shall be included in the scope of the bidder.

Actual number of inputs/outputs to/from DDCMIS shall be finalised during detailed engineering stage. Transducers shall be of dual out put type.

5.4.9. Isolator

6.6 kV Isolator shall be panel mounted. The panel specification shall be same as indicated in the switch gear portion.

33kV & 6.6kV isolator shall be capable of making into fault specified and withstand the dynamic stress involved. The earthing switch shall be of the same rating as that of the main isolator and shall be interlocked with isolator to prevent simultaneous closing. Isolator shall have 10NO + 10NC contacts.

6.6kV, 630 A isolator shall be provided in all the feeders feeding LT distribution Transformers inside the transformer room.

6.6 kV Isolator

1.	System Voltage	:	6.6 kV, 3 phase
2.	System Earthing	:	Unearthed
3.	Type	:	Air-break, Fault make and load break type
4.	No. of Poles	:	Three
5.	Continuous current capacity	:	630 A
6.	Rated Breaking Capacity	:	40 kA for 3 sec.
7.	Termination		
a)	Incomer	:	Cable
b)	Outgoing	:	Cable

5.4.10. Neutral Grounding Resistor (To be installed with Neutral)

NGR shall be used in 6.6 KV system to limit earth fault current to 600 amp.

NGR shall be used in 33 KV system to limit earth fault current to 400 amp

NGR shall be located in transformer room and connected to secondary side of Power transformer.

Enclosure shall be of outdoor duty and with rain protection. Temperature shall be limited to 375^0C at maximum ambient of 50^0C. Temperature rise of enclosure shall be within safe limit.

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Material of the resistance grid shall be punched steel. NGR shall be designed for 30 second duty for 400 amp.

Single pole isolator shall be provided on incoming side. Porcelain insulators shall be used to support the resistance grid. Isolator shall have locking provision.

NGR panel shall be supplied along with single core Aluminium HT cable (to be provided by purchaser free of cost) and termination kits to connect primary side and to connect earth electrode. Outgoing cable shall not be connected with the panel sheet. Panel shall be earthed separately.

Technical Requirement of NGR

1.	Rated system voltage	:	33 kV
2.	System earthing	:	Non effectively earthed
3.	Resistance value	:	47.63 Ohm
4.	System short circuit level	:	31.5 kA
5.	Rating	:	400 A for 30 sec
6.	Supporting /fixing structures	:	To be provided by the bidder

Technical Requirement of NGR

7.	Rated system voltage	:	6.6 kV
8.	System earthing	:	Non effectively earthed
9.	Resistance value	:	6.35 Ohm
10.	System short circuit level	:	43.7 kA
11.	Rating	:	600 A for 30 sec
12.	Supporting /fixing structures	:	To be provided by the bidder

5.4.11. LT Switchboard

General

LT switchgear board shall be metal clad, indoor type front mounted panels, free standing design, with dust and vermin proof construction. The construction shall be compartmentalized with metal/insulation portion between compartments. The panel shall have only two-tier arrangement.

Circuit breaker shall be mounted electrical operated on fully draw out truck with service, test and isolated positions and complete with all safety interlocks and safety shutters with padlock facility. 3 distinct positions viz. service, test, and isolated with the door closed shall be provided. Enclosure shall conform to IP42.

Rated short time withstand current not less than the specified short circuit level for 1 second. Rated peak withstand current not less than 2.1 times the specified short circuit level. One minute power frequency withstand voltage shall be 3.5 kV for 1100 V power circuits and 500 V for control circuits.

All the feeders (Incoming, bus-coupler and outgoing) shall be consisting of air circuit breakers. Three phase, neutral (with at least 50% rating of main buses) and continuous earth bus shall be provided with PVC sleeve.

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Bus bar and connection shall be of high conductivity Aluminium / Aluminium alloy of suitable hardness and purity complying with as per IS 5082 -1981. All bus connectors shall be silver plated. Control and bus wiring by 1100 V grade PVC insulated, single core stranded copper conductor of minimum cross section 2.5 sq. mm conductor.

Air Circuit Breaker shall be air break triple pole draw out type conforming to IS -13947 (Part-II)-1993. Symmetrical breaking capacity shall be 50 kA for 1 second short time rating shall be as specified. Utilization category shall be B. Service Short circuit breaking capacity (Ics) shall be 100% of rated ultimate short circuit breaking capacity (Icu).

Motor operated mechanism shall be provided with spring charged stored energy mechanism to ensure high speed closing and tripping independent of the operating forces. In addition, anti pumping and trip free feature shall also be provided. Closing operation of the breaker will charge the spring.

Closing by closing coil (operating range 85% to 110% of rated voltage) and tripping by trip coil (operating range 70% to 110% of rated voltage) shall be provided. Provision shall also be provided for manual closing with spring charging motor automatically decoupled as soon as charging handle is inserted.

Current Transformer (CTs)

Protection and measuring current transformer shall be window type primary for 1A (as specified) secondary conforming to IS-2705, Part-II,1992 and Part-III,1992 respectively. Measuring CTs shall conform to accuracy class-I of IS 2705 part-II (1992) and burden of CTs shall be as required by the associated measuring equipment. Protection CTs shall have their accuracy as 5P and burden as required by the protection circuits in which they are used and shall have saturation factor of not less than 10.

Potential Transformers (PTs)

PTs provided on each incomer and on each bus section feeder shall be of draw out type. The PTs shall be dry epoxy resin moulded type. Primary windings of voltage transformer shall be protected by current limiting HRC fuses.

Relays / indicating meters
Built-in direct acting type series over current release instantaneously operating and tripping the circuit breaker against short circuit current through a electronic timer independent of line current and voltage. Built in direct acting type series over current release having long time delayed inverse-time current characteristics shall be provided for protection against overloads.

All necessary equipment like energy meter, ammeters, voltmeters, etc shall be provided as per requirement.

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Control buses of two sections shall be connected through auto changeover scheme and manual changeover switch shall also be provided. LEDs shall be provided for the indication purpose.

Potential free contacts in sufficient number shall be provided to have interfacing with DDCMIS. Power/current/voltage transducers shall be provided wherever required.

Following minimum protection shall be provided;

- Microprocessor based numerical releases for over current, short circuit and earth fault releases.
- Motor Protection Relay
- AUX RELAYS (SUFFICIENT NOS.)
- MASTER TRIP RELAY (90)
- ANTIPUMPING RELAY (94)
- UNDERVOLTAGE RELAY (27) WITH TIMER (2)
- Check synchronising relay

Auto-changeover scheme shall be provided such that in case of failure of any of the incoming supplies. The automatic transfer scheme shall be such that the automatic closing of the bus section can be done only once and in case the bus tie breaker trips during auto-changeover, no further auto closing shall be permitted. Auto changeover shall not take place if the incomer breaker trips on fault. Momentary closing of all the incomers and buscoupler breaker shall also be possible for safe change over of supply .

Technical Particulars for LT Switch Gear

General

1.	Type	:	Indoor type, cubicle construction,
2.	standing	:	free
3.	Enclosure	:	IP42
4.	Mounting arrangement	:	Incomer in single tier and O/G in two tier execution
5.	Rated service voltage	:	415V ±10%
6.	Neutral system	:	Effectively earthed
7.	Short circuit withstand capacity	:	50 kA (rms) for 1 sec
8.	Dynamic stability current withstand capacity	:	105 kA (peak)
9.	Protective Relays	:	Numeric type for motors
10.	Control supply	:	220 V DC
11.	Paint shade	:	631, As per IS:5-1978
12.	Feeder arrangement	:	Incoming & Bus coupler - ACB
13.	Outgoing	:	(i) Feeder to MCCs/DBs - ACB (ii) Feeder to Motors - ACB

Air Circuit Breaker

1.	Type /Service	:	Air break /indoor
2.	Rated service voltage	:	415 V ± 10%
3.	System earthing	:	Effectively grounded
4.	Insulation level impulse withstand	:	6 kV (1.2x50 micro Sec)

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5.	Utilization Category	:	B
6.	Short circuit withstand capacity	:	50kA for 1sec.
7.	Operating mechanism	:	Stored energy type
a)	Closing	:	motor wound spring operated
b)	Opening	:	shunt trip coil Latching
8.	Voltage Closing	:	220V D.C. (85% - 110%)
a)	Tripping	:	220V D.C. (70% - 110%)
b)	Spring charging motor	:	240V AC.
c)	Space heater & lamp	:	240V $\pm$ 10% AC 50 Hz
9.	Antipumping feature	:	To be provided
10.	No. of poles of C.B	:	3
11.	Mounting	:	Drawout type
12.	Termination		
	Incomer	:	Busduct / cable
	Outgoing	:	Armoured Al cable

Current Transformers

1. Service	:	Indoor
2. Rated voltage	:	415 V $\pm$10%
3. Ratio and burden	:	Sec. rating shall be 1A
4. Accuracy class	:	5P10 (protection) & 1 (Metering)
5. Mounting	:	Inside switchgear cubicle

Potential Transformer

1. Service	:	Indoor
2. System	:	415V, 3 phase, 4 wire, 50 Hz. Solidly earthed neutral.
3. Rating voltage ratio	:	$\frac{415}{\sqrt{3}} \Big/ \frac{110}{\sqrt{3}}$ V
5. Rated burden	:	As per requirement
6. Accuracy class	:	1.0
7. Mounting	:	Draw-out Type

5.4.12. LT Busducts

Electrical design

Busduct shall be suitable for 415 V, 3 phase, 50 Hz. neutral solidly grounded system. Rated short time withstand current not less than the system short circuit level specified for 1 sec for 415V. Rated peak withstand current not less than 2.1 times the system short circuit level.

Rated continuous current shall be as per requirement while in enclosure and at specified ambient temperature with maximum temperature of bus bars limited to 85°C. Neutral bus in LT with rating not less than half the rating of phase bus.

The busduct shall be rectangular, interlived, totally enclosed type.

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Construction details

Degree of protection for enclosure IP 52 or better for indoor and IP 55 for semi-outdoor and outdoor installation.

Enclosure material : The minimum thickness shall be 2.5 mm. Bidder shall include enclosure with the thickness required for the shape and mechanical/ electrical strength point of view.

Aluminium enclosure shall be provided for rating equal or more than 4000 A. MS enclosure may be provided for LT busducts of rating less than 4000 A. Provision shall also be provided for draining moisture.

Maximum temperature of enclosure under rated operating conditions limited to 70°C. Rubber bellows shall be provided at transformer end to take care of vibration.

GI supporting structures, wherever required, shall be provided with necessary hardwares. In horizontal run of more than 10 mtr of busducts expansion joint with copper flexibles shall be provided at every 10 mtr interval.

Busbars and connections

Bus bar material shall be EC grade aluminium alloy equivalent to E91E WP conforming to IS 5082-1981.

Final operating temperature of both bus bars and joints under continuous operation in enclosure limited to 85 deg. C by thermometer method. While designing the busduct, site condition and solar radiation shall be taken care of.

Bus bar arrangement shall be as per IS 5578 – 1991. Phase identification shall be by colour at ends and at regular intervals. Busbar joints shall be of bolted type, cadmium plated with zinc bichromated high tensile steel bolts, nuts and spring washers and coated with oxide inhibiting grease prior to jointing. Copper flexible busbars shall be tinned.

Busbar support insulators of non-hygroscopic material having high impact and di-electric strength with an anti-tracking contour. Busduct shall be interleaved type.

Protective earthing

Aluminium earth bus shall be provided running throughout the length of the busduct, positively connected to the body of the busduct. Provision shall be there at each end of busduct for terminating external earth conductor.

General technical particulars

1.	Applicable standard	:	IS – 8623
2.	Rated system voltage & frequency	:	415 V, 50 Hz
3.	System earthing	:	Solidly grounded
4.	System short circuit level (kArms)	:	50 kA

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5.	Maximum voltage at which busduct can operate continuously	:	500 V
6.	Busduct support structure required	:	To be provided
7.	Current ratings		
a.	Rated continuous current	:	As per design requirement / SLD
b.	Rated short time withstand duration	:	1 sec
8.	Insulation level		
a.	Insulation class	:	1.1 kV
b.	1 minute dry power frequency withstand	:	2.5 kV
c.	1 minute wet power frequency withstand	:	2.5 kV
9.	Support insulator		
a.	Type	:	Non-hygroscopic SMC moulded /FRP
b.	Maximum distance between supports	:	To be worked out based on short circuit calculation
10.	Clearance		
a.	Phase to phase	:	25.4 mm
b.	Phase to earth	:	19.0 mm
11.	Enclosure		
a.	Material	:	Al
b.	Degree of protection (Minimum)	:	IP52 – Indoor IP55 – Outdoor
c.	Thickness of material	:	2.5 mm (minimum)
12.	Accessories		
a.	Seal – Off bushings with wall frame (for wall crossings)	:	Required
b.	Silica gel breather	:	Required
c.	Space heaters	:	Required
13.	Maximum temp allowed at max. ambient temp		
a.	Bus conductor	:	85° C
b.	Bus enclosure and support structure	:	70° C

5.4.13. LT Motor Control Centre (LT MCC)

General :

In general, the MCCs will be of multi- tier, compartmental arrangement with modular construction. For process MCCs, intelligent modules will be considered which will be communicate with the PLC/OCS/DDCMIS system on 100 Mbps Profinet/Ethernet based protocol.

Constructional Features

Fully drawout type with modules having service, test and isolated positions. Lock out arrangement must be considered in all draw out module to implement LOTO practice. Floor mounting, free standing with base channel 50 mm high for fixing on the inserts on the floor. MCC shall be single front, totally enclosed, dust and vermin proof.

All the module of the MCCs shall be spacious to facilitate maintenance of equipment

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inside the module.

Pollution degree applicable shall be pollution degree 4 as per IS-13947 (Pt-I), 1993.

Incomer and bus coupler panels

MCC incomers and bus couplers shall have Air circuit breakers. Incomers and bus couplers shall be rated for at least 125% of maximum demand taking into account the spare feeders and shall be suitable for the specified fault level. Minimum rating of Incomer and buscoupler shall be 630 A ACB.

Incomers and bus coupler shall be electrically interlocked to prevent parallel operation. However, a definite delay defeat Interlock switch shall be provided to facilitate parallel operation. Changeover facility shall also be provided between the two incomers.

Feeder Modules

Feeders shall be fully drawout type. MCC shall consist of MPCB/MCCB, contactor, overload relay as main power components to ensure type 2 protection. The short circuit release of MCCBs shall be selected such as to avoid tripping during starting of drives. MPCB with electronic O/L relay to be considered for motors upto 18kW.

At least 20% spare feeders (minimum one spare feeder of each type and rating bus section-wise) shall be provided. Ammeters with selector switches shall be provided for all continuous / intermittent running motors beyond 15 kW rated drives.

Busbars and terminations

Busbars and connection shall be of high conductivity aluminium /aluminium alloy of suitable hardness and purity complying with as per IS-5082-1981. Busbars shall be insulated by colour coded heat shrinkable sleeves.

Busbars shall be rated for the nominal current rating of incoming breaker and for the full short-circuit rating. Earth bus shall run throughout the length of MCC at bottom.

Control bus shall be provided in the bus bar chamber isolated with main bus in all the MCCs. Similarly power and control terminations shall be in separate chambers in the MCCs. Cable allay shall have sufficient space for maintenance and minimum width of cable allay shall be 300 mm. Shrouding/isolation shall be provided for outgoing power terminations in the cable allays. Modules of MCCs shall be spacious for easy maintenance of the various equipments inside.

Short circuit strength

Rated short time withstand current shall not be less than 50 kA for 1 second. Rated peak withstand current not less than 2.1 times the specified short circuit level.

Air circuit breaker (ACB)

Air break, draw-out type conforming to IS 13947 (1993) and symmetrical breaking capacity not less than 50 kA for 1 second shall be provided. Service short circuit

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breaking capacity (Ics) shall be 100% of rated ultimate short circuit breaking capacity (Icu).

Motor operated mechanism shall be applicable with air circuit breakers. Spring charged stored energy mechanism shall be there to ensure high speed closing and tripping independent of the operating forces. Electrical anti pumping and trip free feature shall also be provided. Spring charging universal motor suitable for rated control voltage (230 AC). The closing coil and trip coil shall be suitable to DC operation.

Closing and tripping of ACB shall be by closing coil (operating range 85% to 110% of rated voltage) and tripping by trip coil (operating range 70% to 110% of rated voltage) respectively.
All ACB based Incoming and O/G power & motor feeders shall have microprocessor based numerical protection relays.
Built-in direct acting type microprocessor based numerical releases for short circuit, over current and earth fault shall be provided.

Auto changeover shall be done through undervoltage relays and check synchronization relay with time delay. All the relays shall be microprocessor based numerical relays.

Motor protection moulded case circuit breaker (MPCB)

The characteristic shall match the motor duty application. Rated ultimate short circuit breaking capacity (Icu) shall be 50 kA. Ratings selected shall be at least 125% of the full load current of the motor. For small rating drives such as valves, Siemens 3UV13 type (or equivalent) or motor protection circuit breaker (MPCB) shall be used. Utilisation category shall be A.

Magnetic contactors

Pick up shall be positively at voltage between 85% to 110% of rated value. For frequently reversing drives, AC 3 rating selected shall be 50% higher than full load current of the motor at the specified duty cycle shall be provided. For reversible drives, mechanically as well as electrically interlocked contactors shall be used.

Electronic Overcurrent (EOCR) Relays

Protection features shall ensure Overcurrent/load, Phase unbalance, phase loss, ground fault, Overheating trip by Thermistor etc. It shall have Wide & adjustable over current setting. Tripping causes stored in memory shall be available. Microprocessor based with Current detection immune to harmonics and external interference like temperature,ageing etc. It should be possible to either have selection of trip classes (5/10/15/20) or to have starting trip delay. It shall have LCD display with Seven segment displays for parameter settings, diagnosis etc.

Push Buttons / Indicating Lamps / Indicating instruments

Push buttons shall be spring return, push to actuate type and their contacts shall be suitable to carry and break 240 V AC, 10 A and 220 V DC, 1 A. Indicating lamps shall

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be LED LVGP (Low Voltage Glow Protection) type. Standard colours shall be applicable for push buttons and for indicating lamps. Indicating instruments shall be flush mounting, square dial with 90^0 scale with zero adjusting device for external operation. Accuracy class shall be 1.0 or better. KWh meter shall also be provided with incomers.

MCC shall have run/start, stop, tripped, and ready to start push button cum indication lamp for motor feeders.

Current transformers

The thermal and dynamic stability current for CTs and CT ratio shall be as per requirement. Protection and measuring current transformer shall be bar primary/ window type with 1A secondary. Burden of CTs shall be as required by the associated measuring equipment.

Control transformer

Control transformers shall be dry type 415V/240V, primary taps at $\pm$2.5 %, $\pm$5 % and shall be mounted in drawout trolley if outgoing feeders are in drawout execution. Control supply shall have supervision facility, alarm shall be provided for non availability of any one of the control supply. Automatic/manual changeover facility shall also be provided. Auto-changeover shall be blocked if power supply to respective section is not available.

For capacity consideration of control transformers, each shall be capable to meet 100 % load including spare feeders and 10 % cushion for future and 15 VA for each module for remote aux. relays and indication lamps.

DC Control supply

DC supply is required for electrically controlled ACBs. For two sections, two DC buses shall be there. In bus coupler panel, manual switch shall be there for changeover of one supply to other section. Non availability of DC supply shall be annunciated in MCC or nearby control room.

Internal Control Wiring and external Terminations

Control wiring shall be by 1100V grade PVC insulated, single core stranded copper conductor of minimum cross section 4 mm^2 for CTs and space heater circuits and 2.5 mm^2 for other circuits.

For external terminations, 1100V grade multi-way terminal blocks of non-tracking moulded plastic shall be used complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips. Power and control terminals segregated.

Other accessories
Following items shall be provided for the MCCs under the scope of the bidder:

Breaker lifting/handling trolley (for ACBs) : 1 No. per MCC

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Breaker racking handle (for ACBs) : 4 Nos. per MCC
Panel key (if applicable) : 5 Nos. per MCC

Selection of power components & wiring for continuous duty cage motor drives is given below:

Motor Rating at S1 Duty (KW)	Minimum rating of MPCB/ MCCB*	Minimum rating of contactor (AMPS) AC3 duty	Minimum size for internal power connections		Minimum size of power cable Aluminium (sq.mm)
			Copper wire (sq.mm)	Aluminium flat (mm x mm)**	
Up to 3.7	10-16(MPCB)	25	4	---	4x 4(copper)
5.5	10-16(MPCB)	40	4	---	4x 4(copper)
7.5	16-25(MPCB)	40	6	---	4 x 6
11	24-32(MPCB)	40	6	---	4 x 16
15	34-40(MPCB)	63	10	---	4 x 16
18.5	100(MCCB)	63	16	12 x 2	3.5 x 35
22	100(MCCB)	63	16	12 x 2	3.5 x 35
30	100(MCCB)	100	25	12 x 2	3.5 x 70
37	100(MCCB)	100	35	15 x 3	3.5 x 70
45	200(MCCB)	160	50	15 x 3	3.5 x 95
55	200(MCCB)	160	70	20 x 3	3.5 x 120
75	200(MCCB)	200	95	20 x 5	3.5 x 185
90	400(MCCB)	400		20 x 5	3.5 x 185
110	400(MCCB)	400		30 x 5	2(3.5 x 120)
125	400(MCCB)	400		40 x 5	2(3.5 x 120)
135	400(MCCB)	400		40 x 5	2(3.5 x 120)
160	400(MCCB)	400		40 x 5	2(3.5 x 185)

* Minimum rating of MPCB/MCCB shall be selected to achieve type `2' protection.

** Copper flat of equivalent size can be used instead of aluminium flat.
NOTES : Overload relay shall be selected based on actual full load current and starting time.

General Technical Particulars of MCC

General

1. System : 415V, 3 phase, 4 wire, 50 Hz. Solidly earthed neutral
2. Type : Indoor type, cubicle construction, free standing
3. Pollution degree : 4
4. Creepage distance : As per IS-13947 (1993), Part-I
5. Enclosure : IP54
6. Mounting arrangement : I/C & B/C in single tier and O/G in multi-tier execution
7. Neutral earthing : Effectively earthed
8. Control supply : 240V AC / 220 DC for ACB
9. Short time rating : 50 kA for 1 sec
10. Autochangeover required? : Yes
11. Delay drop off required? : Yes
12. Control supply : 240V AC for spring charge motor and 240 V AC for MCCB, etc.

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Air Circuit Breaker

1.	Service	:	Indoor
2.	Type	:	Air – break
3.	Insulation level Impulse withstand	:	6 kV (1.2x50 micro Sec)
4.	Utilization Category	:	B
5.	Operating mechanism	:	Stored energy type
I.	Closing	:	Motor wound spring operated
II.	Opening	:	Shunt trip coil
III.	Latching arrangement	:	Mechanically and electrically trip free
6.	Auxiliary Voltage		
I.	Closing	:	DC
II.	Tripping	:	DC
III.	Spring charging motor	:	240V ± 10% AC
IV.	Space heater & lamp	:	240V ± 10% AC 50 Hz
7.	No. of poles of C.B	:	3

Current Transformers

1.	Type	:	Resin cast, window type
2.	Rated voltage	:	415 V ±10%
3.	C.T. secondary rating	:	1 Amp
4.	Accuracy		
i.	Protection	:	5P10 or better for protection
ii.	Metering	:	Class – 1

Control Transformer

1.	Type	:	Dry cast resin, class B or better
2.	Voltage ratio	:	415V/240V
3.	Rated burden	:	As per requirement
4.	Quantity	:	2 nos. per board and minimum capacity shall be 3 Kva

Moulded Case Circuit Breaker

1.	Type	:	Air break (Motor duty)
2.	Rated service voltage	:	415 V ± 10%
3.	Utilization Category	:	A
4.	Protection	:	Type `2 to the contactor

Contactors

1.	No. poles	:	3
2.	Rated service voltage	:	415 V ± 10%
3.	Control circuit	:	240V ±10% 1ph, 50Hz ±5%
4.	Utilisation category	:	AC23A for uni-directional motors, AC24A for bi-directional motors
5.	Limits of operation		
i.	Closing (pick-up)	:	85% to 110%

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ii. Dropout : Shall not be higher than 75%

Relays/ Release

1. Relay type : Numeric
2. Release type : Numeric

Thermal Overload Relays

1. Type : Ambient temperature compensated bimetal operated hand reset type (direct or C.T. operated)
2. Hand resetting feature : To be provided at the front of the panel
3. Single phasing protection : Built in

5.4.14. DC System (Battery, Battery Charger and DC Distribution Board)

Scope and Mode of Operation

Each of the DC system shall be consisting of the following;

- DC battery set (1 set For DC motor and emergency lighting and other set for control system)
- One set of Float Charger (FC) and One set of Float Cum Boost Charger (FCBC) for each battery set.
- DC distribution switchgear (1 set with 2 sections) for each set.
- All interconnecting cables/wiring with connection accessories and other required items to make the system complete.

Battery charger system shall be parallel redundant (load sharing type). Normally the chargers connected to the battery shall supply the DC load and also keep the battery under float charge. On failure of supply from charger, the battery shall be taken over without any interruption.

When the battery requires boost charging, the charger will operate on boost charge mode while the second battery will supply the DC load on float mode through automatic changeover arrangement. Provision of manual changeover shall also be provided.

Interfacing of DC system with DDCMIS of the respective unit shall be done by the bidder.

The DC distribution switchgear shall feed the power from the charger/battery to the various consumers of the plant.

Battery and accessories

Nominal voltage is 220 V DC. The no. of cells shall be chosen accordingly. Battery cell shall be Plant Type. Ampere hour capacity (minimum) shall be as per requirements of the plant plus 30 % cushion for purchaser's use subject to minimum The discharge test of all the batteries at the rate of 10 hours to the end cell voltage 1.85V per cell as per IS shall be carried out by the bidder at site.

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Following accessories shall be supplied

- Battery stand
- Acid for first filling
- Cell testing voltmeter 3 - 0 - 3 volts complete with leads
- Cell booster for charging 1 to 5 cells
- Level indicator
- Copper cell connectors (5 nos.)
- Bridging clamps for cutting out individual cells in the event of defect
- First aid box
- Torque wrench

Battery Chargers

Parallel redundant, float cum boost chargers with HMI having communication to DDCMIS for each battery shall be comprising of the following;

- MCCB, line contactor and overload relay on the AC side
- 3 phase full wave semi-controlled rectifier bridge complete with free wheeling diode, high speed protection fuses and snubbers
- Dry type double wound rectifier transformer with copper conductor and class `B' insulation
- Filter circuit at the output
- MCCB on DC side
- Control and protection circuits

In float mode, the charger operates with a constant voltage controller and the output voltage of the charger shall be maintained within $\pm$ 1% of the set voltage for $\pm$ 10% input AC voltage variation, or 0 - 100% load variation, or both occurring simultaneously. The output voltage required can be set externally through potentiometers in the range 90-120% steplessly.

In boost mode, the charger shall be suitable to operate in a constant current as well as constant voltage mode with manual selector arrangement, controller suitable for two-rate charging. The charging current shall be externally adjustable from 20 to 100% steplessly.

Provision of charging with manual control of output voltage shall also be provided. Electronic current limit, adjustable between 85-105% of rated current shall be provided. During boost charging, the charger shall be cut-off as soon as over voltage occurs. Ripple content in the charger's output voltage shall not exceed 0.5% in float mode and 3% in boost mode.

Provision shall be provided to isolate the battery from the chargers. MCB may be provided for this purpose.

The supply to the charger will be at 415V $\pm$ 10%, 50 Hz. Charger shall be suitable for frequency variation as per IS.

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Charger shall have a separate over voltage relay with a variable setting from 100 % to 120 % in steps of 5 % of V_n.

DC Distribution board

The DC distribution board shall have double bus bar arrangement with auto changeover. The DCDB shall be provided with all the instruments, AC/DC meters, indicating lamps, relays and other accessories.

The following relays shall be provided :

- AC input supply to charger failure
- Earth fault
- Float bus over and under voltage
- Boost bus over voltage
- Boost over current for each charger circuit
- All relays shall be in drawout cases and with mechanical hand reset operation indicator.

Above relays shall be provided to detect fault in any of the feeders. A separate over volage relay shall also be provided in DCDB. Over voltage setting of the O/V relays shall be variable type with range of 235 – 250 V.

The following indications shall be provided.

- AC supply ON (for 3 phases separately) for each charger
- DC supply ON for charger
- Boost/float mode ON for charger
- Supply ON for each outgoing distribution feeder

Each outgoing circuit shall be connected to bus bars. Each outgoing circuit shall have MCCB. The no. of outgoing circuits shall be as per the requirement plus 10 nos. for purchaser's use and 20 % spare.

The following measurement shall be provided:

- AC input voltage and current of each charger (through voltmeter/ammeter S/S)
- DC output voltage and current of each charger
- Battery charging/drain current of each charger with necessary shunt
- Battery trickle charging current (through amplifier)
- DC bus voltage (through selector switch) to measure between Positive to Earth, Negative to Earth & positive to negative.

DC voltage and DC current transducers (4-20 mA) shall also be provided as per requirement of the DC system.

Static type annunciation shall be provided for the following;

- AC supply failure to charger
- Battery earth fault (+ve & -ve separately)
- Float bus over/under voltage

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- Boost bus over voltage
- Boost over current for each charger
- Failure of thyristor/diodes for each charger
- Failure of blocking diode
- Output MCCB open for each charger
- Battery MCCB open
- Battery room exhaust fan OFF
- D.C.Voltage Low
- D.C.Voltage High
- A.C.Input Under Voltage

One repeat alarm point for all above annunciations shall be provided to facilitate annunciation of "Fault in Charger" in control room.

Switch board shall be floor mounting type sheet steel enclosed with degree of protection IP 52 or better. Board shall be compartmentalized design.

All power wiring shall be done through single core PVC insulated copper wires/buses. All control wiring shall be done through single core, PVC insulated copper wire of 2.5 sq. mm. All connections external to the panel/switch board shall be terminated in suitable terminal blocks. Inter panel wiring shall be only between terminal blocks.

Technical Particulars

1.	No. of DC systems	:	As specified
2.	Voltage	:	220 V DC
3.	Type	:	Plante Type lead acid battery banks
4.	Rating	:	As per requirement of the bidder +30 % cushion. To be estimated by bidder with 10 nos. spare feeders in each board for purchaser's use.

5.4.15. Uninterrupted Power Supply System (UPS)

General System Description

The 230V single phase dual redundant UPS system shall provide continuously operating uninterrupted power supply to critical AC loads such as control system, data acquisition system, annunciators and other critical services. The UPS system shall have by-pass system with static stabilizer (CVCF) type with manual bypass by 415/230V Isolation transformer. UPS shall be rated for 60 min. Battery back up.

Each UPS shall include the following equipment but not necessarily limited to:

a) One (1) set of 100% rated battery banks.
b) Three (3) nos. 100% capacity battery chargers complete with associated incoming AC switchgear.
c) Three (3) nos. 100% capacity inverter banks.

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d) One (1) no. 3 phase to 1 phase transformer and associated AC switchgear, 110V, 1 phase voltage stabilizer and backup source static switch.
e) Isolation Transformer
f) One (1) no. four way manual bypass switch
g) Static switches

Mode of Operation

Normal Mode

During the normal operation the UPS shall be used to provide power to the critical loads. The primary AC source shall be used to supply power to the rectifier charger. Three (3) nos. chargers shall feed regulated DC power to their individual inverter banks and simultaneously float charge the back up battery.

The individual inverters will operate in parallel and will share the load. The inverters are connected through static switches upto the paralleling circuit and a common bank static switch will connect up the paralleled output to the load.

Emergency Mode – Parallel Redundant with by pass

Upon failure of primary AC source supplying three phase power to the battery chargers, the input power to the inverters shall be supplied from the back up battery. When the AC power is restored, input power for the inverter and power for recharging the battery shall automatically be supplied from the rectifier charger. The batteries shall supply the inverter whenever the chargers are unable to supply the sudden load demand or their response to the load change is slow.

In case of internal failure of one inverter, the same will be isolated from the load instantaneously by de-energising the corresponding inverter static switch. Simultaneously the second inverter will take on the full load without any disturbance in the load voltage. During this period of operation, if the second inverter also fails, automatic changeover to the Bypass system(CVCF), it shall be possible to bypass the same through manual bypass switch effectively transferring the load to the automatic voltage stabilizer in the backup supply path. These shall also be connected from the backup transformer output just before the stabilizer leading to the manual bypass switch, so that continuity of supply can be maintained in case stabilizer also fails.

The output of the UPS shall feed all the essential loads through the ACDB. The connection from the UPS to ACDB shall be through a switch and fast acting semiconductor fuses, trip fuses and micro switch with alarm contacts. The feeders shall be designed by the bidder to suit the load requirements.

Battery Charger

Three (3) nos. each of 100% capacity, battery chargers shall be provided for each UPS system. These chargers shall be of static type and shall be provided with suitable transformer and full wave, SCR type rectifiers. Chargers shall share automatically the load during parallel operation of the inverter system and shall maintain output voltage within plus or minus one percent of the nominal value from no load to full load.

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Suitable ripple filtering circuits shall be provided to give a smooth DC output. The ripple content shall be limited to less than +1% on resistive load.

The rectifier charger shall have float, equalizing and boost charging facility as well as furnish the inverter input current. During float charging, the chargers shall furnish the continuous DC load as well as float charge its associated batteries and shall maintain a DC voltage that will pass the minimum current through the cells to keep them charged without overcharging. In order to change their current output, the chargers shall sense a DC voltage drop or rise at their output. During boost charging the DC load shall be fed by the float charger and an appropriate percentage of the battery cells shall float across the load terminal to take care of emergency DC load demand. Necessary blocking diode shall be provided so that boost charging voltage does not appear at the load terminals.

In the `Boost' mode, the `boost' chargers shall recharge the completely discharged battery to full capacity in eight (8) hours.

The chargers shall be current limiting and shall be provided with surge suppression networks for both float and boost charging. All equipment and devices required to protect the chargers from short circuits e.g. fast acting semiconductor fuses, trip fuses and micro switch with alarm contacts etc. shall be provided.

The charger section shall be complete with the AC input switchgear and DC switchgear wherein the outputs from the batteries and the battery chargers shall be interconnected forming the common DC bus. The DC bus shall be designed to withstand and short circuit discharge current of the battery.

Static Inverters

The three (3) nos. 100% capacity, required kVA inverters shall be of IGBT based PWM technology with Digital control employing micro controllers and embedded software, integrated control modules including necessary oscillators, voltage regulators, current limiting and surge suppression networks. In addition the inverters shall have features of soft start, wave shaping, transient recovery etc. Any other equipment required for normal operation of the inverter shall be included irrespective of whether specified or not.

The inverter input voltage shall match with the battery and rectifier charger output voltages and shall be designed to operate over the entire range of variation of input DC voltage to accommodate decrease in battery voltage during discharge and to accept voltage increase under battery boost charge or equalizing charge conditions.

The inverters shall always work on their internal oscillators or frequency variations with either of the two inverters as master synchronizer and the other following it. Suitable selection facility shall be provided for selecting either of the two inverters as master/follower. In addition an independent mode of operation shall be provided for each inverter when the other is under fault/trouble/maintenance. The plant AC electrical system will provide a signal to each inverter to control the frequency and phase relationship of its output during normal operations. When this signal to an inverter deviates more than one hertz from the desired 50 Hz frequency, the inverter

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shall transfer automatically to its internal oscillator which will maintain inverter frequency at 50 Hz within 0.5%.

During operation on its internal frequency signal source, an inverter shall continuously monitor the frequency of the plant auxiliary AC electrical system. Upon restoration of the plant auxiliary AC electrical system to 50 Hz operation, each inverter shall automatically adjust the phase relationship between its output and the plant auxiliary Ac electrical system and return to the plant auxiliary Ac electrical system as its output frequency and phase relationship signal source. During operation on its internal oscillator an inverter shall inhibit transfer of the static transfer switch to the alternate source. The automatic adjustment of the phase relationship between the inverter output and plant auxiliary AC system shall be accomplished at a controlled rate which shall not exceed one hertz per second.

The two inverters shall be designed for normal continuous parallel operation. The inverter shall be designed for natural cooling for the maximum ambient temperature involved.

The DC input current shall never exceed twice the full load current except for a short circuit within the inverter.

The inverters shall include a separate voltage distribution and voltage monitoring system for all command and interlock logic. Selective protection shall be provided for each individual drive card and its associated interlock logic.

All the fuses used in inverter power and control circuits shall be fast acting type, operating in less than5 ms. Indications and alarms shall be provided to enable fault to be located and rectified at the earliest. Lamps to indicate fault/trouble/failure of each subgroup shall be provided on the cubicle front and lamps for each logic card shall be provided on the card itself. Each logic card shall be provided with all monitoring and testing terminals, brought out on the front of the card, for quick monitoring/testing/trouble shooting. Test points shall be brought out on the front of the cubicle for the following measurements but not necessarily limited to these :

a) Output voltage of each charger

b) Input voltage to each inverter

c) Prefilter output voltage of each inverter

d) Postfilter output voltage of each inverter

e) Output voltage of standby transformer.

Static Transfer Switches

The static transfer switches shall use SCRs and other static devices, for automatic transfer of load from the Normal source to the Alternate source. The continuous capacity of each static switch shall be equal to the full load capacity of one inverter. maximum transfer time including sensing shall not be more than 1/4 cycle. The transition shall be "make before break" in both directions.

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The voltage failure shall be sensed at the output of the static switch. Failure shall cause the static switch to transfer. The load from the working inverter shall be transferred to the alternate source, i.e. second inverter or auxiliary power supply source by static switches, when ever the output voltage of the inverter deviates more than ±10% from nominal. However, transfer shall not be made to the alternate source on over current conditions. Transfer shall be permitted only if voltage of the alternate source is within ±2% of nominal. contacts shall be provided to alarm deviation of the alternate source voltage beyond these limits.

Before transfer takes place, from any inverter to alternate source, whether initiated manually or automatically, synchronism of the output of the inverter with the alternate source shall have been automatically accomplished.

Return to normal shall be automatic for all externally caused transfer such as overload or clearing of a branch circuit fuse, but shall be manual for all internally caused transfers such as inverters, filter or normal path failure. Automatic transfer shall occur after approximately 2 seconds time delay during which normal source voltage must remain at 110V ±2%. Time delay shall be field adjustable over the range of 1 to 10 seconds. Manual retransfer shall be initiated through push button.

The static switch shall be provided with fuses in both `normal' and `alternate' power source. Provision for annunciation of failure of fuse or failure of alternate source shall be made. The switch shall be provided with surge suppression networks and shall also be rated to withstand transient voltages upto 150% of rated voltage. The short time rating of the switch shall be 150% of the rated full load current for two (2) minutes.

Three phase/single phase Transformer and voltage stabilizer

The transformer shall be dry type, double wound enclosed in a sheet steel panel 2 mm thick, if cold rolled or 2.5 mm thick if hot rolled. The cooling shall be by means of natural convection.

The transformer connection shall preferably be of Le blanc type with delta connected winding on the three phase side or of open delta connection type. Other alternatives shall also be considered, provided the connection has minimum unbalance on the primary side. The transformer shall be encapsulated in Class B insulation. The transformer shall be adequately rated for the duty involved. The actual value may be slightly increased to take care of any losses in the static voltage stabilizer.

The voltage stabilizer shall employ silicon solid state circuitry and shall maintain the specified output voltage for 0 to 100% load, with maximum input voltage variation as specified in technical particulars. The make and rating shall be subject to purchaser's approval.

Manual Bypass Switch

The manual bypass switch shall be a four (4) position switch. It shall be used to isolate a static switch from its load and alternate power supply and to take it out of service without power interruption to the load. It shall be make before break type contacts, so

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that power supply to the loads is continuous during switch operations. It shall be capable of carrying rated continuous full load inverter current.

Basic particulars for design

- Features and performance in line with IEEE446.
- 110% of the rated output for continious.
- Suitable for connecting to a 415 V, 3 phase, 50 Hz, 4 wire, grounded neutral system with a symmetrical fault level of 40 kA rms.
- Three phase voltage and frequency controlled output
-
- With isolating transformer, rectifier, inverter unit and necessary DC batteries.
- DC battery shall be Lead acid with plante cells type.
- Battery shall be suitable to maintain the power supply for at least 60 minutes in the event of mains failure.
- The changeover time shall be less than 0.25 cycles.
- Necessary distribution board for distribution of power from UPS output to individual consumers.

Permissible Variations:

- Mains power supply system
- Voltage : + 10 % , -15 %
- Frequency : +3% , -5%
- Harmonic distortion : < 5%
- Output of the uninterruptable power supply system while delivering a load of its rated capacity
- Voltage regulation : 1% (For 0-100% load)
- Frequency : (+/-) 0.5% (-do-)
- Efficiency : Above 80%
- 100% to 0% and 0% to 100% load : Volt dip +/- 10%

Protective Features:

- Earth fault monitoring and protection

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- Thermal overload protection
- Semiconductor high speed fuses for outgoing feeders.

Transformer

- Rating suitable for the application
- Dry type , with class H insulation
- ± 2.5% with tappings on primary

Rectifier Protective Features:

- Maximum current limiting
- Automatic reduction of current limit in the event of cooling fan failure
- Boost charging and float charging current limiting

Indications:

- Rectifier On
- Battery runout timer/counter
- Low battery voltage or blown battery fuse
- High battery voltage
- Charging failure
- Failure in line voltage or auxiliary supply
- Blown fuse, single phasing or over current
- Fan failure
- Battery on float charge /boost charge.

Inverter Protective Features:

- Abnormal output voltage
- Abnormal link voltage
- Over current on output
- Over current on input or commutating failure

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- Low battery voltage
- High transformer temperature
- Auxiliary supply failure
- Fan failure
- Logic failure
- Clock failure

Indications:

- Inverter On

Meters:

- Output voltage: Phase-neutral & between phases
- Output frequency
- Ammeter in each phase
- Battery current and voltage with indication of status.
- A repeat alarm point for all abnormalities shall be provided to facilitate annunciation of `Fault in UPS' in control room.

Static by-pass switch Protective Feature:

- High speed fuses shall be provided for protecting the thyristor against accidental overload.

Indication:

- Load on inverter
- Load on by-pass
- Reserve within limits

Alarms:

- Reserve out of limits
- Static switch off

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Panel Constructional Details

- Unitised construction
- Free standing, floor mounted and indoor type
- Dust and vermin proof
- Sheet steel clad

  : Min 2.5 mm thick for panels

  : Min 2.0 mm thick for doors and side covers
- With illumination lamps, door switches, space heaters and sockets for soldering
- All control block plug-in type with test sockets
- Units shall be self contained and serviceable
- Shall be split into a power unit and a control unit. The power unit shall contain reactors, where necessary, protective gear and switchgear, thyristor converters and gate control units. The control unit shall house all control, regulation measurement and error indication devices in single cubicle which shall be connected with the power unit by means of plug-in data links.
- The arrangement and layout shall facilitate easy and convenient supervision of the unit while running as well as quick detection of disturbances and trouble shooting.

Enclosure and ventilation

- Enclosure conforming to IP-41 class
- Units shall be provided with cooling fans and louvers at the bottom sides.
- Individual ventilation ducts for each unit shall be provided.
- UPS shall be suitable to meet the requirement based on approved calculation and in addition to above 5 kVA capacity shall be kept for purchaser's use alongwith 4 feeders in the panel in each Unit.

Technical Particulars

1. Application : Uninterruptible Power supply for DAS and other essential loads.
2. Ambient conditions : Min. temp:15.6 deg.C
   Max. temp:50 deg.C
3. Degree of protection

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as per IS 2147 : IP 41

4. Cable entry : Bottom

5. Input Supply Voltage : 415 ± 10% 3phase 4 wire 50 Hz ± 5%

6. Input MCCB shall be of 40 kA for 1 sec.

7. All the input and output isolation through isolation transformer shall be provided in the UPS.

8. Max ripple current in output of battery charger/Inverter is less than 1%.

10. Space heater, door switch with panel illumination system shall be provided as per spec.

11. 100% fan redundancy shall be provided.

12. UPS input supply connection shall be Insensitive for its phase sequence.

13. Reverse Battery polarity protection shall be provided.

14. Online automatic battery open circuit test in regular interval through software programming shall be provided.

15. Redundant static switch on each ups module shall be provided.

16. Each UPS shall be provided with Alpha Numeric L.C.D display with fault logging facilities.

17. UPS shall be true parallel redundant type with out any common component so as to avoid any single point failure.

18. Criss cross facilities shall be achieved.

19. Asynchronous transfer facilities shall be provided.

20. MOD BUS interface connectivity shall be provided to hook up to plant DDCMIS system.

21. Branch MCCB clearing capacity shall be provided with 30 % of UPS rating.

22. Frequency Synchronous window with Bypass shall be with 50 HZ ±6%.

Batteries

1. Type : Stationery heavy duty lead acid storage type with plante positive plates.

2. Application : UPS System

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3. Number of battery banks required	:	1 Set
4. Number of cells in each bank in series	:	As per requirement
5. Ambient temperature	:	Min.temp. :15.6 deg.c Max.temp. :50 deg. c
6. D.C.nominal system voltage	:	220 V
7. Ampere hour capacity of battery at 27 deg.c, 10hr rate to give final cell voltage of 1.85 volts/cell	:	Bidder to furnish along with calculations
8. Cell Voltage	:	a) Nominal : 2.00 b) End discharge : 1.85
9. Mounting arrangement	:	Open type / multi tier
10. Charging method proposed	:	Float and boost
11. Emergency load duration	:	60 minutes

Battery Chargers

1. Number required	:	2 nos. per UPS
2. Type	:	IGBT based PWM Technology with Digital control.
3. Method of charging	:	Float and boost charge type
4. DC system voltage	:	220 V
5. Automatic voltage regulator required(AVR)	:	Yes
6. Regulation with AVR	:	±1%
7. Permissible harmonics at rated continuous load	:	±1%
8. Minium permissible power factor at rated continuous load	:	0.9
9. Cable entry from	:	Bottom

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10. Maximum time for boost charging	:	8 Hours

Inverters

1. Type	:	IGBT based PWM technology with digital control employing micro controllers and embedded software.
2. Number required	:	Three per unit
3. Suitable for parallel operation/not operation	:	suitable for parallel
4. Service	:	Indoor
5. Output rating of each	:	As required
6. Output Voltage	:	230V A.C.
7. Voltage regulation	:	Combined Voltage regulation±2% from 0 to 100% load at 0.8power-factor with in 50 milliseconds.
8. Phase	:	Single phase
9. Frequency	:	50 Hz
10. Frequency regulation	:	±5% for 0 to 100% load variation (continuous or step load change) and full range of input variation.
11. a) Transient voltage regulation on application or removal of 100% load	:	± 8%
b) Time to recover from transient to normal voltage	:	50 milli seconds.
12. Duty	:	Continuous.
13. Overload capacity	:	110% continious 125% for 15 minute at 0.8 p.f 150% for one minute, 200% for 1 sec.
14. Short time rating	:	1 second for short circuit at inverter output terminals.
15. Short circuit current	:	Shall be capable of withstanding short circuit withstandability current for the

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largest fuse to clear the fault in less than 1/45 cycle

16. Efficiency : Not less than 80% at rated load.
17. Cooling : Natural air cooled

18. Synchronization with alternate source required : Yes

Static Transfer Switch

1. Capacity Continuous : Make and carry full load current of inverter at 0.8 p.f

2. Type : Make before break

3. Voltage : 110V, single phase

4. Short time rating : Short circuit rating of the inverter for 1 second and 150% of full load current for 2 min.

5. Frequency : 50 Hz

6. Retransfer : Automatic retransfer shall occur after approximately 2 sec. time delay during which normal source voltage must remain at 110V +/-2%

7. Indication, protection/ Annunciation : i) Indicating lamp for static switch in normal position.

ii) Indicating lamp for static switch connected to alternate source

iii) Protection of all semiconductor devices against short circuit and transients.

iv) Annuciations for the following conditions

a) Static switch connected to alternate source.

b) Alternate source voltage deviation greater than ±2% from nominal.

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Manual Bypass Switch

1. Capacity Continuous	:	Make and carry full load current of inverters at 0.8 p.f.
2. Type	:	Make before break.
3. No. of positions	:	4
4. Short time rating	:	Short time rating of the inverter for 1 second and 150% of full load current for 2 minutes.
5. Transfer	:	Manual.

5.4.16. Electric Motors / Actuators

Motors

General

All motors shall generally conform to IS 325 and CBIP publication No. 140. Motors shall run continuously at rated output with ± 5 % variation in frequency and ± 10 % variation in voltage and ± 10 % combined variation of frequency and voltage (absolute sum). Motor shall not stall due to momentary drop in voltage up to 70 % of rated value and shall run satisfactorily for five minutes at a supply voltage of 75 % of rated value.

The limiting value of voltage at rated frequency under which motor will successfully start and accelerate to rated speed with load shall be assumed to be a constant value of 80 % rated voltage throughout the starting period.

All the motors above 75kW shall be provided with soft starters with DOL bypass.

All motors shall be supplied with foundation bolts (if applicable), drain holes with plugs. Motors shall be designed for 50°C ambient temperature.

Motors supplied shall be complete with required double compression cable glands, crimp type cable lugs and first filling of lubrication, name plate, etc. Lifting facility to be provided for all HT motors and big size LT motors. Guards shall be provided to prevent accidental touch for couplings and for free shaft ends shall be provided.

For HT motors and LT motors above 7.5kW, motor handling facility to be provided where EOT crane facility is not available as a permanent installation for maintenance.

For LT motors above 7.5kW, lifting facility for driven equipment shall also take care of the associated motors

Degree of protection for motor and bearings shall be IP-55 for indoor and IP55 with rain canopy and weather proof construction for outdoor. Motor shall be suitable to

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withstand at least three successive starts from system cold condition and two starts from hot condition at normal system voltage and frequency.

The drive motor shall have at least 15 % margin over the maximum power requirement of the driven equipment after considering all losses, derating due to temperature and specific site and operating conditions.

Irrespective of the kW rating of the ID Fan, the FD Fan motors shall be fed from HT supply only.

The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to phase difference between the incoming voltage and motor residual voltage.

For VVVF converters, adequate measures shall be taken to restrict the harmonics content within the acceptable limit as stipulated in IEEE 519.

Motor handling facility and canopy

Handling facility and space shall be provided for all the HT and LT motors. Mono rail shall be provided and shall be extended up to open maintenance space for each of the HT motors. Canopies made of GI sheet of minimum thickness of 2 mm shall be provided to each of the HT/LT motors located outdoor.

Low Voltage Induction Motors

Frame sizes shall be as per IEC. Casing feet shall be integral with the motor body. For motor of rating up to 5 kW, ball bearings shall be used for both DE & NDE end. For ratings above 5 kW the DE end shall be provided with ball/roller bearing and NDE end shall be provided with ball bearing. Bearings shall be suitable for running of motor in either direction. Motors 110 kW and above shall be provided with bearing temperature indicators. Explosion proof/increased safety design for explosion hazardous areas as per requirement.

Terminal box shall be of suitable dimension to receive aluminium cables and shall be rotatable by $4x90^0$.

Cooling of motors shall be of TEFC (IC0141) design. Ventilation shall be effective irrespective of direction of rotation.

Motors shall be dynamically balanced. Vibration intensity shall be limited as per IS 12075 (1987). Continuous noise level should not exceed 85 dBA at a distance of 1.0 m from motor body.

Starting current shall be less than or equal to six times the rated current with IS tolerance. Motors shall have class ' F' insulation with temperature limited to class ‘B’. Permissible temperature shall be limited to 120°C in case of class 'B' insulation and 130°C in case of class F insulation as measured by resistance method. Class H insulation shall be considered in specific cases. Limiting temperature shall also be limited to 130 deg C in case of Class H insulation as measured by resistance method.

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Space heaters shall be provided for all motors rated above 30kW.

Adequate handling space shall be provided for all the big LT motors.

Intermediate local Junction Box for power cable near LT motors shall be provided for motors above 45KW

High Voltage Motors

Degree of protection for motor and bearings shall be IP-55 for indoor use and IP-55 with removable rain canopy for outdoor use.

. Vibration sensors (X & Y direction) in both DE and NDE end for all HT motors shall be considered for monitoring purpose. On line vibration measurements shall be provided for larger and critical motors.

All motors shall be provided with Bearing (DE & NDE) temperature detectors and 6 nos stator winding temperature detectors, RTDs for monitoring alarm and trip conditions. Temperature shall be displayed on VDU's. RTD's shall be of PT100 type and suitable for digital scanner and DDCMIS/PLC input requirement. Temperature scanner with soft communication facility to DDCMIS shall be considered.

The VDU (visual display unit) shall be a integral part of the VFD drives / HT panel as applicable. The temp scanner / VDU shall have the RS 485 protocol for further soft communication. However Temperature scanner with soft communication facility to DDCMIS shall be considered.

Digital type bearing temperature indicator for all motors shall be provided for local measurement with adjustable alarm contacts.

Phase segregated terminal box to be provided on both side of the motor for interchangeability of terminal box and star point. Each terminal box shall have fault withstand capacity equal to at least rated short circuit level of the system voltage for 0.25 sec and shall have pressure relief device. Terminal boxes shall be suitable for termination of FRLS, XLPE cables with cable end seals. Separate terminal boxes shall be provided for space heaters, RTDs for winding/ bearings temperatures, vibration monitors etc.

All terminal boxes shall be provided with two earthing studs for termination of protective earth conductor. Box covers shall be provided with handle to facilitate easy removal.

Low kW range machines may be of TEFC (IC0141) design. For higher rating, type of cooling shall be CACA (IC0151). General accessories like flow switches, space heater, terminal boxes, drain plug, dowel pipe cable lugs, glands clamp etc. shall be provided.

Vibration intensity shall be limited to values as stipulated in the IS. Motor shall be designed to withstand the vibration produced by the driven equipment. Continuous noise level should not exceed 85 dBA at a distance of 1.0 m from the motor body.

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Electrical design shall be same as incase of low voltage induction motors except the following;

All HT motors shall have class F insulation but with total permissible temperature limited to 130^0C (as measured by resistance method). Space heaters to be provided for all HT motors. Heaters to be automatically turned OFF when the motor is switched ON. Starting current of the drives shall be limited to six times of full load current.

Motors of rating 1000 kW and above shall be provided with differential protection. Matching CT and cabling up to switchgear shall be provided by the bidder.

Motors shall be capable of withstanding locked rotor current at 110 % rated voltage for at least 2.5 sec (for motors having staring time up to 20 sec) or 5 sec (for motors having staring time more than 20 sec) longer up to than starting time under rated load condition at 80 % voltage. If above condition is not possible then, centrifugal type speed switch to be provided which has to be connected to the motor protection relay. Speed switch shall be capable to withstand 120 % of the overspeed in either direction.

Insulation of motors shall be designed conforming to IEC 34-15/ 1990. Gland plate for single core cable shall be non-magnetic type.

Dial gauge (along with probe) to be provided for DE & NDE bearing temperature indication.

All HT motors shall have individual dedicated handling and lifting facilities preferably by dedicated electric hoist.

DC Motors

DC motors shall be industrial type, heavy duty, continuously rated, totally enclosed, generally designed and manufactured as per IEC 34/1, BS :2613, IS :4722

Brush holder shall be so as to maintain constant brush pressure regardless of brush wear and to ensure sparkless commutation at top speeds and overload. Degree of protection for motor, bearing housing and terminal box shall be IP- 55.

20% spare feeders shall be provided by the bidder.

Terminal box shall be dimensioned adequately for receiving aluminium cable.

Operation shall be unaffected by voltage or current ripples and shall be suitable to run continuously at 80 % of rated voltage. Overload capacity shall be minimum 160% frequently repeated momentary load for 15 seconds. Motors shall be over-speed capability of withstanding an over-speed of 20% above rated maximum field weakening speed.

Insulation shall be provided with class F insulation throughout the stator and rotor windings but designed for temperature rise (as measured by resistance method) corresponding to that of class B insulation.

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Electrical Actuators

All control valves, dampers in boiler , TG and blower areas shall be motorized electrically operated with manual operating handles having integral actuators.

The actuator shall be designed for operation on 415V, 3 phase, 50 Hz system. The actuators shall consist of motor, torque/ position limit switches, clutch, hand wheel, position indicator, space heater.

The actuator enclosure shall be totally enclosed dust tight, water proof without the necessity of any canopy. Insulation of the drive shall be class `B'.

Two torque limit switch one for each direction and four for end of travel limit switch (two for each direction) shall be provided. Emergency manual operation shall be provided and hand wheel shall de-clutch automatically when motor is energised.

Position transmitter, potentiometer type shall be provided for remote indications wherever required.

Internal wiring shall be of 1.5 sq.mm copper wire, however, terminals for external connections shall be suitable for 2.5 sq.mm.
In addition to the Make list provided by ISP for motorised actuator, Antrieb Make may also be considered by the bidder.

05.04.17. **Cable and Cable Accessories**

Type 1 : 33 kV (UE) XLPE Cables suitable for 33 kV, Three phase, 50 Hz, resistance grounded system.

33 kV (UE) heavy duty power cable, 3-core, with compact circular stranded (rm/V) Aluminium conductor with extruded conductor shielding of semi conducting material, XLPE insulated, with insulation shielding over individual cores consisting of extruded semi-conducting compound followed by lapped semi conducting material and copper tape, cores stranded together with a holding tape provided with a common covering of extruded inner FRLS sheath of type ST2 compound, galvanised round steel wire armoured and PVC outer sheath of type ST2 compound for 33 kV system as per IS : 7098 (Pt-II)-1985 as amended upto date. Copper screen shall be suitable to carry 1 kA E/F current for one second.

Minimum size of 33kV cable shall be 300mm^2

Type 2 : 6.6 kV (UE) XLPE Cables suitable for 6.6 kV, single phase, 50 Hz, resistance grounded system.

6.6 kV (UE) heavy duty power cable, 3-core, with compact circular stranded (rm/V) Aluminium conductor with extruded conductor shielding of semi conducting material, XLPE insulated, with insulation shielding over individual cores consisting of extruded semi-conducting compound followed by lapped semi conducting material and copper tape, cores stranded together with a holding tape provided with a common covering of extruded inner FRLS sheath of type ST2 compound, galvanised round steel wire armoured and PVC outer sheath of type ST2 compound for 6.6 kV system as per IS :

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7098 (Pt-II)-1985 as amended upto date. Copper screen shall be suitable to carry 1 kA E/F current for one second.

Minimum size of 6.6kV cable shall be 185mm^2

Type 3 : 1.1 kV, PVC aluminium power cables suitable for 415 V, 3 phase, 50 Hz, solidly grounded system.

1.1 kV, heavy duty power cable multicore with standard sector shaped (sm) or with compact circular stranded (rm/V) or circular stranded (rm) aluminium conductors as applicable, PVC insulated of type C PVC compound suitable for 85 deg.C. operation as per IS:5831-1984, core stranded together provided with a common covering of FRLS PVC inner sheath of type ST2 PVC compound, galvanised round steel wire armoured and FRLS PVC outer sheathed of type ST2 PVC compound conforming to IS:1554 (Part-I) - 1976, as ammended upto date. Type AYWY.

Type 4 : 1.1kV PVC copper control cables

1.1 kV circular stranded (rm) annealed copper conductor, PVC insulated of type A PVC compound suitable for 70 deg.C operation,as per IS:5831 - 1984, cores stranded together provided with a common covering of FRLS PVC inner sheath of type ST1 PVC compound, galvanised round steel wire armoured and overall FRLS PVC sheathed of type ST1 PVC compound and multi-core to IS : 1554 (Part-I) - 1976, Type YWY.

Cable Selection

- In general, size and type of cables for specific applications shall be selected giving due consideration for the following:
- Thermal heating effect/permissible current carrying capacity.
- Voltage drop
- Short time current/overload requirement
- Protection system grading and short circuit current carrying capacity.
- Ambient conditions
- Cable grouping factors

In selection of the cables following ambient conditions shall be taken into account.

Cables laid directly in ground in single way ducts or pipes buried underground.

-	Thermal resistivity of soil	:	150 deg.C cm/W
-	Soil temperature	:	40 deg.C
-	Depth of laying (to the highest point of cable or top surfaces of ducts)	:	75 cm for 1.1kV grade cables and 90 cm for HT cables
-	Horizontal formation axial spacing	:	15 cm in case of cables laid in a group directly in ground and approximately touching in case of single way ducts or pipes.

Cables laid in free air/in conduits in free air.

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Ambient air temperature	:	50 Deg.C & As specified For the respective shops.

Cables laid in ventilated ducts/gallery

Ambient air temperature	:	50 Deg.C.

The minimum cross sectional area for HT power cables shall be 185 sq.mm.

The minimum cross-sectional area of the cables used in LT power circuits shall be 6 sqmm per core if with aluminium conductor or 4 sqmm per core if with copper conductor. Maximum cable size shall be 240 sqmm for incomers to MCCs, PCCs etc.

For control circuits, PVC insulated and FRLS PVC sheathed multicore cables with copper conductors having a minimum cross-sectional area of 2.5 sqmm per core shall be used. The number of cores may be standardized as 2,3,4,5,7,10,14,19,24.Each core of control cable with 7 core and above shall be numbered at every 1 meter intervals.

In multi-core control cables, the following minimum reserve cores shall be kept at the engineering stage:

- Upto 7 cores - One reserve core
- 10 cores - Two reserve cores
- 14,19 & 24 cores - Three reserve cores

Sequential length marking shall be provided in outer sheath of all power and control cables.

Standard drum length for all types of power and control cables shall be offered. ISI marking at every meter of cable length shall be provided.

Cores of multi-core control cables shall be serially numbered.

For all cables, extra length of 2 metres will be left before jointing.

Additional Tests on cable:

To prove the fire retardent low smoke characteristics, the following additional tests shall be conducted at works on any size of each type of cable namely, H.T/ power, L.T. power, control and instrumentation cables.

Oxygen index test as per ASTM D 2863. Minimum value of Oxygen index shall be 30.

Flammability tests on finished cable as per the requirements of IEEE-383 and IEC-332-1.

Smoke generation by inner/outer sheath fire as per ASTM D 2843. The cables shall meet the requirements of light transmission of minimum 40% after the test.

HT Cable termination & joints

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Following type of cable termination and joints shall be used for HT cables in indoor and outdoor applications :

Heat shrinkable type

The stress control and grading wherever necessary shall be by means of semi conducting heat shrinkable tubing. Environmental sealing between heat shrinakable material and cable surfaces shall be achieved by using hot melted sealants or adhesives. Where such sealents or adhesives shall be exposed to high electrical stress, same shall be track resistant type.

The termination and straight joints for HT/LT cables shall be supplied in kit form. The kit shall include all insulating and sealing material apart from conductors fittings and consumable items. Necessary devices required for termination and joints shall be provided.

Specifications for miscellaneous materials

Connectors

Cable termination shall be made with aluminium/ tinned copper crimped type solderless lugs of approved make for all aluminium conductor and stud type terminals.

Cable identification

Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number as per cable schedule.

Ferrules

Ferrules shall be approved interlocked type & size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

Cable Glands

Cable glands to be supplied shall be nickel plated brass double compression type. Glands for classified hazardous areas shall be certified by CMRS and approved by CCE, Nagpur.

Cable clamps

All cables shall be clamped with metal clamps and single core cables shall be clamped with trefoil clamps made of aluminium.

Cable trays

This shall be prefabricated hot dip galvanised sheet steel trays. Runner size shall be 50x50x6 and rung size shall be 25x5 at every 250 mm. At one meter interval two rungs shall be provided side by side to facilitate clamping. Galvanising content shall be 86 microns.

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All the cable trays shall be hot dip galvanized GI trays, ladder or perforated as the case may be. Beside, bidder shall also provide 900/450 bends of cable trays at the bends as per actual site requirement.

5.4.18. **AC Distribution Board / Power Distribution Board / Auxiliary AC Distribution Board**

ACDB shall be suitable for 415V, 3 phase, 4 wire, 600A, 50 kA (short time rating for 1 sec.) indoor type.

Board shall be single front, metal clad, front matched, dust and vermin proof, draw-out, fully compartmentalised and extensible on both sides, IP54 type enclosure. However, thermoplastic polycarbonate material for DM plant and boiler area shall be provided.
Shall have isolated busbar chamber for main busbar at the top, running through out the length of the board. Chamber shall have removable cover.

Busbars shall have same cross section through out the length . Rating of the neutral busbar shall be 50% of the main busbar. Earth bus bar shall run in bottom chamber throughout the length of the panel.

Shall have Air Circuit Breaker (ACB) or Moulded case circuit breaker (MCCB) triple pole, air break type with independent manual quick make and quick break type. ACB/MCCB shall be capable of breaking rated current at 0.3 pf at rated voltage. ACB/MCCB shall withstand the fault current envisaged for 415V system.

The number of ACDBs/PDBs and their locations shall be decided based on consumers and shall be finalised during drawing approval stage.

Generally all boards will have following feeder arrangement. However, details of feeders e.g no. type and capacity, etc shall be finalized during detailed engineering.

Incomer - ACB/MCCB of 600A (or as indicated in SLD)

Outgoings - MCCBs of 400/250/125A (or as indicated in SLD)

Number and capacity of ACDB/PDB given in the enclosed Single Line Diagram is minimum and indicative. Bidder shall provide as per actual load requirement and same shall be finalized during detailed engineering.

Auxiliary AC Distribution Board / Auxiliary Power Distribution Board

These are required for feeding small loads. The board will be wall mounted type and other constructional features as given in above specification for ACDB.

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Number of aux. ACDBs shall be as per requirement and shall be decided during detailed engineering stage.

5.4.19. Plant Illumination System

The scope includes complete plant illumination system to achieve required illumination levels as per IS and as per CBIP guidelines. The scope shall cover the following illumination systems;

- Normal AC lighting of the plant
- Emergency DC lighting of the plant
- Maintenance lighting
- Peripheral, road/street and area lighting within battery limit

Illumination shall be provided in all premises like TG building (all floors), control room & switchgear rooms (all floors) including control room, TG hall, UPS/charger room, boiler plant (all floors), staircase, toilets, MCC rooms, piping gallery, ID fan areas, BFP hall, instrumentation rooms, analyser room, offices, shift incharge room, cable gallery, electrical annexie rooms, any other premises coming under the battery limit of the package, peripheral lighting, area lighting, road/street lighting, etc within battery limit of this package.

Emergency lighting is proposed for substations, control rooms and other strategic points of the plant. Emergency lighting from Inverter/UPS will be arranged for isolated buildings/substations and for process plants, emergency lighting will be provided through DG set. The lighting power supply will be taken from the 415 to 240 V AC, 3-phase, 4-wire distribution system.

20% spare feeders shall be provided by the bidder for emergency lighting system.

Separate MLDBs shall be provided for the Power and Blowing station. Each of the MLDBs shall have two sections separated by a bus coupler, one section shall be fed through adequate kVA 0.415/0.433 kV dry type lighting transformer. Each MLDB shall have sufficient nos. of feeders of adequate ratings to feed various LDBs.

Bidder shall consider sufficient number of area wise LDBs and SLDBs and shall indicate the number of feeders required from the MLDB.

The illumination system shall include the following in required quantities;

- Lighting DBs
- Light fittings with lamps
- Lighting fixtures and accessories
- Cables and wiring
- Ceiling fans
- Receptacles
- Lighting poles/masts
- Switches
- Conduits
- Brackets
- Hangers
- Clamps
- JBs
- Any other items as required

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All lighting in outdoor area such as road & street lighting as well as peripheral lighting shall have auto ON/OFF facility with suitable timer.

Illumination levels envisaged for different areas will be as indicated below;

Plant department	Illumination level
	Lux
Conveyor gallery and junction house	50-100
Coke oven, sinter plant, blast furnace, steel melt shop including continuous casting, calcining plant and rolling mills	150-200
Air separation plant, compressor house, chilled water plant and pump houses, power plant & blower house,.	150-200
Repair and maintenance shops	200-350
Switchgear room	150-200
Control rooms, offices	300-350
Cable cellars, basements	50-60
Laboratories	350-400
Open storage yard and loading/ unloading areas	15-20
Roads	10-20
Railway tracks	10-15

Main lighting supply will be from main lighting distribution board (MLDB) at purchaser's end.

Sufficient numbers of areas wise lighting distribution boards (LDBs) and sub lighting distribution boards (SLDBs) will be distributed all over the plant. All the LDBs will be fed from MLDB. All the SLDBs of an area will be fed from LDB of the concerned area.

All LDBs and SLDBs will have one incomer only. LDB shall have MCCBs as incomer as well as outgoing feeders. SLDBs will have MCCB as incomer and MCCB/MCB (as per requirement) as outgoing feeders.

Separate circuit will be used for DC emergency lighting system. DC emergency system will be fed from DC batteries and will be automatically switched 'ON' on failure of AC general supply.

Separate LDBs shall be provided for DC emergency lighting.

Explosion hazardous areas will have flame proof fittings/junction boxes. Flame proof fittings/JB for light fittings shall be considerd in boiler area & cable celler. Battery Room, Dust proof/tight light fittings will be used for exceptionally dusty environment areas.

Well glass fittings (including flame-proof fittings) shall be integral type. Glass fitting arrangement in flame proof fittings shall be threaded type instead of bolted type.

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The voltage of maintenance lighting network and cable premises lighting network will be 24 volts.

Street and area lighting shall be done with 250 W HPSV lamps with suitable control gear compartment having ballast, igniter, P.F. improvement capacitor and connector block. The fittings shall be of outdoor use with degree of protection not less than IP 54 (for lamp compartment) and IP 53 (for control gear compartment).

Steel tubular poles of 12 m length swaged with one arm on top to carry luminaries shall be under bidder's scope. Bidder shall provide all mounting accessories with cable box erection of foundation etc. and wiring /cabling up to light fittings. Poles shall be earthed as per approved scheme.

Sufficient numbers of GI bolted towers shall be considered at strategic locations for area lighting.

Timer control with auto manual switch shall be provided in all the LDBs/SLDBs used for lighting.

Sufficient no of switch socket outlets shall be provided in electrical repair shop and electrical lab and shall be fed from the respective LDB.

All civil works required for illumination shall be under bidder's scope.

The complete drawings of lighting networks and lighting layout shall be prepared and submitted by the bidder for approval.

Following types of light fittings shall be considered;

Area of Installation	Type of Fittings	Plant Units
High bay Areas	High bay type fittings with LED lighting	Shop Area, compressor plant including all other high bay areas
Low bay Areas	Direct or semi-direct type fluorescent fittings. Weather/ vapour/flame-proof well glass type fittings with LED lighting wherever practicable	All low bay areas of plant units including switch rooms, basement, cellars, tunnels etc.
Buildings	LED lighting	Offices, canteens, control rooms, laboratories, etc.
Flood light towers	Flood light fittings with LED Lighting/high mast tower.	Outdoor yards
Road lighting	Road light fittings with LED Lighting	Roads

1400 mm sweep ceiling fans shall be provided at other required places. The ceiling fan shall be complete with electronic regulator.

230 V, 3 pin, 15/5 A decorative sockets shall be provided in the various premises as per requirement. Items such as brackets, hangers, clamps, junction boxes, etc which

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are required to make the lighting installations complete in all respects shall also be supplied.

Power supply to individual fittings shall be through 2x2.5 sq.mm armoured cables. Higher size cables like 10/16 sq.mm shall be considered for street lighting.

Lighting DBs of all the areas shall preferably be located inside the rooms like switchgear cum MCC rooms, etc.

In addition to above on demand lighting shall be provided for premises like, cable gallery, boiler floors, etc with proper operational convenience.

Miscellaneous items like 240 V single pole switch, 240 V socket outlets, 24 V maintenance (with 240/24 V dry type transformer), portable emergency lights, steel tubular poles for street & area lighting , cables and wiring, etc shall be provided by the bidder as per requirement of the plant.

Complete earthing of the illumination network shall be under scope of the bidder.

Following type of lamps shall be generally used;

FL	:	40W
SV	:	70W, 150W, 250W, 400W
MV	:	70W, 150W, 250W, 400W
Incand. GLS	:	500W
DC emergency	:	60W

The complete drawings of lighting networks and lighting layout of each and every premise shall be prepared and submitted by the bidder for approval.

Lighting Distribution Board

415V, 3 phase, 4 wire, 600A/400A (as applicable and required area wise), 25 kA (short time rating for 1 sec.) indoor type.

Board shall be single front, metal clad, front matched, dust and vermin proof, non-draw-out, fully compartmentalized and extensible on both sides, IP51 type enclosure. Incomers shall be draw out type.

Shall have base channel of size ISM 75.

Shall have isolated bus bar chamber for main bus bar at the top, running through out the length of the board. Chamber shall have removable cover.

Cable alley shall have sufficient space for aluminum power cables and bottom cable chamber shall be left free completely isolated from the vertical bus bars.

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Bus bars shall have same cross-section through out the length. Rating of the neutral bus bar shall be 50% of the main bus bar. Earth bus bar shall run in bottom chamber throughout the length of the panel.

Shall have moulded case circuit breaker triple pole, air break type with independent manual quick make and quick break type. MCCB shall be capable of breaking rated current at .3 pf at rated voltage. MCCB shall withstand the fault current envisaged for 415V system and shall be current limiting type. All outgoing feeders shall have earth fault protection.

Generally all boards will have following feeder arrangement:

Incomer	-	600A/400A MCCB (As applicable and required)
Outgoings	-	400/250/125A – MCCBs
No. of feeders	-	As per requirement

Sub Lighting Distribution Board

The LDBs shall be suitable for 415 V, 3 phase and neutral.

The LDB shall generally comprise of incoming MCCB, requisite no of outgoing MCCBs/MCBs (as applicable and required) and adequately rated bus bars.

The board shall be sheet steel clad, totally enclosed, dust & vermin proof and wall mounting type. The board shall have welded back and sides and gasketted hinged door at the front with door handle and suitable locking devices, Detachable gland plates shall be provided a the top and bottom with suitable gaskets for cable entry. Operating knobs of MCCB shall be accessible only after opening the front door of the cubicle. Protective insulated cover plate shall be provided inside the cubicle to shroud all the live parts. Adequate space shall be provided within the board to facilitate termination of incoming & outgoing cables. The boards shall be factory wired and assembled. Where specifically called for, the boards shall be of special weatherproof design suitable for outdoor installation. Colour shade of the boards shall be 631 of IS:5-1991.

The enclosure class of LDB shall be IP 54. The terminals of MCCB shall be fully shrouded. The LDBs shall be fed from MLDB. Identification labels and inscription plates shall be provided for the boards. These shall be as per approved drawings.

One continuous earth bus shall be provided at the bottom part of the LDBs along the full-length of the board with two bolted type earthing terminals. Proper danger plates shall also be provided on each board.
Number of LDBs and their locations shall be finalized during drawing approval stage.

Incomer	-	up to 250A MCCB and above ACB
Outgoings	-	125/63/32/16A – MCCBs/MCBs (As applicable and required)

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No. of feeders - As per requirement

5.4.20. Electrics of EOT Crane and Other Material Handling Equipment

EOT Crane

Complete electrics including power supply arrangement and control, monitoring & protection systems shall be provided for EOT crane of power house For hoist motor DCEM and ACEHT brakes shall be provided for power house EOT crane. The scope shall also include supply and installation of all the materials including cables, angles, insulators, aluminium flat, etc. Following items shall be included in the scope suitably for smooth running of the power house EOT crane.

1. Motors for LT, CT and hoist (LT, CT & hoist shall be VVVF type)
2. Power disconnecting switch
3. Main protective control panel
4. LT, CT, main and aux hoist motor control panel
5. Emergency switches
6. Protective switchgears, resistors
7. Thrusters, DCEM brakes, limit switches
8. Power and control cables including incoming cables to DSL switch
9. LDB panel along with crane lighting
10. Current collector system
11. Master controller
12. Indication lamp, push button
13. Equipment earthing

The crane shall be provided with VVVF control for LT, CT and hoist. The VVVF control drives shall be heavy duty with 50 % overload capacity.
All the crane drive motors shall have cylindrical shaft.
Isolating switches for cranes/hoists shall be located at the floor level at approachable height (1.5 mtr for easy maintenance).
All control cubicle for hoist shall be at ground floor for easy maintenance. Flexible trailing cables shall be provided as per actual requirement.
Anti drop device shall be provided in hoisting motor.

Other Crane/ Hoist and Material Handling Equipment

Complete electrics including power supply arrangement and control, monitoring & protection systems shall be provided for all the cranes/hoist coming and other material handling equipment like elevator, etc within the battery limit.

Bidder shall include complete electrics including source feeders, associated cabling & their termination, local DBs, all power and control accessories, all related annunciations, etc.

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Isolating switches for cranes/hoists shall be located at working height for easy maintenance.

All hoists/cranes shall be provided with continuous rails/monorail (whichever is applicable).

Technical Features for EOT Crane (Double Girder)

Power supply

415 V ±10%, 3 phase, 4-wire, 50 Hz +3%,- 6% AC, 50 KA fault level, through trolley lines (DSL).

Voltage other than 415 V, AC, shall be obtained through suitable transformer or transformer rectifier units on the crane with miniature circuit breakers on both primary & secondary sides. Control supply voltage shall be 240V AC derived from 415/240V transformer.

Each transformer shall have ± 5% & ± 10% tappings on secondary side.

Current collectors

Suitable for trolley line system consisting of R,Y&B phases & earthbus. 2 Nos. current collectors shall be provided per trolley line each rated for 100% of total rating. Double collectors on each earth trolley line shall be provided.

Power distribution on crane

An off-load manual isolator with locking facility shall be provided immediately after current collectors on incoming line on the crane.

Power from the isolator shall be taken to the air circuit breaker to be provided in the operator's cabin. In case of pendant operated cranes, this circuit breaker shall be located in the protective panel. The breaker shall be with under voltage, over load & short circuit releases.

The breaker can be closed only when:

- All master controller handles are in neutral position.
- None of the starter or directional contactors are in closed position.
- Emergency corner switches not operated.
- Emergency stop PB not operated.
- Door/gate switches are not actuated.
- Gravity limit switch for hoist motion not operated.

Power for lighting circuits shall be tapped from the incoming side of the isolator near current collectors.

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Meters

Ammeters & voltmeters with selector switches shall be provided on the incoming line in operator's cabin. Ammeter & voltmeter on DC side for electromagnets.

Control features

All controls shall be fully magnetic - operated through master controller.

All travel motions shall be provided with VVVF control. For Long travel drives, the electrical controls shall be grouped for the individual pair of motor drive & each pair of motors shall be able to drive the crane at reduced acceleration & speed.

Hoist motion shall have control during lifting operation & while lowering, counter torque, single phase dynamic braking & super synchronous braking method shall be provided on successive master controller notches.
Additional radio remote control shall also be considered.

Brakes shall not be used for speed control. Synchronisation of separate drives, where required shall be done with the use of solid state thyristor controls.

AC thyristor voltage control shall be used for hoist motion wherever creep speed is required through electrical means. The creep speed shall be provided for both hoisting & lowering directions.

Hoist control circuit shall be provided with anti-drop feature i.e, whenever the master controller is brought back to zero position from higher notches in both directions, the motor shall automatically be connected to hoisting direction for sometime (time adjustable through a timer) to avoid the downward drift of the load.

Master controller zero position interlock shall be provided on control circuit of each motion in under voltage coil circuit. Brakes shall clamp in zero position of the master controller.

The two EOT cranes in TG hall shall be used together for handling of the generator stator from any one cabin of the crane. A selector switch having two positions; `tandem' and individual shall be provided. Master controllers required for operation of both the crane in tandem mode shall be common for operation of both the crane.

Panels

All panels shall be of free -standing floor - mounting dust and vermin proof construction suitable to withstand vibrations encountered on crane. Hinged doors shall be provided for closed type panels and shall have locking and latching arrangement. Front wired with bottom most equipment mounted at least 350 mm above the bottom cover of the panel. Panel shall be fabricated from 2.0 mm thick steel sheet. The height of panel shall be accessible.

Power & control terminals shall be segregated. 10% spare control terminals shall be provided in each panel. Equipment in the panel shall be so mounted that removal or replacement from the front is easy.

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Power and control connections strips should be laid at the bottom end horizontally and at the side end vertically respectively. Panel shall be mounted atleast 150 mm above floor.

Separate control panel for each motion shall be provided.

Panels shall be closed type when mounted on bridge platform. Sufficient clearances shall be provided between the panels. A minimum clearance of 500 mm shall be provided in front of panels for walkway & approach. Open type panels shall be used for installation inside the box girders. In this case, adequate lighting & ventilation shall be provided for the room.

Switch gears

Each mechanism motor shall be provided with MCCB, contactors on stator & rotor sides, oil dash pot type overload relays & suitably rated rotor resistance.

In case of thyristor-controlled drive, each mechanism motor shall be provided with breaker / switches, transformers, thyristors, rotor resistances, contactors on rotor & stator side, etc. Each motor shall be fitted with a tacho-generator for speed feed back. The overload capacity of thyristor shall be 200% for 2 minutes. The speed range shall be 0 to 100% of the rated speed.

MCB shall be provided in the control circuit of each motion. Each brake circuit shall be provided with a suitable contactor.

Rating of contactor selected for any mechanism shall be atleast 50% higher than respective motor full load current at mechanism duty cycle. The min. rating of the contactor used shall be 40 A & the life of each contactor shall not be less than 10,000 hrs. of operation. Reversible contactor shall be interlocked both mechanically & electrically.

Motors

For heavy duty reversible crane motors, TEFC wound rotor motor shall be used for various drives. The motors shall have tapered shafts. Pull-out torque to be not less than 300% of the full load torque corresponding to 40% CDF. The ratings not less than 40%.

The class of insulation shall be `B' and for slip ring motor, class of rotor insulation shall be class F but temperature rise shall be limited to class B. All motors shall have terminal box at top.

Frame sizes shall conform to IEC Standards. Horizontal foot mounted & tapered shaft extension.

Crane hoist motors and other drives shall have minimum 60 starts/hr.

Overload capacity : 150% of full load current for 2 minutes without damage or permanent deformation.

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Brakes

Brakes shall be DC electromagnetic type with copper coil.

Brakes shall be designed to fail safe whenever the current is interrupted either intentionally or by failure of the mains supply.

Field forcing relay shall be provided for DC brakes. DC brake circuit shall be switched-off on DC circuit for quick operation of the brake.

For cranes above 75 t capacity,brake opening sensing interlock shall be provided through limit switch.

Limit switches

Roller lever operated, self-resetting limit switches shall be provided for all travel motions.

For each hoist motion, a rotary type over hoist & over lower self-resetting limit switch shall be provided. In addition to this, a back up ultimate limit switch of series/shunt gravity type shall be of manual reset type. Provision shall be made to bridge the gravity type limit switch contact by push button/ switch to lower the load.An indication panel shall be provided to the operator whenever this limit switch has been operated.

Resistances

Aircooled, robust, heavy duty, corrosion resistant punched stainless steel grid type. Resistances shall have vibration proof assembly & mounting. Resistance shall be rated for 10 minutes.

Maximum temp. of resistor elements shall be limited to 275^0C (when measured by resistance method) at desired duty. Each step of rotor resistance for hoist mechanism should be for 100% CDR. Resistance shall have suitable tapping points.

Complete resistance of one phase should be accommodated in enclosure and not distributed alongwith other resistance of other phases. Resistance boxes shall be mounted in racks that permit independent removal of any selected box. Distance between live & earthed part shall not be less than 100 mm.

Master controller

Cam type master controllers with joy stick type lever shall be used. Master for magnetic controls shall have five notches in each direction.

Lighting, socket outlet, bell, etc.

Lighting shall be provided in driver's cabin, stair cases, platforms & working area. Selective switching ON/OFF arrangement should be provided from a central post.

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400 W high pressure sodium vapour lights equally spaced under crane girders about the crane span shall be provided alongwith shock absorbing & anti-swing suspension arrangements.

Fluorescent lamps with necessary fittings shall be used for driver's cabin, stair cases, platforms, etc. One 500 watt HPMV fitting below the cabin shall be provided.

Adequate No. of hand lamp socket outlets & power socket outlets shall be provided alongwith switches.

A hand lamp alongwith sufficient length of cable with a plug shall also be provided for each crane.

Trolley feed

Angle iron shall be provided as described else where to feed the power supply to the crane.

Festooned cable arrangement shall be provided for power supply to crane trolley. This shall have cable trolleys, chain etc. with flexible cables.

Equipment in operator's cabin

Cabin shall contain the following :

- Switch for closing of power supply air circuit breaker.
- Master controllers for all motions & magnets (wherever applicable).
- Emergency stop push button.
- Foot switch for alarm bell.
- Switches for all lighting equipment on crane.
- Switches for fan, 15A socket in the cabin.
- Fire extinguishers.
- Insulating mat & operator's chair.
- Cabin light.
- A foot mounted type warning electric bell (heavy duty industrial type) shall be provided outside the cabin.
- Annunciation panel with LED indication lamps for power "ON", control "ON", emergency corner switch operated, volt meter & ammeters with selector switches for all drives.

Cables

Power cable shall be PVC, FRLS suitable for 3-phase, 4 wire, AC power supply system.

All cables shall have stranded copper conductors of 2.5 sq.mm size for control wiring & 4.0 sq.mm (min.) size for power wiring.

Fixed wiring on cranes shall be carried out with PVC insulated, PVC sheathed armoured cable or EPR insulated, CSP sheathed cable. All flexible cables (i.e. cables for trolley feed, pendant unit, etc.) shall have EPR insulation & CSP sheathing.

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All cables shall be suitably derated for grouping & higher ambient temperature.

All cables shall be of 660/1100 V grade. All accessories like cable guards, lugs, clamps, pipes, wire & terminal markers, etc. shall also be provided. Cable laying & terminations shall be such that chances of cable getting damaged is remote.

5.4.21. Earthing and Lightning Protection

Earthing

Bidder shall include complete earthing of the plant within battery limit including the following;

1. Earthing mat in the complete plant
2. Equipment earthing / Structure earthing
3. Electronic earthing, etc
4. Ring earthing

Bidder shall include complete earthing material including earth electrodes, risers, MS rod, earthing strips, other accessories, etc. and carry out main earth grid, earth pits, risers, interconnections, equipment earthing, all associated civil works, etc within battery limit of the package. All the interconnections with other earthing systems of the plant and with existing systems shall be under scope of the bidder.

The scope of bidder shall include the supply of all earthing materials viz. MS rod, earthing flats and all other required material to complete earthing system and lightning protection.

The actual soil resistivity of plant area shall be obtained by the bidder by carrying out soil resistivity tests and design the earthing system accordingly. The design of the earthing system shall be such that the earthing resistance shall be 50ohms.

While designing the earthing system, bidder shall note following fault levels at different buses;

33 kV	:	40 kA
6.6 kV	:	40 kA
415 V	:	50 kA

The materials shall be galvanized steel laid over the ground and mild steel buried inside the ground/concrete. Complete civil works related with earthing shall be under scope of the bidder.

Fault clearing time for sizing of earth conductors shall be considered as 3 seconds and fault clearing time for step and touch potential shall be consider as0.5 secoends. Maximum allowable temperature rise for steel bolted joints shall be taken as 310^0C taking ambient temperature of 50^0C.

Plant earthing system shall be designed such that overall earthing resistance is less than 1 (One) Ohm without interconnections. Earth mat shall be provided in complete plant

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area like boiler plant area, TG bay area, switchgear/control room bay area, ID fan area, etc. The earthing system including earth mat shall be designed for a specified short circuit current 40kA for a fault duration of 3 seconds.

The earthing protection system shall be generally designed on the basis of the following codes & standards:

- IS 3043 Code of practices for safety and standards
- IEEE 80 Guide for safety in AC substation grounding
- Indian Electricity Rules

In case of HT system, E/F current will be made to flow through copper screen tape provided over inner sheathing. Screen will be connected to earth bus at both ends. In case of LT the TN-S system will be followed, i.e. neutral bus of the switchgear shall be connected to switchgear earth bus and then to MCCs/DBs shall be through 4 core of the cable.

Bidder shall submit the layout drawings of earth mat with supported calculations for approval of purchaser/consultant. Taking approval of Electrical inspector/CEA and providing al inputs to them like data/drawings are under scope of the bidder.

The earth mat shall be provided in complete area within the battery limit.

Earthing conductors run on walls/floors/cable and equipment structures etc. shall be supported at suitable intervals and painted with black oxide paint.

All joints in the branch connections except at earthing electrode shall be welded and painted black.

At road /rail crossings earthing strips/rods shall be laid through conduits /concrete ducts.

For different floors in a structure / building, localized internal earthing ring shall be formed and connected to the ground earthing ring through vertical risers. The earthing mat shall be common to both power and lighting installations.

Each RCC steel column of the building will be interconnected to the under-ground earthing grid in basement/ground floor.

All earth risers at main columns of the power house shall be 2 X 40 mm MS Rod to a minimum height of 1 M from FFL. Earth r8isers of auxiliary columns of power house, Boiler, etc shall be with 50 X 6 mm GI Strip and to the height of minimum 1 m from the FFL.

The Armour of cables and all conduits for cables shall also be connected to the earthing mains. A continuous earth strip shall run in each side of cable channel and in cable ducts and trenches.

All joints in the run of the main earthing conductors will be welded or brazed type. Connection to equipment structure shall be bolted type. All welded joints shall be

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protected from corrosion by applying bitumen paint.

Separate RF earthing system shall be provided for all electronic equipment like PCs, instrument panels, computer etc.

Earthing system for computers and microprocessor based equipment/PCs shall be distinct and separate from the power and lighting equipment earthing system.

Lightning protection

All buildings and plant structures shall be protected against atmospheric flash over and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein. Stipulations of IS : 2309 - 1969 shall be followed.

A 'Faraday Cage' made of hot galvanised strip steel connected to all buried pipes and steel structures crossing this cage ring shall be laid around each main building or plant unit as earthing device. This shall be separate from the electrical equipment earthing ring main.

However, as a minimum, following buildings/structures shall be provided with lightning protection

1. Main Plant Building
2. Boiler area
3. Chimney
4. CWPH building
5. DM Plant building

Design shall be as per the standard like IS 2309 (latest revision) and Indian Electricity Rules.

All lightning arrestor earth leads of the buildings and plant units shall be connected to this cage ring.

Air termination network should cover all salient points of the structure. All metallic structures, ducts and the like above the roof of the structure shall be bonded to and form part of the air termination network. Vertical air termination points shall project at least 30 cm above the object on which it is fixed.

Down conductors shall follow the most direct path possible between air termination and earth termination avoiding sharp bends. Down conductor shall have a testing point adjacent to the earth electrode. Each conductor shall have an independent earth termination. All earth terminations shall be interconnected.

Earthing electrodes and grid for lightning protection will be distinct separate from the earthing system for earthing of electrical equipment and at no place will be connected to other earthing system.

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5.4.22. Fire Detection and Alarm System

A microprocessor based analogue addressable type automatic fire detection cum alarm system shall be provided for complete power plant including all electrical and common facility premises .

In all the electrical premises multisensor addressable intelligent detectors in double configuration shall be provided except for transformer room and battery room where rate of rise cum fixed temperature type heat detectors shall be provided .

The system shall have self-monitored microprocessor panel incorporating the latest technological developments. The automatic fire detection cum alarm system shall operate taking into consideration the air change/air velocity of the ventilation system. Response indicators shall also be provided for all the detectors above false ceiling in control room.

Bidder to assess the quantity of interconnecting cables and wires, supporting arrangement and include the same on lump sum basis.

Following parts of fire detection and alarm system shall be provided :
- Main Fire Alarm Panel
- Personal computer with visual display unit, key board, mouse and printer

- Manual call points(indoor type)

- Manual call points (outdoor type) with canopies

- Hooters (indoor type)

- Hooters (outdoor type) with canopies

- Multi-sensor detectors (photo electric cum rate of rise and heat detector (type)

- Rate of rise cum fixed temp type heat detectors

- Isolators

- Relay modules

- Response indicators

- Area panels

- Maintenance-free Lead acid battery and battery chargers

- FRLS cables, conduits, junction boxes, earthing materials etc.

- Siren and hooter

- Infrared detectors

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-Linear Heat Sensing Cables

System Description

Microprocessor based control panel shall be provided to detect, differentiate and monitor the following conditions of the detectors.

- Fire
- Fault condition
- Open circuit
- Short circuit
- Low voltage condition of batteries.

Panels shall have provision to accommodate 20% extra locations or one loop for future use (whichever is more).

The system shall have display as well as print options. Fire alarm panel shall have mimic and text display.

The system shall also be suitable to work on UPS system. Purchaser will provide one feeder from their board. Requirement of UPS power shall be furnished by the bidder.

There will be one number Main Fire Alarm Panel to be installed in main control room and a number of Area Panels (AP) to be installed in other different control rooms. In case of detection of fire, the fire signal (audio-visual alarm) of particular area shall appear in the respective Area Panel. The signal from AP shall be duplicated in Main Fire Alarm Panel.

In all area panels and Main Fire Alarm Panel, audio fire telephone with public address system consisting of loudspeakers etc shall be provided to facilitate voice communication between main control room and other control rooms where fire panels shall be located. Public address system shall be used for emergency instructions.

For tripping of A/C, ventilation drives, signals shall be initiated from Area Panels only if two adjacent detectors give fire signal.

Number of loops in fire alarm system shall be finalised based on requirements / future use during detailed engineering stage. The bidder to note that all loops shall be closed type. Panel shall have provision to adjust the sensitivity of the detectors from the panel itself. In main panel mimic LED lamps shall be provided to know at a glance operation of detectors in a particular area.

The supplied Fire Alarm system will be connected to central Fire Station Graphics workstation through the plant area network which will be under the scope of a separate package. The supplier of this package will provide all softcopies of data base and programming software for integration with the central graphics station.

Plant FDA system will establish communication with the proposed TCP/IP based plant wide gigabit network. Plant wide gigabit network will be based on 9/125 µm single mode fiber. Necessary Lx -1000 fiber optic (FO) modules will be provided in

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the switch of plant FDA system by the respective package bidder to achieve the same.

Single mode fiber optic cable laying from plant FDA system switch to edge switch of the plant wide network will be in the scope of respective shop package Bidder.

These details will be worked out at requirement specification / detail engineering stage. Respective Shop package Bidder will confirm the same.

Main Fire Alarm Panel (MFAP)

MFAP shall be located in main control room. Fire signal from all the area panels shall be repeated in MFAP. All annunciation of Fire Pump House panel shall also be repeated in Main Fire Alarm Panel. The panel at FPH shall be connected to network bus with suitable hooking devices. MFAP shall have text display.

Personal Computer and printer

Personal computer with visual display unit along with key board and printer shall be provided to monitor all the data loggings of events , system diagnostics and to print out the required events / data logged with date, time, etc. Status of all the detectors shall be displayed on demand on VDU . VDU shall display alarm , pre-warning faults and location of the fire or faults like open circuits and short circuits.

VDU screen shall be of minimum 21 inch size, processor type shall be latest version of Pentium . Printer shall be laser jet type. Suitable furniture for PC and printer with revolving and rolling chair shall be included in the scope of the bidder. In PC it shall be possible to have geographical mimic and graphic display for the complete area. PC and printer shall be located in main control room and connected to MFAP.

Networking

The MFAP and APs shall be networked using RS 485 interface. A provision shall be kept to add/ remove panels from the network. Necessary cabling, interface cards, hardware and software is included in the scope of the bidder. In network connection, bidder to provide two spare cores to be used in case of fault in working cores.

Power Supply

Bidder to include all power supply cabling for the fire alarm panel from the existing power supply boards.

The fire alarm panel shall be provided with 24 V DC battery along with battery charger of adequate capacity so that if AC power fails, DC source will be available automatically without interruption. Batteries for above shall be lead acid sealed maintenance free type. Battery shall be capable to withstand the total normal requirement for a duration of 48 hours and for a duration of 30 minutes to meet alarm load requirement. Alarm load shall consist of normal detection equipment plus all sounders/siren etc. Boost/trickle charging facility shall be provided in the panel. Battery shall be kept separately in the control room at suitable place.

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Detectors

Detectors shall be of latest series intelligent type. Close loop shall be formed with connections of detectors. Each close area shall have isolator at entry points and exit points which will automatically open the part of loop on short circuit. Alert signal (first) and final fire signal (second) shall have differentiable sound. All detectors shall be mounted with a suitable junction box.

Heat and smoke detectors shall have similar bases which shall be push-twist type and fabricated type shall not be acceptable. Detectors and panels shall be compatible. It shall be possible to adjust sensitivity of detectors through area panel or MFAP.

In lead acid battery rooms rate of rise-cum- fixed type heat detectors shall be provided .

Remote response indicators shall be provided for all detectors located above false ceilings in control room. Required work for fixing of the indicator above ceiling shall have to be carried out by the bidder. For detectors to be mounted in existing control room over the false ceiling, bidder to take necessary precautions so that existing facilities shall not be disturbed.

In conveyor galleries infra red (IR) flame detectors shall be provided. Length of conveyor is approximately 110m. It shall have built in cleaning arrangement to facilitate removal of coal dust. In case bidder desires to provide another type of cleaning system then same arrangement shall be described in the bid document. IR detectors shall be ember type suitable to detect moving fire. In each conveyor two detectors shall be provided. Bidder to submit unit rates for any addition/ deletion on above arrangement if required during detailed engineering stage. IR shall have corrosion resistant metal body and sensitivity checking feature. All required interfacing devices for IR detector shall be supplied. IR detectors shall be suitable to work in the event of vibration in any axis.

Detectors shall not foul with ventilation duct and shall not be located near diffuser. Detectors and fire panels shall have UL listing FM approval. Fire alarm panel shall be UL/FM/LPC/TAC approved .

Smoke detectors and heat detectors shall be installed as per latest practices indicated in IS:2189-1988, TAC and NFPA codes. Minimum two numbers of detectors for the smallest premise shall be provided. Coverage area shall conform to IS 2189-1988.Bidder shall select the spacing of detectors considering the air change factor of the ventilation/air conditioning system ,height of room ,beam depth etc. as per IS 2189-1988.

In cable shafts smoke detectors at top of the shaft shall be provided with required fixing arrangement.

Manual Call Points (MCP)

MCP shall be provided at each entry /exit point of electrical room, , emergency exit (to be provided under this package), transformer bay, , Pump Houses, lift in the main building etc. MCP shall be analogue addressable, break glass type connected to its

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location card. Both indoor/outdoor MCP shall have glass cover and removal of glass shall initiate communication to area panel and main fire alarm panel.

Total numbers of call points and their locations shall be finalised during detailed engineering. Travel distance between two consecutive MCP shall not be more than 50 meters. Signal of the MCP shall appear at the Area Panel and Main Fire Alarm panel. At main entry points of buildings and electrical rooms minimum one number Manual Call Point shall be provided. In outdoor areas, MCP shall be suitable for outdoor location with rain canopy and shall be mounted on structure or wall at prominent places. Whenever existing supports are not available, bidder to consider steel structure support arrangement so that MCP shall be located at 1 meter from ground level.

Bidder to calculate the required length of LHS cables and number of interface devices, hooking up arrangement to control/ area panels based on belt lengths, drum location, belt width etc. All required fixing accessories for the items needed as per site conditions shall be included in the scope of bidder.

Area Panel (AP)

Area Panels with alphanumeric mode and LED indication for each zone shall be provided at locations shown in block diagram . APs shall have their own power supply unit and 24 V standby battery. APs shall have facility to display all alarm and fault conditions, status of all detectors of their respective area.

In each area panel one 'NO' contact (indicating operation of any devices or any alarm situation) shall be provided to facilitate monitoring in Plant's DDCMIS system.

Linear Heat Sensing (LHS) Cable

LHS cable shall be provided in cable galleries, along the length of galleries . LHS cables shall be digital type. and Necessary braiding for mechanical strength shall be provided in LHS cables. Support arrangement shall be provided by the bidder to suit site conditions. In LHS cable system bidder to include all interface devices required to hook up to area panel.

Siren /Hooter

Siren shall be mounted on suitable support near chimney (capacity 1 Km range to operate in case of confirmed fire is registered in the main fire alarm panel). Siren shall also be suitable for manual operation. Siren shall have three types of sound; first alarm (or alert), second fire (or emergency) and third clear. Bidder shall furnish details for the above. Siren shall be connected to UPS power supply and all necessary arrangement shall be provided by the bidder for this. Purchaser will provide only one UPS feeder from the DB located in main control room.

Hooter shall be connected in each zone internally as well as externallly. External hooters may be clubbed together w.r.t. common entry/exit point of view for cable areas.

Cables & Cable laying

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Cables used for interconnecting hooters shall be limited to one premise only. All incoming-outgoing power supply cables & inter connecting cables used for the system shall be fire resistance low smoke (FRLS) type 1100 V grade PVC insulated, PVC inner and outer sheathed having 1.5 mm^2 copper conductor conforming to IS:1554 (Pt.-1). Three core cables (keeping one core as spare) shall be used for the detector/ device connection.

Fire cable routing shall be separated from other cables to the extent possible. All switches, cable ending junction boxes, multi-way junction boxes, FRLS connecting cables, panels etc. shall be included to make the system complete in all respect. This shall include wiring/cabling up to Area Annunciation panels. Cables for detection system shall be laid keeping sufficient space from illumination cables. Cable shall be laid as per approved cable routing and cable layout drawings and as per normal plant practice and manufacturer's guideline. Route markers for fire cables shall be separate and distinct from other markers.

Quantities of items

No. of detectors, response indicators, manual call points, isolators, interconnected cables, incoming cables, conduit for laying of cables shall be provided by the bidder as per the requirement to cover all the areas based on approved drawings. Quantities are to be calculated by the bidder and shall be provided to meet all requirements. List of electrical premises has been enclosed, however bidder to ensure coverage of detection network for all electrical rooms of the plant and cable galleries, basement and walkable cable tunnels. Bidder to cover all electrical rooms by Fire Detection System whether same is indicated specifically or not.

Interface Devices

Bidder to include all interface/ hooking up devices for connecting output of LHS cables, alarm points, interlock points etc.

Interlocking with A/C & Ventilation system

There will be interlocks to shut off the exhaust fans and simultaneous tripping of A/C and ventilation system. The fire signal from first detector will operate the audio-visual alarm whereas on confirmation of fire signal from the other detector the ventilation/air conditioning system shall be switched off automatically.

Pressurized ventilation shall be provided for all the electrical premises except control room where air conditioning shall be provided. Appropriate tripping relays and their contacts shall be provided by the bidder for this purpose considering zone wise operation, partitions in cable gallery/ basement and number of fans/ system operating in the electrical rooms.

The air conditioning and ventilation system motors shall be fed from separate MCC/PDB and shall not be fed from process MCCs.

Potential free contacts shall be made available for each zone for tripping of respective ventilation/air conditioning system. Location of above relay module shall be as finalised

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during detailed engineering stage. Bidder to consider all accessories such as cabling/ wiring, contact multiplication etc required to achieve the system requirement.

Contact of auxillary relays shall be made available in relay auxillary panel of the above mentioned places and shall be suitable to wire directly in MCC control circuit.

Provision for Interlocking with Fire Fighting System

Medium Velocity Water Spray (MVWS) envisaged for cable galleries & conveyors. In the event of fire in these premises, the detection system will give signal to **Main Fire Alarm Control Panel** which in turn will actuate the solenoid of the deluge valve concerned. Apart from this, HVWS system which have been envisaged for out-door transformer of capacity more than 10 MVA OR having oil more than 2000 Litre will have provision for annunciation in the FACP. The scope of work of Bidder will also include power supply &cabling to Solenoid valves & taking feed back of pressure switches through cabling. The Bidder will be fully responsible for testing & commissioning of water spraying system with Deluges valves as per specification for providing Fire Hydrant system & water spraying with Deluge valves. All annunciation of the Deluge valves & accessories will come in the Fire Alarm panel along with automatic control.

5.4.23. CCTV

General

The Closed Circuit Video Monitoring (C.C.V.M) system shall be intended for comprehensive round the clock surveillance for control and supervision of technological processes at points which are difficult to be observed directly or which require monitoring from a Remote Control room by operational people.

The proposed location and numbers of CCTV equipment shall be submitted by the bidder along with the offer for review and finalization by the purchaser during detail engineering. Bidder shall be responsible to supply the same as detailed during execution stage, without any implication

The system shall consist of IP cameras (CCD/CMOS type) with fixed/zoom lens, minimum 21" HD colour monitors, water cooling jackets, blower units, wiper & washer unit of the weather proof housings, remote controlled Pan & Tilt units, Receiver Driver units, Network Video recorders, Video management softwares, Networking switches and components, Camera mounting platforms/structures, PC console with control units for complete control of the cameras, Inter connecting Ethernet cables, OFC cables and all other auxiliary equipments, connectors and erection accessories etc. as required for completeness of the system.

System Requirements

The system shall provide clear and sharp picture on monitors in industrial lighting conditions at any point of time of day or night.

The complete CCVM Systems shall work on 240 V single phase AC supply which shall be arranged through UPS power supply. In case, any other voltage required for

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the CCVM system, same shall be arranged by the supplier from the above available source. The CCVM system shall be provided with uninterrupted power supply system for feeding stabilized and continuous power supply to all equipment.

The Control rooms of the CPP shall have Control units installed which will perform all control functions related to the CCVM Systems comprising of IP Cameras, Colour Monitors, Water cooling jacket, blower unit and wiper & washer unit of the weatherproof housing etc.

All the CCTV Cameras shall be connected to NVR through the corresponding Network switches for central monitoring of videos.

Equipment Details

The C.C.V.M. system will comprise of the following.

- IP color cameras (fixed & PTZ type), both Indoor & Outdoor type.
- Remote controlled Pan & Tilt units, as required.
- Network video recorders or Servers
- PC consoles
- Large video monitors
- Interconnecting Ethernet cable, OFC cable and power cables
- Camera mounting platforms / structures.
- Water cooling jackets, complete with wiper and washer units, compressed air arrangement as per requirement
- All other auxiliary equipments, connectors, erection accessories etc. as required.

Camera Mounting Platform:

The camera mounting platform will be suitable for mounting the camera assembly on walls / column / structures as per the actual requirements at site and keeping in view the area to be covered by the individual camera. The mounting will be with adjustable support so as to have flexibility to move the camera assembly as and when required. Wherever necessary, structures / vertical poles to mount the cameras shall be fabricated and supplied by bidder.

Camera Housing

The outdoor camera housing should be weather proof with IP class 65

Water Cooling Jacket For The Camera

At the locations where the ambient temperature is high i.e more than 50 deg C, the protective camera housings will be provided with water cooling jacket to protect the

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camera against high temperature. Cooling water will be supplied to the jacket continuously to cool the camera and keep it fully efficient & operational.

Double walled stainless steel housing will be provided for protection of cameras from high temperature. Back cover of the water cooled housing will be detachable so that the camera can be taken out/installed from the rear for service and inspection. Piping for cooling water and purging air must be suitably protected against high ambient temperature/ radiation heat. The glass panes of the housing will be resistant to influences like quick changes in radiation temperatures.

The cooling jacket will have temperature sensor to monitor the temperature of the camera, a toughened glass front, filter & an annunciator. Whenever the camera temperature crosses the upper threshold limit of the desired temperature there will be audio visual indication in the control room for the attention of operator.

Compressed air and a wiper & washer unit will be installed with the water cooling jacket to keep the front glass of the cooling jacket clean from dust & dirt.

The housing will have enclosure as per IP 65.

Pan and Tilt Unit

The pan and tilt unit will comprise of pan & tilt head and control unit. The pan and tilt head will be remotely controlled from the control unit.

The pan & tilt head will be heavy/ medium duty type, rugged in construction and smooth in operation.

The unit will be suitable for mounting on walls / column / structures / hanging from ceiling as per the site requirements. The unit will have complete freedom of movement throughout the entire pan & tilt scan. The unit will be completely sealed for all weather proof use.

The pan and tilt units will be designed so as to ensure long operational life. The units will employ electric motors with quick reversibility and dynamic braking characteristics, have rugged worm gears assembly to minimize backlash and ensure drift free operation. It will be possible with ease to reposition the cameras field of view at any time. The unit will have manual over ride on the auto mode to enable the operator to choose the area of scan as and when required.

Servers/NVR, CCTV Viewing Station and Switches

Server/NVR, Monitors, Switches shall be kept inside the nearest control room. Enclosures with ventilation fans shall be included for server/NVR and switches.

Servers /Network Video Recorder Hardware & Software

Network video recorder shall receive live video data from all camera sources, store live video in the storage hard disk, playback and control. NVR shall be ONVIF complaint.

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Servers/NVR shall be suitable to meet this specification. The hard disk shall be of size to meet the requirement of minimum 64 cameras at minimum 25fps and D1 resolution, for round the clock surveillance for 30 days..Server/ NVR sizing shall be decided during detail engineering. Servers/NVR should be designed such that the hard disk space is maximum 60% loaded. The Server/NVR shall have space and provision for addition of hard disks for 64 more cameras in future.

Data saving in compressed format in DVD's and facility of retrieving it shall be made possible. The server/ NVR shall have this facility.

The Server/ NVR shall be of state of art and of latest technology. Server/NVR shall have IP connectivity for Building management system (BMS) in future.

Minimum One No.65" monitor for viewing and monitoring of videos shall be provided.

Server

The server shall be latest at the time of supply with following minimum facility
Server shall be modular rack mounted (Resultant speed 2.8GhZ minimum), Intel Xeon processor or better.

Shall have 4MB Cache memory minimum, minimum 8GB RAM memory with provision to expand upto minimum 16 GB.

Shall have minimum 1 parallel port and 4 USB ports and dual gigabit network interface (Ethernet).

Shall have HDD to meet the requirement of this specification.

Shall have CD & DVD Reader / Writer with windows preloaded. This includes licenses also.

Shall have 22" TFT colour monitor with keyboard and mouse.

Network Video Recorder (NVR)

The server/NVR shall contain database of all network connected cameras and their configuration. This shall manage the system database comprising of:

- System configuration
- Camera configurations and setting
- Recording configurations and setting
- Configuration of quad views and settings
- Details of recordings
- Schedules
- Operating security details
- Configuration of surveillance and alarm monitors

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- Configuration of video motion detection
- Communication between cameras and camera server
- Allow alarm/events in security system to initiate recordings
- Report camera failures
- Full audit log all system equipments.

This must be capable of supporting a large amount of disk space for online video storage and access to high capacity archiving mechanisms, for removal of stored video to offline media and vice versa.

The server/NVR shall:

- Manage live videos from cameras
- Transmit live video to operator station
- Receive camera control command from operator station and then send to cameras
- Store live video in hard disk
- Transmit previously stored video to operator station
- Archive and retrieve previously stored video to/from offline media
- Provide video motion detection
- Export the recordings to MPEG format so that it can be viewed using standard tools.

Software Function

All related software, as required to meet the specification shall be preloaded and shall be of licensed version.

The software should be capable of viewing the video of IP cameras installed at various locations, recording and storing of the same in database.

CCTV Viewing Stations / Monitors

The CCTV monitors shall have required numbers of PCs with minimum 32” Colour LED screen of latest configuration having necessary controls.

Minimum 1 No.65 LED Screen display (24x7 operation) shall be provided for viewing and monitoring of cameras or required numbers of 32” LED Monitors, ie. each monitor for viewing maximum of 4 cameras.

Joystick for controlling cameras.

All related software, as required to meet the specification shall be preloaded and shall be licensed copy.

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This shall be suitable for continuous operation (24x7).

The CCTV monitors will be suitable for indoor applications and compatible for the cameras. The PC's shall be compatible with Client software of NVR.

Network Switches

All the cameras and NVR/ Server shall be connected to the L2+ managed switch. All the network switches shall be of high quality & latest model and shall be sized to meet the functional requirement as specified. The location and details of network switches shall be decided during detail engineering and shall be subject to approval of purchaser/consultant

Network Rack

Network Rack of suitable size to place the NVR, network switch and patch panel shall be provided. The rack shall be of wall mount/ floor mount type and provided with required power sockets, cooling fan, cable manager and mounting frames.

The rack shall be made from steel sheet of 1.6mm thick and powder coated. Front shall be glass door with lock and key. Legend plates, cable entries and earthing shall be provided.

Cables

Power Supply Cable:

Brief details are as under:

No of cores -- 3 (Three)

Conductor size -- min 2.5 sq mm, 7/0.68 multi strand with standard annealed electrolytic copper conductor.

Primary insulation -- PVC insulated of 85º C PVC as IS-5831Type C

Thickness of PVC insulation -- 0.8 mm

Color code -- Red, Black and Green

Inner and Outer Jacket -- Extruded Flame retardant and 90º C PVC to IS 5831-Type ST2

Armouring -- Galvanized Steel Wire/flat as per IS-1554 part-I.

Ethernet/Video Cable

Shielded twisted pair, Category 6, 23 SWG solid copper conductor, PE insulated, Outer jacket FRPVC. Suitable for Network of 10/100/1000 mbps Ethernet.

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Optical Fibre Cable

This shall be minimum of 6/12fibre, armoured steel/electrical chromium coated steel (ECCS) tape, HDPE sheath, Strength by steel wire/rod. Operating temperature 0 to 70 degree C.

Optical fibres shall be single mode compliant to ITU-T G652 and fibrecolours shall be as per IEC-600793-2 & IEC600304. Fibres shall be coated with UV cured double acrylic resin.

This shall have moisture barrier of polymer coated Aluminium tape / water swellable tape. Inner sheath shall be HDPE and outer sheath shall be FRLS PVC.

5.4.24. Telecommunication System

General

This Technical Specification covers the technical requirement of IP based Loudspeaker talk back system.

IP based loudspeaker talk back system shall be provided for facilitating reliable two-way intercommunication between various strategic points of the plant complex.

The system shall have requisite number of subscribers provided in various areas of the plant complex for smooth flow of information between process points as per operational and process requirement.

Numbers of Field stations shall be as proposed by the bidder which shall be reviewed and finalized by the purchaser during details engineering stage. Bidder shall be responsible for supplying the same as detailed out during detail engineering stage, without any implication to the purchaser.

The Servers, Master control station, PC, Printers shall be suitably installed in the Control room.

The scope shall also include all required items e.g. erection hardware, sacks, cables, cable trays, conduits, etc. as required, for the proper installation (conforming to IS: 1881, IS:1882) to make the IP based PA system complete and functional in all respects.

System Features

The equipment furnished under this section shall meet the requirement of all applicable codes and standards as applicable.

The system shall be adequately protected from signed and power line noise and meet the Surge Withstand Capability (SWC) requirements of ANSI C37.90 A/IEEE standard 472-1989 or equivalent. Equipment shall be self- protecting against transients in the input AC supply.

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Power Supply Arrangement

The PA system along with all its system components i.e. network switches, servers, media converters, PC stations etc. shall be powered from UPS system. Required power distribution shall be designed by the bidder and supply of same shall be in the scope of bidder.

For call stations & amplifiers, UPS of suitable rating are in the scope of bidder. Tenderer shall also consider local power distribution boxes as required for sub-distribution of supply from UPS to call stations & amplifiers. The location of UPS & power distribution scheme shall be finalized during detail engineering.

System Description & Design and Technical Requirement

The PA system shall be designed as standalone IP based network architecture. The system shall be based on centralized control together with distributed nodes permitting speech broadcasts and pre-recorded messages/ alarm tones etc. The complete system is divided into zones as per process and plant requirement. The PA system shall be designed such that no single failure shall disrupt the availability of complete system. The network switches in PA system shall be connected employing ring topology. Redundant servers shall be provided to cater to all zones of the plant. These shall be interconnected through redundant OFC based network.

The Carrier system shall be based on Voice Over IP, extended to provide IP communication across the complete PA system. The call stations and standalone amplifiers shall be individually IP addressable. Any conversion of the analog field call station to IP mode by separate attachment of the intelligent module/ unit shall not be acceptable. Each call station should be able to selectively call another call station without manual intervention of any other equipment. The design shall be such as to provide highly intelligible full duplex voice communication even in areas of high background noise (up to 110db).

PA System Management Software

Configuration of the system shall be achieved by user Friendly GUI based software for maximum flexibility, easy re-configuration, maintenance & future expansion. This software should be configured on each PC station, which enables an operator to implement speed commissioning and also carry out routine diagnostic cheeks / fault finding functions of PA system components. It should be possible to make adjustments when the system is installed without resulting in modification to the system wiring. It shall be possible to download / store the configuration parameters & scheme from the server without taking the system out of service. Levels of system access and privileges shall be maintained through security passwords etc. The software shall be able to work with the latest windows version. All software utilized shall be latest and upgraded version.

Built in Diagnostic Features

The Bidder shall provide all hardware / software in order to have a comprehensive built in diagnostic test feature covering the complete PA system components including call stations & amplifiers, standalone amplifiers along with associated

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loudspeakers, servers, network components i.e. network switches and interconnecting cables, power supplies etc. so that at all times, the status of the complete system can be monitored . Active fault reporting concerning all aspects of PA system shall be extended to PC Stations which shall record the system malfunction messages with time & date stamp.

Recording functionally for calls to and from master call station in each zone shall be provided. System shall ensure that once recorded, audio cannot be altered.

Communication within A Zone

The PA system shall allow party calls i.e. between one call station to another and also Group/ conference calls i.e. simultaneous conversation amongst multiple call station. Party calls and group/ conference calls shall be in full duplex mode.

Each call station shall be able to broadcast a message to all the associated call stations or selected call stations in a zone. The priority of call mode or broadcast mode or Emergency priority settings shall be configurable for each call station.

Unless requested, announcements / communication within a zone shall not be audible in other zones.

Inter Zone Communication

One indoor desktop mounted call station in control room shall be Master Control Unit. Any inter zone communication shall be possible through this master control unit.

Multiple group or individual calls shall be possible at the same time across multiple zones without interfering with each other.

Call Station

Call stations shall be of the following types:

a) Outdoor Wall/ column mounting type (Type-A)
b) Indoor desk-top mounting type (Type-B)

Each Call station shall have LCD indicator, 10 digit dial pad & 2 special keys, Pre-amplifier & power amplifier, indication for `Power Supply On' and `network Connection Healthy' as a minimum.

The outdoor wall/ column mounting type call station shall be dust-tight and weather proof, with appropriate protection against direct rain, ingress of dust and moisture conforming to IP-65 degree of protection as per IS/IEC:60947-1. Outdoor wall / column mounting type. The indoor desk-top mounting type call station shall have a degree of protection of at least IP-32. All call stations and their components shall be capable of continued satisfactory operation at an ambient temperature at 55 Deg.C
The indoor desk mounting type call station shall preferably be PoE powered and the same shall be IEEE802. compliant.

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Amplifiers

Amplifiers shall be solid state class-D push-pull type, in built with the call station fully conforming to IS: 10426 or equivalent international standard.

Amplifier shall have 0-100% volume control facility for coarse and fine setting, input sensitivity control, Receiver volume control, bass cut filter and Anti-side tone control feature.

Standalone Amplifier

Amplifiers of suitable rating shall be provided for general announcement. Multiple loudspeakers spread across a zone shall be used along with a standalone amplifier. This amplifier shall be IP based and monitoring of the associated loudspeakers shall be provided.

Loudspeakers

Indoor loudspeaker shall be cone type housed in sturdy metal cabinet suitable for wall / column mounting. The mounting bracket shall be treated with acoustic under-coats to prevent resonance. They shall have IP-52 degree of protection as per IS/ IEC: 60947-1.

Outdoor loudspeaker shall be industrial horn type and of pressure die cast aluminum or equivalent industrial grade material construction. The mounting bracket shall be with adjustable base suitable for vertical and horizontal orientation They shall have IP-65 degree of protection as per IS/IEC:60947-1.

Server

Redundant Servers shall be supplied. The server shall be based on state of art technology. The server should support protocols including SIP or equivalent, TCP, IPV4 / IPV6, Codec G722, SNMP, RTP, NTP etc. Suitable built in IP security such a firewall, SSH, HTTPS etc. shall be provided in server. The server should be able to support the required number of call stations with future provision. Required software licenses to be provided accordingly.

The server shall be capable of self-recovery in case of any fault / network break down. It shall be rack mounted type.

The server shall be able to support minimum 4 channels for GSM communication with PA system . Suitable interface for the same shall be considered by the Tenderer. All programming tools & software that are required to program / reprogram the system shall also be provided along with the server.

Master Control Unit

The Master Control Unit shall facilitate inter zone communication amongst different zones. It shall have minimum 40 direct access keys with LED indication, which shall be configured as per requirement, a goose neck type Microphone and a hand receiver unit attached to it.

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Network Switch

All the network switches shall be of high quality & managed type and shall be sized to meet the functional requirement as specified. The location of network switches shall be decided during detail engineering and shall be subject to approval of purchaser/consultant.

Cables and Junction Boxes

The successful tenderer shall supply the all required cables for PA system. All cables of PA system shall be armoured, if unarmored, the same shall necessarily be laid in GI conduits.

Cable shall be FRLS PVC sheathed cables for use in PA system and shall conform to latest edition of Indian standards.

Fiber optic cables are to be provided as per requirement.

Twisted multipart, multistoried with at least one spare pair, minimum 0.5 mm2 cross section, annealed copper (shielded and armoured) shall be provided for loud speakers

5.4.25. Sub-station Automation System (SAS)

For all 33 kV, 11 kV and 6.6 kV substations, Power SCADA HMIs for that Substation will be provided which will act as local SAS.

The switchboard/CRP supplier will provide required network switches, bay control units/bay control protection units (BCU/BCPU) with CT/PT inputs for measuring analog parameter, numerical relays, transformer control unit (as applicable) and lED for interfacing with Power Scada on IEC 61850. One no. of Engineering Work Station and One no. of Operator Work Station shall be considered in GIS control room and also one no. of Operator Work Station shall be considered in central control room of this package. Engineering station with relay parameterisation all well as required software for automatic retrieval of DFR files from relays/BCUs in the local engineering PC will be provided by CRP/Switchboard supplier with required software. The DFR viewing will be done locally as well as centrally from SCADA control room. SAS will be interconnected through suitable ring network (on PRP) with all communicable type numerical relays, multi-function electronic meters, intelligent electronic devices provided for HT boards, transformer RTCC panels (as applicable) for collection of various data/information as well as control as required.

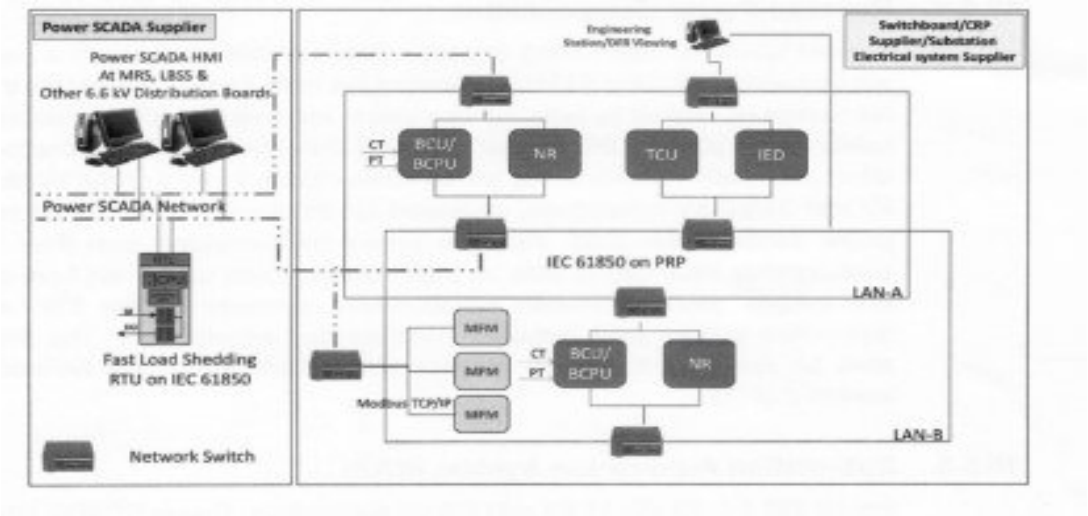
Smart Sensors including online DGA will be considered for large transformers for remote monitoring. BCU will be considered from 33 kV level onwards. Bay control Protection Units (BCPU) will be considered in 11 kV & 6.6 kV level. Separate control and relay panels will be provided for 220 kV and 33 kV switchgears. Separate wall mounted control panels will be provided for controlling 11 kV and 6.6 kV circuit breakers. All numerical relays and IEDs will comply with IEC 61850 communication protocol.

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SAS will also have provision for transmission of relevant data to the power system SCADA for centralized status monitoring, metering, and control functions for the 220 kV, 33 kV, 11 kV and 6.6 kV distribution systems proposed for the plant. all LBSSs and other 6.6 kV distribution switchboards.

Basic concept of interfacing & packing philosophy is indicated in below mentioned drawing.

Figure : Basic Concept of interfacing and Packing Philosophy



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5.4.26. Miscellaneous Electrics

Local Control Station

Near all drives local control stations shall be provided. Local stations shall be made of thermoplastic polycarbonate material, dust and vermin proof, and wall/structure mounting. Push buttons shall be mounted on front hinged gasketted and lockable door. For HT motors, start, stop, and emergency stop push button and for LT motors, open/close/trip or start/stop, as applicable, shall be provided along with Local/Remote Selector switch, ON/OFF indication lamps, ammeter for motor rated 30 kW and above..

Suitable knockouts with glands shall be provided on the bottom or top cover for cable entry. Terminals shall be suitable for 2 cores of 2.5 sq.mm conductors with 20% spare terminals. Stop push button to be lockable type with mushroom head and key to release. Enclosure conforming to IP-54 class for indoor and IP55 with canopy for outdoor. Explosion proof/increased safety type shall be provided in hazardous areas.

All LPB stations shall be made of thermoplastic polycarbonate material with minimum thickness of 2.5 mm. Press to stop and press to release (red colour) shall be provided for all the motors. All LPBS for HT Motors shall be provided with Ammeters.

DC Starter Panel

The starting resistors for the DC motors shall be enclosed in a metal clad naturally ventilated self standing panel(s) with sheet steel material of minimum 2.0 mm thick with degree of protection IP-54. It shall be dust and vermin-proof. The number of resistance steps shall be decided by the bidder depending on application. Alternatively permanently connected resistor is also acceptable.

The resistor elements shall be made of unbreakable, corrosion proof, jointless stainless steal grids or ferro-chrome aluminium alloy. The grids shall be in punched form and suitable for use in tropical climate.

Passive Fire Protection

Passive fire protection is an integral part of a complete fire protection system and is essential for prevention of spread of fire through openings in walls or floors. Passive fire protection measures like Fire Retardant Coating/Painting of cables, Fire barrier / Sealing of Cable Openings, Fire barrier / Sealing of Cable Openings, Partition and fire door etc will be provided.

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Electrical Lab

33kV GIS building shall have electrical lab.and furnished store room with following minimum requisite items/equipment

Test bench (With Incoming source of power-3PH-N 415V AC, conversion to voltage sources viz. 230VAC, 110V AC & 24V AC ; For DC, 220V DC incoming supply shall be made available at Test Bench with further conversion to 24V DC)
1-ph Variac,
3 ph Variac,
5-500V Megger,
5kV Megger
Measuring instruments like multi meter, clamp meter AC/DC, Lux meter, Milliamp meter for CT secondary current, earth tester, Phase sequence tester, HT tester,SF6 gas leak detector, Online SF6 gas analyser,SF6 gas handling/DILO machine, Oil BDV test kit, Hand stacker, Hydraulic pallet truck, Vibration measuring instrument, Thermal Imaging camera, Online PD tester

Furniture like Steel Almirah (5Nos.), Work Tables (4 nos.), Steel Cabinets (4 nos.), High back-rest Modular Chairs (8 nos.), normal office tables (4 nos.) shall be provided. Further, Two Desktop Computers (21" monitor), One B/W LaserJet Printer along with associated tables/cabinets shall be also be provided.

Electrical Lab shall have Air Conditioning system

Erection, Installation Accessories

All support structures required for cables, busducts and for electrical equipment including conduits, inserts, shall be provided to complete the erection job in all respect. Cable tag markers, clamps, sealing compound, pull boxes, marshalling boxes etc. shall be considered as part of the bidders scope.

Other Items

All required safety items like shock treatment chart, first aid boxes, danger boards, boards indicating 'Man on Work, Do not switch ON', 'Do not switch OFF', 'EARTHED' etc. shall be provided in each electrical premises.

PVC floor of suitable voltage grades of 1 Mtr width in front of all the panels like HT switchboards, LT switchboards (PCCs), MCCs, PMCCs, DBs, control panels, etc

Wall mounted aux. AC and DC distribution boards shall be provided in sufficient number to facilitate proper distribution of the power supply to various users.

Industrial type, metal clad welding socket, 240V & 415V power sockets shall be

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provided in sufficient number to facilitate extension of power supply to various machine tools, welding sets etc. in all the areas and floors. In addition to above 24V AC sockets with portable hand lamps shall be provided for maintenance lighting. All cabling for sockets shall be laid in conduit.

Bidder to include closing of all cable and panel openings through a Fire sealing material. This shall include closing of all bottom opening of control room panels, MCC switch boards, wall openings in all the areas, etc. Bidder shall also include earthing of all equipments/system, wherever required, under his scope of supply.

The bidder shall confirm that dummy panels in HT & LT boards if required during detail engineering to avoid beams or for termination of large number of cables shall be provided by them without any extra cost

Welding socket outlets shall be provided at every 60 Mtr distance. The number of welding socket outlet shall be as per requirement and approach. Generally they shall be provided in such a way that using 30 mtr flexible cable with welding set, total plant area can be covered. They shall be fed from separate aux. ACDBs.

Bidder shall include painting of all the plant and equipment with approved shades and include primers as well as finishing paints.

Sufficient quantity of GI ladder type factory fabricated cable trays made from 2.5 mm thick hot welded steel sheets grade ‘o’ as per IS : 2062 shall be provided. Hot dip galvanizing of 85 micron thick as per IS-2629, IS-4759 and IS- 209. Trays shall be of standard length of 3 m with max deflection not exceeding 1/400 of span with sufficient load bearing capacity. Wherever required, hot dip galvanized GI perforated tray shall also be provided.

All cable trays shall be hot dip galvanized GI trays ladder or perforated type as the case may be. Bidder shall also include 900/450 bends of the cable trays at the bends as per actual site requirement.

All the cable supporting structures, racks, trays, etc., and equipment supporting structures shall be galvanized. The thickness of galvanizing shall not be less than 80micron. The spacing between cable supporting structures shall not exceed mm (when laid on trays) on straight run. In addition cable structures shall be provided at all the turning points.

All cable supporting structures including all accessories shall be under scope of the bidder.

All metallic equipment/parts not intend to live shall be painted and appropriately earthed.

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5.4.27. Variable Frequency Drive (VFD)

1.0	Basic design particulars	- IGBT based with sine coded PWM control. - VFD shall communicate to basic automation system on system communication bus. - Suitable for variable torque or constant torque applications. Harmonic control shall be as defined by IEEE 519-1992. - VFD shall be provided with dynamic braking system to avoid DC bus overvoltage during sudden stoppages unless the application is of very low inertia
2.0	Reference Standards	- IEC 146 - IEC 61800- 2, IEC 61800- 3, IEC 61800- 5 - IEC 61508
3.0	Drive controller technology	- Full closed loop flux vector control shall be available for constant torque applications. - Operating the drive with motor disconnected. - Suitable for use on both Constant Torque or Variable Torque. - Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S-curve. - Multiple acceleration and deceleration rates.
4.0	Type of connection	- Three full wave IGBT rectifiers supplied by phase shifted, three phase IGBT to provide a fixed DC voltage. - DC bus inductor on all ratings - DC link capacitors

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		- Insulated Gate Bipolar Transistor (IGBT) power section, shall be rated for variable / constant torque applications. The power section shall use vector dispersal pulsewidth modulated (PWM) IGBT gate control algorithm and soft switching IGBT's to reduce motor terminal dv/dt and allow longer cable length from drive to motor without output filters. - Common control connection for all ratings.
5.0	Overload capacity	- 150% of the rated current for 1 minute overload for constant torque applications .
6.0	Efficiency	More than 97% or better at full speed and full load.
7.0	Input power supply	- As per design basis clause 1.04 to 1.07
8.0	Voltage variation	- Voltage variation of (+/-) 0.1 % with an input variation as per design basis clause 1.06. - Steady state regulation of (+/-) 0.25% guaranteed against 100 to 200 % load disturbance and input supply frequency variation as per design basis clause 1.06. - The drive should be designed to operate on an AC supply, which may contain line notching, and up to 10% harmonic distortion.
9	**Environmental Conditions**	
9.1	Storage ambient temperature range	Upto to 70º C.
9.2	Enclosure class Operating ambient temperature range	- IP42 & above - 0º C to 50º C
9.3	Relative humidity	Upto 97% non-condensing.
9.4	Operating elevation	As per site condition furnished elsewhere in this tender specification
9.5	Shock	As per IEC 61800

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9.6	Vibrations	As per IEC 61800
10	**Reference**	
10.1	Input reference voltage	0 +/- 10 V DC / 0 – 10 V DC / 4 – 20 mA .
10.2	Reference signals	The drive should be capable of the following speed reference signals • Digital MOP • Jog • HMI (Program/Control panel) • Analog Input signals • Preset Speeds • Communication module commands
10.3	Loss of reference	The drive should be capable of sensing the reference loss conditions . In the event of loss of an analog input reference signal, the drive should be user programmable to the following • Fault the drive • Alarm and maintain last reference • Alarm and go to preset speed • Alarm and go to minimum speed • Alarm and go to maximum speed • Alarm and maintain last output frequency Signal loss detection should be available regardless of the function of the analog input.
11	**Output**	

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11.1	Output voltage	From 0 to rated motor voltage.
11.2	Output frequency	0.5 - 400 Hz.
11.3	Output Waveform	The inverter section should produce a pulse width modulated (PWM) waveform using latest generation IGBT.
11.4	Output frequency resolution	0.01 Hz.
12.0	Reflected wave	Maximum of 2.25 times the bus voltage or 1600V, whichever is less, up to cable lengths of 200 metres.
13.0	Starting torque	150 % / 1 Hz. (without PG) 150 % / 0 RPM (with PG)
14.0	Torque accuracy	+ / - 5 %.
15.0	Speed control accuracy	+ / - 0.02 %, 0.1% without encoder. IR compensation to be provided for drive without PG.
16.0	Ramp rate	- Linear acceleration and deceleration adjustable independently from 0 to 3600 seconds. - Provision of remotely selectable Accel / Decel settings should be accessible through digital inputs also.
17.0	Main power components in incoming AC side	- ACB / MCCB with 50 KA rating. ACB to be considered in case rating is more than 630A. MCCB to be considered in case rating is 630A or less. - Matching input isolation transformer/ line reactor for harmonic and noise suppression. For input isolation transformer, the K factor shall be 4.0 or less. - AC line surge suppression network. - Input contactor.
18.0	Converter –Inverter	- IGBT bridge for AC/DC.

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	Equipment	- DC link circuit with reactor/capacitor. - IGBT bridge for Inverter for DC/AC. - Input isolation transformer / line reactor. - Input harmonic filter. - Main PLC to take care of interlocking and sequencing etc.
19.0	Load side components	- Filter network (du/dt filter or sine filter or Line reactor based on the requirement). - Over-load relay for each motor (in case of group drive). - Line contactors in input &output side (as per application requirement. - Output reactor / terminator (if required).
20.0	Terminal blocks	- Separate for control and power wiring. - Power terminal blocks marked for both inputs and outputs . - Ferrule numbers of control wires shall be same as TB numbers - 20% spare terminals shall be provided
21.0	By-pass Arrangement	Wherever VFD is provided for drives of 415 V motors where normal operation is possible on rated frequency of 50 Hz or where speed control is not a process requirement DOL By-pass arrangement with selector switch shall be provided.
22.0	Input / Outputs	- **Hard-Wired I/O** **Hardwired I/O should be provided via separate I/O cards** - **Standard I/O Card**

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		The "Standard I/O board should consist of both digital and analog I/O. It should be available in two versions; one for 115/240 VAC digital I/O and one for 24V AC/DC digital I/O. - **Analog I/O** • **Differentially isolated ±10V (bi-polar) / 4-20Ma analog inputs .** - **Digital Outputs** • **Relay outputs – Minimum 02 nos.** • **Contact output ratings should be 240V AC / 24V DC,Maximum 2.0 Amp**
23.0	Protective features	- AC line surge suppression network and over voltage protection. - Under voltage in supply network. - Phase sequence protection and monitoring. - Under voltage in DC bus. - Over voltage in DC bus. - Over speed protection in the event that the output frequency exceeds the maximum reference by a specified amount. - Over load - Earth fault - Instantaneous over current - Transformer fault ,If applicable - Cooling fan failure - Stall monitor for motor alarms - Controlled shut down, when properly fused, with no

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		component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.
24.0	Annunciations	All type of faults shall be annunciated in Control Panel of the drive which shall be provided and mounted on Panel front door. The faults listed below shall be displayed as far possible. - AC line surge suppression network and overvoltage protection . - Under voltage in supply network - Phase sequence protection and monitoring - Under voltage in DC bus - Over voltage in DC bus - Over speed monitor - Over load - Earth fault - Instantaneous over current - Transformer fault ,If applicable - Cooling fan failure – Stall monitor for motor alarms - Motor fault (winding / bearing temperature, vibration) as applicable - Loss of frequency command - Shall be able to store at least 16 previous faults in memory on FIFO sequence .
25.0	Meters	- Input Volt meter with selector switches shall be provided and mounted on Panel door. Separate meters with SS shall be provided for following

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		incase it is not available with control panel of VFD - Input current - Output voltage & Current - Output frequency (digital display) - KW meter for drive ratings above 200 KW.
26	**Other features**	
26.1	Bus Regulation	DC Bus regulation should be available to reduce the possibility of drive overvoltage trips due to regenerative conditions.
26.2	Current Limit	Programmable current limit from 1 amps to 150% of drive rated amps. Current limit to be active for all drive states; accelerating, constant speed and decelerating.
26.3	Dynamic Braking	The drive shall have an internal, built in 7th IGBT for use as a dynamic braking chopper. This IGBT shall have enough capacity to handle greater than or equal to 100% regeneration power from the output, continuously. The drive shall also have a "drive mounted" dynamic braking resistor for low level braking applications and interactive software to protect the "internally" mounted resistor from abuse.
27.0	Selector switches	Numbers of selector switches shall be provided as per control requirement during design stage considering control philosophy. All the selector switches shall be of 10 A rating .
28.0	Pushbuttons	- Trip reset . - Start if required as per control philosophy - Emergency stop.
29.0	Lamps	Following minimum indication lamps shall be provided - R, Y, B phase power ON

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		- Drive ready. - Drive trip . - Drive/Motor Run, OFF. - Control supply ON . All the lamps shall be of cluster LED type
30.0	Regulation & control facilities	- Reference speed setter - Ramp generator - Speed feed back - Current feed back - Trigger module - Pulse transformers - Logic control module - Sequence module - PID control - Zero speed/ over speed monitor as applicable. - Momentary power loss restart. - Auto tuning. - Current limiter. - Skip Frequency. - Counter current/ regenerative braking unit as applicable. - Active electronic components used shall be of industrial grade hermetically sealed. - Output signals for fault alarm, frequency arrival,

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		running signal.
31.0	Communication Bus	ModBus/ProfiBus-DP/DeviceNet/Ethernet/ Profinet
32.0	Operator panel	Shall be mounted on the front door of the unit. - All adjustments to be made with the door closed. - Status and Power LEDs viewable through the cover.
33.0	Membrane keypad	- The keypad shall be logically designed for two operating areas with required number of keys. - Local operator control like - local start /stop, - jog forward / reverse. - Programming.
34.0	LCD display	- Display shall be black lighted, enabling viewing in extremes of lighting conditions - Display shall be in alphanumeric (in English only) - All the faults stored in memory shall be displayed by scrolling .
35.0	Construction features	- Floor mounted, free standing - Dust and vermin proof - Sheet steel clad - Minimum 2.0 mm thick for panels. - Minimum 2.0 mm thick for doors and side covers. - Suitable to withstand vibrations to be encountered in steel plant application. - Cubicles with illumination lamps, door switches, space heaters and adequate sockets for soldering.

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		- All control blocks plug–in-type with necessary test sockets. - Units shall be self contained and serviceable.
36.0	Ventilation	- Units shall be provided with cooling fans and louvers at the bottom sides. All louvers shall have fine mesh behind them. - Ventilation through individual ventilation ducts from bottom not acceptable.

5.5. Erection of Electrical Equipment

Bidder shall include erection of all the equipments under his scope of supply.

Bidder shall ensure that Erection of equipment shall have to be carried out as follows;

1. Procedure mentioned in bidder's/OEM's manual
2. Under the expert supervision of the bidder
3. Erection shall be as per prevailing statutory norms and regulations
4. Sequence and plan of erection as per the guidance of purchaser's Site Incharge or their consultant
5. During erection of supplier's equipment, existing equipment /system shall not be disturbed.
6. Erection shall be in accordance with approved layout drawing and installation details.
7. Cable laying shall be as per approved cable layout drawings and work shall be carried out in a neat manner.

All erection-installation accessories required for erection/installation of equipment and handling equipment required for handling of equipment from store to installation site are included in the scope of work of the bidder as a whole.

5.6. Inspection and Testing

Inspection

Extent of inspection

The extent of inspection & testing by the Purchaser shall vary from equipment to equipment as per design requirements. For details of inspection and inspection category, bidder shall refer to separate chapter

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However, indicative extent of inspection for electrical equipment is furnished below.
It shall be an obligation to get all electrical inspection and any modifications if necessary will be taken care of by them without any extra cost to purchaser.
Extent of inspection to be carried out shall be finalised with the Bidder after award of the contract on the basis of scope of supply, technical specification and approved GA drawings. However, in case of similar bulk manufactured items, methods of sampling for inspection of different lots shall be governed by relevant Indian or international standards.
In case of critical components, the Purchaser reserves the right to undertake 100% inspection.
The inspection shall be carried out on the basis of QAP dully approved by purchaser / consultant.

Testing

General

Test of all equipment shall be conducted as per latest BIS. Wherever no such standard exists, tests shall be as per International Standards like IEC/DIN/BS/IEEL/JIS, etc.
All routine tests shall be carried out at manufacturer's works in presence of purchaser or his representative.

The bidder shall submit type test certificates (not more than 5 years old) for similar equipment supplied by him elsewhere. In case type test certificates for similar equipment is not available, the same shall be conducted in presence of purchaser or his representative, without any financial implications to purchaser. Heat run test shall be conducted in one of each type of HT motor, dry type transformer and 6.6KV panel at works.

The type test and routine tests on the generators shall be as per prevailing standards and as per manufacturer’s guidelines. However, purchaser reserves the right to witness all or any of the tests.

5.7. List of Specification Drawings

MEC/11/ E1/M/0033/CPP1/01, Rev. 01 : SLD FOR CPP

**** End of Clauses ****

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6. CONTROL, INSTRUMENTATION & AUTOMATION

6.1. General

This specification is intended to define the requirements of Control and Instrumentation equipment for the Captive Power Plant (CPP) & its auxiliaries and associated Balance of Plant (BOP) packages of SAIL-ISP's 4.08 MTPA expansion. Broadly the Control and Instrumentation for the following major equipment/facilities are covered in this package:-

- 03 nos. of mixed fuel fired Steam Generator (SG) along with its associated auxiliaries.
- 03 nos. of Steam Turbine Generators (TG) along with associated auxiliaries
- 03 nos. of Steam Turbine driven blowers (TB) along with associated auxiliaries
- All other common auxiliaries of the above-mentioned technological equipment
- BOP packages associated with the CPP i.e. ACW system, CW system, Compressed Air Station and DM Plant.

The basic philosophy of Control and Instrumentation (C&I) system shall be based on Digital Distributed Control, Monitoring and Information System (DDCMIS) with 4-20 mA unified current signal with superimposed digital HART signal. The C&I system shall ensure safe, efficient and smooth operation of the plant and equipment with minimum intervention of the operating personnel during normal operation, start-up, load fluctuation and shut down of the units.

This specification shall be the main guiding document for finalization of instrumentation & control system item specification for the CPP & its auxiliaries and associated BOP Packages. Purchaser and Consultant may decide to waive requirements which are deemed non-essential and incidental in nature at their sole discretion.

6.1.1 Design Criteria

i. Instrumentation & control equipment shall comply with the latest Indian Electricity Rules, along with their latest amendments regarding safety, grounding and other required stipulations specified therein for installation and operation of electrical systems in the plants.

ii. Instrumentation & control equipment shall conform to the safety requirements stipulated in relevant BIS eg. IS 9858:1981(R2020) for Safety requirements of electronic measuring apparatus / IEC 61508:2010 for Functional Safety of Electrical / Electronic / Programmable Electronic safety related system, IS 616:2017(reaffirmed 2023) / IEC 60065:2014 for Audio, Video and similar electronic apparatus Safety requirements, IS/IEC 60079:2023 for Electrical Apparatus for Explosives Gas Atmosphere, etc. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 61000-4:2024 and shall be immune to RFI and EMI radiation caused by Hand held Radios/ Radio stations/ Hands free systems/ mobile phones used in wireless communication system. Wherever equipment in compliance to the above standards shall not available, for those cases equivalent IEEE, ISA, NEMA or other Internationally accepted standards shall be followed, as applicable.

iii. All solid state equipment, power supply to electronic cards, power supply to controllers, PLC panels, DDCMIS panels, control panels, SMPS power supply, UPS, battery chargers, Master clock system, Plant Communication system, any other microprocessor/electronic control system, Relay based control panels, etc. shall have external surge protection device with Plugability and life indication as per IEC 61643.

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iv. All solid-state equipment shall be able to withstand the noise, transients and surges inherent in a power plant area. The equipment shall be designed to successfully withstand without any damage to system components and/or wiring, as defined in IEEE C37.90.1-2002, "IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electronic Power Apparatus". External Surge Protection devices (SPD) shall be provided by bidder as per recommendation specified in IEEE 1100-2005, “IEEE recommended practice for Powering and Grounding Electronic Equipment”.

v. All the DDCMIS panels, PLC panels, RIO panels, etc. shall be provided with Type-2 Surge Protection Device.

vi. SPDs shall be provided for all analog signals from field to withstand a surge current of 20kA (8/20 µs).

vii. For communication lines i.e LAN, Ethernet, communication bus, serial communication systems, RS-485, MODBUS etc. surge protection device to withstand a surge current of 20kA (8/20 µs) shall be provided.

viii. All the surge protection system shall be pluggable and capable of onsite testing.

ix. All electronic modules or cards shall withstand overvoltage upto 500V DC (common mode) even though these modules may be designed to operate at lower voltage levels such as 24V DC.

x. All the electronic modules or cards shall be provided with reverse polarity protection.

xi. The instrumentation and control equipment offered by the bidder shall be tropicalised. All instruments shall be suitable for outdoor installation considering the local climatic condition at site indicated elsewhere in this document.

xii. All SMART transmitters shall be based on HART 7 (min.) platform. Signals from all the HART based instruments shall be connected with HART enabled I/O cards of DDCMIS.

xiii. All the SADC dampers and drives with hydraulic coupling shall be provided with SMART positioners.

xiv. Remote operation facility for Goggle valves from DDCMIS shall be provided.

xv. All the temperature elements shall be wired to the DDCMIS through temperature transmitters. No direct wiring of the temperature elements shall be accepted, except for motor winding temperature measurements.

xvi. Head mounted temperature transmitters are not acceptable.

xvii. Specially designed draft pressure/DP transmitters shall be provided for draft range pressure or very low (less than 300mmWC) static pressure or DP measurement.

xviii. Venturi meter or Coriolis flow meters shall be used for fuel gas flow measurements as per clause no. 6.3. Each venturi meter shall be provided with 1” piezo rings for Flow (DP) measurement. Bidder shall note that pitot tubes for fuel gas flow measurements shall not be accepted.

xix. All the instrument tappings for BF Gas and Coke Oven Gas application shall be of 1” size.

xx. Ultrasonic and displacer type level transmitters are not acceptable. Instead, the bidder shall offer Non-contact Radar/Guided wave Radar level transmitters.

xxi. All flow measurements in gaseous state or gaseous fluid shall be provided with pressure and temperature compensation.

xxii. Flow measurement (with pressure and temperature compensation) of all the utilities with totalisation shall be carried out at the TOP for DM water, Nitrogen, instrument air, service air, potable water, service water, fuel gases and any other utility.

xxiii. Magnetic flow meter & other inline flow meters for line size up to 400 NB must be provided with isolation valves & bypass valve & line arrangement for sensor replacement and maintenance.

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xxiv. Non-contact type level measurement shall be provided for acid applications.

xxv. All the control valves shall be provided with isolation valves and motor operated bypass valves.

xxvi. Online ambient hazardous gas monitors shall be hooked up to the DDCMIS.

xxvii. Redundant field instruments shall be connected to separate/independent tapping points. Also, it may be noted that no two instruments shall share the same tapping point.

xxviii. Generally, for alarm and interlocking purpose, transmitters/flow meters shall be used for generating contacts from the DDCMIS instead of pressure/flow/level/temperature switches. However, contacts/signals related to unit trip or equipment protection shall necessarily be generated from triple redundant conventional type process actuated switches only and one transmitter shall also be provided for monitoring the process parameters along with the triple redundant process actuated switches. Any other process actuated switches if provided shall be electronic type with digital (LED) display and keypad for configuration.

xxix. The interrogation voltage for all field switches (pressure switch, level switch, flow switches, etc.) shall be 24V DC with dedicated isolation, including the ones directly wired to the MCC.

xxx. Intrinsically safe instruments along with safety barriers (for all analog & digital field signals) shall be provided for hazardous area applications, as well as for all lube oil applications, all fuel gas applications and in furnace area irrespective of area classification. Explosion proof instruments are not envisaged for this package. However, incase of non-availability of a specific type of intrinsically safe instrument bidder may provide explosion proof instrument. All the instruments shall have statutory approvals (i.e. CCOE, PESO etc.) as per prevailing regulations in India.

xxxi. Both indoor and outdoor mounted remote indicating instruments i.e. transmitters, analysers (field mounted) and process actuated switches shall be provided with weather protection cabinets/boxes (closed type with 360^{o} protection) of SS material with lock and key arrangement. Alternatively, the instruments can also be placed in Local Instrument Enclosures (LIE). ***Open type transmitter canopies, boxes or Local Instrument Racks (LIR) are not acceptable.***

xxxii. Gasket (asbestos free) material for instrumentation equipment shall be suitable to withstand physical and chemical properties of process fluid. Gaskets used shall be spiral wound type only with suitable non asbestos filler material as per ANSI B16.20. All spiral wound gaskets shall be provided with SS centering ring. Spiral wound gasket shall be self-aligning type. Min. gasket thickness shall be 3mm for line size up to 24", 4.5mm for line size >24"<40", 6.5mm for line size >40". Compressed asbestos fibre (CAF) gaskets shall not be used.

xxxiii. All flanged type instruments and control valves shall be provided with matching flanges, nuts, studs/bolts & gaskets, expander/ reducer (if reqd.). For instruments, matching flange material shall be similar to the process piping material. For control valves and flow elements matching flange shall be in line with the body material and process piping respectively.

xxxiv. MOC for field junction boxes for all areas except DM Plant shall be SS (the sheet thickness shall be 1.5mm or more). Doors shall be hinged type, lockable/latch and ingress protection class shall be IP-65 or better. Unused cable entries shall be plugged using SS plugs. Each junction box shall be provided with 20% spare terminal blocks. Explosionproof junction boxes (CCOE certified) shall be provided for the field termination of cables from explosionproof instruments. FRP or GRP junction boxes with IP-65 protection class shall be used in DM Plant area.

xxxv. SS or nickel plated brass weatherproof double compression cable glands shall be used for

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all applications. For ex-proof instruments and junction boxes in hazardous area applications, explosion proof cable glands and plugs (CCOE certified) shall be provided. All the cable glands shall be provided with PVC hoods to prevent water ingress into the electronics compartment of the instrument/analyser.

xxxvi. Only pair/triad, screened, armoured type cable shall be considered for all analog & digital signals. Multi-core cables shall not be used for the same.

xxxvii. Cables shall be run in GI perforated cables trays or conduits. Dedicated cable trays shall be provided for power, control and signal cables. Field joints for cables used for instrumentation application shall not be acceptable.

xxxviii. All field instruments to be 24VDC powered with fused TB in marshalling rack along with LED for fuse blow indication.

xxxix. All the instruments shall be supplied with calibration certificates. The instruments shall also be calibrated at site before erection.

xl. Stainless steel tag plate shall be provided for all the instruments, which shall include the details like tag no., make, model no., span, calibrated range, connection size, rating & standard for flanged type end connection, etc. as per the approved datasheet. All the tag plate should have item specific QR code, which shall be used for asset management and tracking. For implementation of the same 02 nos. of tablet or laptop with 02 nos. of QR code scanner with preloaded Application Programming Interface (API) software shall be provided for fetching entire details like approved data sheet, calibration details, GA drg. etc. On scanning QR code of any instrumentation and automation equipment, end user should be able to get all the supplemental information related to that equipment. Direct reading instruments or local gauges shall also have the instrument tag no. printed on the dial.

xli. For vibration prone areas inert gas filled type temperature gauges with capillary extension shall be provided. Capillary tubing MOC shall be flexible SS316 with flexible SS armouring with PVC sheath.

xlii. For pressure gauges mounted at the outlet of pumps or in pulsating services, snubbers or pulsation dampeners shall be provided. Alternatively, liquid filled gauges are also acceptable for vibration prone areas, pulsating or fluctuating services.

xliii. For machine mounted or skid mounted applications, instruments (gauges) less the 150mm dial size are also acceptable.

xliv. Only cold bending of impulse pipes shall be followed. Hot bending is not allowed.

xlv. Instrumentation cable drain wire shall be terminated at control panel end only.

xlvi. All the cables shall be identified using ferrules (cross ferruling) and termination shall be done using lugs only.

xlvii. All the cables for instrumentation use shall be provided with aluminum cable tags.

xlviii. All transmitters (PT, DPT, FT, LT, TT, etc.), flow meters, smart positioners, liquid/gas analyzers electronics shall be protected against transients induced by lightning and power supply surges irrespective of their mounting location i.e. indoor or outdoor. Transient protection shall be external type (to be connected in the terminal block).

xlix. Transmitters/electronics with 2” mounting shall be provided in general. All the mounting accessories/brackets shall be provided with the instrument and MOC of the mounting accessories shall be SS.

l. Provision for steam purging and nitrogen purging (and cooling) facility shall be provided for BF gas line and coke oven gas line instruments. Steam and nitrogen piping and alignment shall be planned accordingly.

li. MOC bolts and nuts shall be ASTM A193/A193M-24 Gr. B7 and ASTM A194/A194M-24 Gr. 2H respectively.

lii. Use / supply of any equipment containing mercury or other toxic substances should be

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avoided.

liii. Ten years of spare availability shall be ensured for all control and instrumentation equipment from the date of approval of the drawing/documents.

6.2. Scope of Supply and Works

Bidder's scope of work and supply shall include design, engineering, manufacture/ procurement, assembly, factory calibration, factory testing, inspection at works, painting, packing, transportation to site including loading, unloading, storage & handling of all instrumentation & control equipment including electrical accessories, cables, pipes, erection accessories, panels/ cabinets and all associated hardware, as required for completeness of control and instrumentation system in all respect along with calibration, erection, interconnection, testing & commissioning of the entire control and instrumentation system to ensure satisfactory & stable operation of CPP & its auxiliaries and associated BOP packages as per intent and requirement of this TS.

The scope of work shall also include liquidation of defect points, participation in tests for establishment of plant performance guarantee (PG) and post commissioning activities till issue of final acceptance certificate (FAC) as detailed elsewhere in this TS.

All the indigenous instrumentation & automation equipment shall be supplied brand new & from the product ranges of manufacturers as per the List of Acceptable Makes, furnished in this Tender document. For all imported items, make approval is not required. However, provision of Indian channel partner/representative with capability to supply/support of spares is mandatory and details shall be furnished during detailed engineering.

6.2.1. Scope of Supply

Control and Instrumentation equipment offered shall be complete in all respect and any equipment / accessories not explicitly indicated in this specification, but considered essential for proper functioning of equipment and process shall be included in the Bidder's scope of supply. The brief scope of supply shall include but not limited to the following:-

i. Digital Distributed Control, Monitoring and Information System (DDCMIS) for the entire Captive Power Plant and BOP packages associated with the CPP (i.e. ACW system, CW system, Compressed Air Station and DM Plant) as per clause no. 6.10 and DDCMIS Configuration Drawing no. MEC/11/E5/M/0033/TS/27/101.
ii. Mosaic based mimic cum hardwired annunciation and control panel for emergency operation of major technological equipment and critical drives of CPP.
iii. All types of field instruments, control valves, flow elements, process analysers, etc. for Captive Power Plant and BOP packages associated with CPP as per clause no. 6.9.
iv. Dedicated flame scanners for each type of flame at each corner of every elevation
v. Artificial Intelligence based Condition Based Monitoring System (CBMS) for Steam Turbine Generator and Steam Turbine driven Blowers along with Analysis and Diagnostics (A&D) Software.
vi. Vibration Monitoring System (VMS) for all HT drives.
vii. Steam and Water Analysis System (SWAS)
viii. Continuous Emission Monitoring System (CEMS) for each Steam Generator
ix. Online ambient hazardous gas (carbon monoxide gas, BF gas, propane, LPG and methane) monitors (min. 25 nos.) with 02 sets of calibration kits. Additionally, the bidder shall also provide 20 sets of portable ambient hazardous (LEL) gas monitors.

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x. Furnace and flame viewing system for each Steam Generator

xi. Online Early Tube Leak Detection System with Portable Sensor Calibrator for each Steam Generator.

xii. All the software (latest) including antivirus application required for C&I equipment under this package. All the software shall be provided with project specific perpetual license (irrevocable) and lifetime updates, machine specific software licenses are not acceptable.

xiii. Fully wired cabinets/panels, junction boxes, transmitter cabinets (LIE), etc. for all the instrumentation & control equipment under bidder's scope of supply. Suitable panels for the analyzer systems; electronics units of the level transmitters and transmitter cabinets/ junction boxes for the transmitters; etc., shall be provided and suitably located at the field/rooms.

xiv. All types of instrumentation cables i.e. signal cables, control cables, power cables for instrumentation system, communication cable, all types of prefabricated cables and all other special cables. Alongwith, cables all required connectors, convertors, adaptors etc. shall also be provided.

xv. All electrical accessories for instrumentation system including UPS and other instrument power supply equipment. Bidder shall also provide UPS and utility power supply to BF Automation RIO panel (01 no.) and TRT OWS to be placed in the CPP CCR.

xvi. Earthing system (as per IS 3043:2018) for the control and instrumentation equipment. Separate power and electronic earthing with dedicated earthing pits shall be provided for the C&I equipment. The earthing system for the C&I equipment shall be designed by the bidder and all the material for the same shall be supplied by the bidder.

xvii. Supply of all erection materials/hardware required for mounting field instruments i.e impulse pipes and tubes, fasteners, fittings, cable trays, junction box, pull-boxes, transmitter boxes/LIE, cable glands (double compression type), structural supports and stands, conduits etc.

xviii. Distribution of instrument quality air, N_2 and purge/cooling air/ N_2/Steam as required shall be in Bidder's scope. Necessary equipment & accessories required for the same shall be supplied by Bidder.

xix. Instrument grade air/Nitrogen shall be used for pneumatic instruments, for purging/cooling of instruments, etc. Two air driers (one for each area) shall be provided for instrument air at CPP area and at DM plant area along with condensate monitor (with switching output, which shall be interfaced with automation system). There shall be auto-change-over facility for change of media (Instrument air/ N2), in case of pressure drops below preset value of primary media and revert to primary media, whenever the pressure of primary media shall reach a preset value. Two nos. of (one for each area) buffer tanks shall be provided for storage of dry Instrument grade air with drain facility with a storage capacity designed for 30 minutes back-up of instrument air for operation of the pneumatically operated valves & other equipment of CPP area and DM plant area.

xx. 02 nos. of laptops or tablets with 02 nos. of QR code readers with preloaded Application Programming Interface (API) software.

xxi. Maintenance and Calibration Equipment for **C&I Laboratory** as per clause no. 6.8 and 6.11 of the TS.

xxii. Furniture for Central Control Room (CPP), DM Plant Control Room, SWAS Rooms (CPP and DM Plant), CEMS Room and C&I Laboratory. Each workstation/PC/Server and printer shall be supplied along with 01 workstation/printer console (desk). Also, 01 no. of modular chair shall be provided with each workstation/PC/Server.

xxiii. Furniture for Executive Room and Shift Room in power house building. Modular chairs and office tables shall be considered for 04 persons in executive room. 12 modular chairs and 04 office tables shall be provided for the executive room.

xxiv. 01 set of modular chair and table shall be provided for C&I Incharge room.

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xxv. All the required commissioning spares and consumables shall be supplied on 'AS REQUIRED' basis. All the consumable shall be supplied upto the commissioning of the CPP & its auxiliaries and associated BOP packages. The delivery of the consumables with shelf life shall be deferred till the testing and commissioning of the equipment/analyser.

xxvi. Central Control Room (CPP), DM Plant Control room, Engineering/Server room, Control Equipment Room and RIO Rooms shall be provided with ambient temperature and humidity monitoring sensors with interfacing to DDCMIS.

xxvii. Bidder shall arrange all necessary tools, tackles, testing & calibration instruments or any other special instrument/equipment along with experienced personnel for undertaking calibration, erection, testing and commissioning of all the control and instrumentation equipment.

xxviii. Bidder shall arrange all necessary tools, tackles, field instruments or any other special equipment/instrument required for PG test, on returnable basis.

xxix. Any other Control & Instrumentation equipment considered necessary for the safe, efficient, reliable and desired operation of the CPP and associated BOP packages during the detailed engineering and commissioning shall be supplied by the successful bidder even though the same may not be explicitly mentioned in this specification without any additional cost implication to the Purchaser.

6.2.2. Scope of Works

The scope of **work** shall include but not limited to the following:-

i. Design and engineering of the entire C&I system for this package to meet the intent and requirement of this technical specification.

ii. Arrangement of inspection by the bidder and joint participation in inspection of Instrumentation & control equipment by the OEM, bidder and Purchaser/ Consultant. Inspection and Testing shall be carried out in compliance with the Quality Assurance Plans, to be approved during detailed engineering stage.

iii. Erection of all the bidder supplied C&I equipment.

iv. Erection of all structural stands/supports, wall mounted brackets etc. for mounting the bidder supplied C&I equipment. The scope of work shall also include all civil work like chipping, digging, concreting, including filling material etc., and associated erection of instrumentation equipment.

v. Calibration, testing and commissioning of all the Control & Instrumentation equipment supplied by the bidder.

vi. Maintenance platforms and access ladders for instrumentation equipment installed at inaccessible heights.

vii. Arranging services of OEM specialists, experts or associates for erection, testing and commissioning of the C&I equipment, if felt necessary by the Purchaser.

viii. Design, engineering, preparation, uploading & downloading on *Digital Project Management Solution (DPMS) of SAIL-ISP*, approval (by Purchaser or representative of Purchaser) and distribution of all the Basic Engineering (BE), Detailed Engineering (DE) and Construction Drawings/Documents/Datasheets including O&M manuals for the C&I equipment supplied by the bidder.

ix. List of Two years maintenance spares, including brief specification, make, model no., part no., etc. shall be submitted by the successful bidder after approval of all instrumentation and control equipment.

x. Participation in the engineering review meetings, interface meeting and coordination meetings with the Purchaser/Consultant and other related package contractor of SAIL-

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ISP i.e blast furnace, CPP civil & structural contractor, IPPL etc.

xi. Quality assurance checks for the C&I equipment at various stages of design, engineering, manufacturing, fabrication, assembly, erection, interconnection, testing and commissioning. All the shop tests and site tests shall be carried out according approved Quality Assurance Plan (QAP) and Field Quality Plan (FQP).

xii. Guarantees for all the C&I equipment supplied under this package as per SBD.

xiii. Training of Purchaser's personnel as per clause no. 2.28 of this TS.

6.3. List of Measurements and Controls

6.3.1. Major Control Loops of CPP

i. SG-C&I DDCMIS

a) Combustion Control
b) Fuel Gas Pressure and Flow Control
c) Secondary Air Damper Control
d) Soot Blower Control
e) PRDS Control

ii. TG-C&I DDCMIS (Applicable for Blower drive Turbine also)

a) Digital Electro-hydraulic Turbine Governing Control
b) Turbine Extraction Control
c) Gland Sealing Steam Pressure and Temperature Control
d) Ejector Steam Pressure Control.
e) Exhaust Hood Temperature Control
f) Turbine Bypass HP Steam Dumping Control (Dumping PRDS)
g) Condenser Pressure Control

iii. TB-C&I DDCMIS

a) Anti-surge Control
b) Load Sharing Control
c) Stove changeover control
d) Cold blast pressure and flow control
e) Digital Electro-hydraulic Turbine Governing Control
f) Turbine Extraction Control
g) Gland Sealing Steam Pressure and Temperature Control
h) Ejector Steam Pressure Control.
i) Exhaust Hood Temperature Control
j) Turbine Bypass HP Steam Dumping Control (Dumping PRDS)
k) Condenser Pressure Control

iv. Station-C&I DDCMIS

a) Coordinated Master Pressure Control
b) Furnace Draft Control
c) Boiler Drum Level Control
d) Super-heater Steam Pressure Control
e) Feedwater Flow Control
f) Condenser Hot-well Level Control
g) CEP minimum Recirculation Control
h) Deaerator Level and Pressure Control
i) Boiler Feed Pump Minimum Recirculation Control

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j) Air Pre-heater Cold End Temperature Control
k) HPH Level Control
l) LPH Level Control
m) Blow-down Tank Level Control

v. Balance of Plant Packages

a) DM Plant Control
b) CW System Control
c) ACW System Control
d) CAS System Control

6.3.2. Steam Generator (Boiler)

i. Water and Steam Circuit (DDCMIS List of measurements and controls)

a) Superheated steam flow measurement (and recording) with pressure and temperature compensation at the outlet of each boiler.
b) Superheated steam pressure measurement (and recording) and temperature measurement (and recording) at the outlet of each boiler.
c) Superheated steam flow measurement (and recording) with pressure and temperature compensation from CDQ at the CPP TOP.
d) Superheated steam pressure measurement (and recording) and temperature measurement (and recording) from CDQ at CPP TOP.
e) Indication of steam flow through each PRDS.
f) Indication of steam pressure before and after each PRDS. Pressure transmitter for PRDS pressure control loop shall be provided in redundant configuration.
g) Indication of steam temperature before and after each PRDS. Temperature element for PRDS temperature control loop shall be provided in redundant configuration.
h) Boiler drum pressure measurement in triple redundant configuration.
i) Boiler drum level measurement in triple redundant configuration on left and right side of the drum. Total six nos. of transmitters shall be provided for drum measurement.
j) Electronic drum level measurement on left and right side. Drum level indication shall be provided locally as well as in the control room on the hardwired mosaic based mimic panel.
k) Min. six nos. of temperature elements shall be provided for drum metal temperature measurement.
l) Measurement of tube metal temperature of superheaters.
m) Measurement of steam pressure and temperature after primary superheater in redundant configuration.
n) Measurement of steam pressure and temperature after secondary superheater in redundant configuration.
o) Measurement of steam pressure and temperature after desuperheater in redundant configuration.
p) Measurement of steam pressure on different auxiliary steam headers i.e. soot blowing steam, gland sealing steam, SCAPH steam, deaerator pegging steam, atomising steam etc.
q) Measurement of atomising steam pressure.
r) Super-heater injection water header pressure and temperature measurement.
s) Indication of soot blowing steam flow.
t) Indication of pressure before and after the soot blowing steam pressure control valve. Pressure transmitter for soot blowing steam pressure control shall be provided in

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redundant configuration.

u) Indication of temperature before and after the soot blowing steam pressure control valve.
v) Redundant temperature elements shall be provided for soot blowing steam drain control.

ii. Air and Flue Gas Circuit (DDCMIS List of measurements and controls)

a) Furnace draft measurement using triple redundant draft pressure measurement transmitters. Six nos. of furnace draft pressure switches for trip due very high and very low furnace pressure shall also be provided.
b) Differential pressure measurement between furnace and the wind box at the left and right side of furnace.
c) Differential pressure measurement between furnace and the scanner air.
d) Scanner air fan discharge pressure.
e) Differential pressure indication across scanner air fan suction filter.
f) Secondary air pressure measurement after each FD fan.
g) Secondary air pressure and temperature at the inlet and outlet of air pre-heater.
h) Hot secondary air flow measurement with pressure and temperature measurement.
i) Measurement of secondary air pressure before and after the air pre-heater.
j) Oxygen analyser at the inlet and outlet of air pre-heater in flue gas circuit.
k) Carbon Monoxide analyser the outlet of air pre-heater.
l) Furnace Temperature Probes at the left and right of the furnace.
m) Indication of flue gas pressure and temperature at the primary and secondary super-heater zone.
n) Indication of flue gas pressure and temperature at the inlet and outlet of economiser.
o) Indication of flue gas pressure and temperature at the inlet and outlet of air pre-heater.
p) Indication of flue gas pressure and temperature at the inlet of each ID fan.
q) Flue gas pressure and temperature indication at the outlet of each ID fan.
r) Stack flue gas flow, pressure and temperature for each boiler.
s) Flame sensing and control for each gas burners with flame intensity indication in control room and necessary interlocks for protection against flame failure and dull flame.

iii. Fuel Gas Circuit (DDCMIS List of measurements and controls)

a) Indication of Flow, Pressure and Temperature of BF Gas to each boiler. Redundant flow transmitters shall be provided for BF Gas flow control to each boiler.
b) Indication of pressure of BF Gas to each boiler in redundant configuration for SADC. Dedicated triple redundant pressure (06 nos.) switches shall be provided for very low and very high BF Gas pressure.
c) BF Gas pressure to each firing corner.
d) Indication of Flow, Pressure and Temperature of BOF Gas to each boiler. Redundant flow transmitters shall be provided for BOF Gas flow control to each boiler.
e) Indication of pressure of BOF Gas to each boiler in redundant configuration for SADC. Dedicated triple redundant pressure (06 nos.) switches shall be provided for very low and very high BOF Gas pressure.
f) BOF Gas pressure to each firing corner.
g) Indication of Flow, Pressure and Temperature of COG to each boiler. Redundant flow transmitters shall be provided for COG flow control to each boiler.
h) Indication of pressure of COG to each boiler in redundant configuration for SADC.

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Dedicated triple redundant pressure (06 nos.) switches shall be provided for very low and very high COG pressure.

i) COG pressure to each firing corner.
j) Indication of Flow, Pressure and Temperature of CBM to each boiler. Redundant flow transmitters shall be provided for CBM flow control to each boiler.
k) Indication of pressure of CBM to each boiler in redundant configuration for SADC. Dedicated triple redundant pressure (06 nos.) switches shall be provided for very low and very high CBM pressure.
l) CBM pressure to each firing corner.
m) Indication of Flow, Pressure and Temperature of LPG and propane to each boiler. Redundant flow transmitters shall be provided for LPG and propane flow control to each boiler.
n) LPG and propane pressure to each firing corner.
o) Indication of Calorific value, Flow, Pressure and Temperature of BOF Gas at CPP TOP.
p) Indication of Calorific value, Flow, Pressure and Temperature of COG at CPP TOP.
q) Indication of Calorific value, Flow, Pressure and Temperature of CBM at CPP TOP. Flow measurement of the CBM shall be carried out using Coriolis flowmeter. Flow totaliser shall be provided at TOP.
r) Indication of Flow, Pressure and Temperature of propane and LPG at CPP TOP. Flow measurement of the propane and LPG shall be carried out using Coriolis flowmeter. Flow totaliser shall be provided at TOP.
s) Indication of Calorific value, Flow, Pressure and Temperature of BF Gas at CPP TOP.
t) All the seal pots and U-seals shall be provided with level transmitters for level monitoring and control from DDCMIS.
u) Ambient hazardous gas/LEL detectors at different plant locations (25 nos.).

iv. Temperature & Vibration Monitoring System (VMS) for HT drives (DDCMIS List of measurements and controls)

a) Vibration measurement (along X & Y axis) of HT drives (i.e. pumps and motors) at the drive end and non-drive end.
b) Gearbox casing vibration (wherever applicable)
c) Bearing temperature measurement of pumps driven by HT motors.

6.3.3. Steam Turbine Generator

i. Water and Steam Circuit (DDCMIS List of measurements and controls)

a) Superheated steam flow measurement (and recording) with pressure and temperature compensation at the inlet of each steam turbine (for both STGs and TBs). The electronic flow transmitters shall be offered in redundant configuration.
b) Superheated steam pressure measurement (and recording) and temperature measurement (and recording) at the inlet of each steam turbine (for both STGs and TBs).
c) Turbine wheel chamber pressure.
d) Indication of turbine exhaust pressure and temperature in triple redundant configuration.
e) Indication of condenser vacuum pressure in dual redundant configuration.
f) Condenser hot-well level indication in triple redundant configuration. Guided wave radar type level transmitters shall be used for this application.

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g) Indication of make-up water flow to condenser.
h) Indication of extraction steam flow, pressure and temperature from each turbine.
i) Indication of turbine exhaust hood temperature**.** Alarm and interlock for exhaust hood temperature shall be provided using a dedicated temperature switch.
j) Pressure and temperature indication for turbine steam dumping control loop. These instruments shall be offered in redundant configuration.
k) Indication of pressure and temperature of turbine gland sealing steam to each turbine. The bidder shall offer pressure measurement in dual redundant configuration.
l) Gland steam condenser level indication.
m) Differential pressure measurement across CEP suction strainer.
n) Indication of condensate pressure, flow and temperature at the CEP discharge header.
o) Level indication of Condensate Storage Tank.
p) Differential pressure measurement across the suction strainer of condensate transfer pump.
q) Pressure and temperature indication at Condensate Transfer Pump discharge header.
r) HP heater level measurement shall be provided in dual redundant configuration.
s) Indication of feed-water temperature before and after each HP heater.
t) HP heater drain temperature measurement.
u) LP heater level measurement shall be provided in dual redundant configuration. Guided wave radar type level transmitters shall be used for this application.
v) Indication of condensate temperature before and after each LP heater.
w) LP heater drain temperature measurement.
x) Indication of condensate temperature and pressure at the outlet header of LP heater.
y) Indication of condensate flow to each deaerator.
z) Deaerator level measurement shall be provided in triple redundant configuration.
aa) Indication of deaerator pressure.
bb) Indication of water temperature in deaerator.
cc) Indication of pegging steam pressure and temperature to each deaerator.
dd) Indication of make-up water pressure, temperature and flow to deaerator.
ee) Differential pressure measurement across the suction strainer of each BFP.
ff) Indication of suction and discharge pressure of each BFP. Pressure transmitter at the discharge of each BFP shall be provided in redundant configuration.
gg) Indication of suction and discharge temperature of each BFP.
hh) Condensate flow measurement at the suction of each BFP in redundant configuration.
ii) BFP discharge header pressure and temperature measurement. Pressure measurement shall be provided in redundant configuration.
jj) Differential pressure measurement across each feed-water control system in triple redundant configuration.
kk) Indication of feed-water flow to each economiser (before feed-water control station) in triple redundant configuration.
ll) Indication of temperature of feedwater to each economiser (before feedwater control station) in triple redundant configuration.
mm) Indication of pressure before feed-water control station.
nn) Differential pressure measurement across the inlet and outlet of the condenser cooling water for each condenser.
oo) Temperature measurement at the outlet line of each condenser cooling water.
pp) Temperature measurement at the condenser cooling water return header.
qq) Pressure and temperature measurement at the condenser cooling water supply header at TOP.
rr) Flow measurement at the condenser cooling water supply header at TOP.
ss) Temperature measurement at each individual auxiliary cooling water return header.

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tt) Pressure measurement at each individual auxiliary cooling water supply header.
uu) Pressure and temperature measurement at the auxiliary cooling water supply header at TOP.
vv) Flow measurement at the auxiliary cooling water supply header at TOP.

ii. Lube Oil and Jacking Oil Circuit (DDCMIS List of measurements and controls)

a) Indication of lube oil tank level of each turbine.
b) Indication of lube oil overhead/rundown tank level.
c) Indication of lube oil tank temperature of each turbine.
d) Indication lube oil pressure at the discharge header of lube oil pumps.
e) Indication of lube oil main supply header pressure of each turbine. Three nos. of pressure switches shall be provided for turbine emergency trip. Additionally, dedicated pressure switches shall be provided for turning gear interlock and DCEOP start-up as per turbine supplier standard.
f) Indication of lube oil main supply header temperature of each turbine.
g) Indication of temperature on each lube oil return line from each bearing and gearbox.
h) Indication of lube oil main return header temperature of each turbine.
i) Indication of lube oil temperature at the outlet of lube oil cooler.
j) Indication of test oil pressure.
k) Differential pressure measurement across lube oil strainer.
l) Indication of central lube oil storage tank (dirty oil).
m) Indication of central lube oil storage tank (clean oil).
n) Jacking oil header pressure measurement. Additionally, one no. pressure switch shall be provided for interlocking facility.

iii. Hydraulic Oil Circuit (DDCMIS List of measurements and controls)

a) Differential pressure transmitter across hydraulic oil filter.
b) Indication of hydraulic oil header pressure. All signals leading to turbine trip due to very low hydraulic oil pressure shall be generated using triple redundant pressure switches.
c) TCV and TSV/ESV position feedback.
d) Position feedback of steam extraction valves of the steam turbine.
e) Pressure measurement and interlocks for secondary oil, trip oil, control oil etc.

iv. Turbo Supervisory Instruments (TSI) (DDCMIS List of measurements and controls)

a) Indication of differential temperature between inner & outer casing of turbine.
b) Indication of differential temperature between 50% & 100% of turbine casing.
c) Turbine metal temperature measurement.
d) Turbine and generator bearing metal temperature measurement.
e) Thrust pad metal temperature measurement at min. 04 points
f) Speed sensors in triple redundant configuration for turbine over-speed trip protection.
g) Speed sensor in triple redundant configuration for turbine governing system (DEHG).
h) Zero speed indication.
i) Reference Phase (Key Phasor) indication.
j) Axial displacement measurement in triple redundant configuration.
k) Absolute and relative shaft vibration measurement (in X and Y axis) for turbine, generator and gearbox.

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l) Casing overall expansion measurement.
m) Casing and rotor differential expansion measurement.
n) Shaft eccentricity measurement
o) Feedback of turbine barring (or ratcheting).
p) Absolute bearing vibration in 'X' and 'Y' direction for turbine and generator.
q) Casing vibration

NOTE: *Clause no. 6.3.3(iv) shall be read along with Clause no. 6.9.8.1 if this TS.*

v. Vibration Monitoring System (VMS) for HT drives (DDCMIS List of measurements and controls)

a) Vibration measurement (along X & Y axis) of HT drives (i.e. pumps and motors) at the drive end and non-drive ends.
b) Gearbox casing vibration (wherever applicable)
c) Bearing temperature measurement of pumps driven by HT motors.

6.3.4. Steam Turbine driven Blower

i. Water and Steam Circuit (DDCMIS List of measurements and controls)

a) Superheated steam flow measurement (and recording) with pressure and temperature compensation at the inlet of each steam turbine (for both STGs and TBs). The electronic flow transmitters shall be offered in redundant configuration.
b) Superheated steam pressure measurement (and recording) and temperature measurement (and recording) at the inlet of each steam turbine (for both STGs and TBs).
c) Turbine wheel chamber pressure.
d) Indication of turbine exhaust pressure and temperature in triple redundant configuration.
e) Indication of condenser vacuum pressure in dual redundant configuration.
f) Condenser hot-well level indication in triple redundant configuration. Guided wave radar type level transmitters shall be used for this application.
g) Indication of make-up water flow to condenser.
h) Indication of extraction steam flow, pressure and temperature from each turbine.
i) Indication of turbine exhaust hood temperature**.** Alarm and interlock for exhaust hood temperature shall be provided using a dedicated temperature switch.
j) Pressure and temperature indication for turbine steam dumping control loop. These instruments shall be offered in redundant configuration.
k) Indication of pressure and temperature of turbine gland sealing steam to each turbine. The bidder shall offer pressure measurement in dual redundant configuration.
l) Gland steam condenser level indication.
m) Differential pressure measurement across CEP suction strainer.
n) Indication of condensate flow, pressure and temperature at the CEP discharge header.
o) Level indication of Condensate Storage Tank.
p) Differential pressure measurement across the suction strainer of condensate transfer pump.
q) Pressure and temperature indication at Condensate Transfer Pump discharge header.
r) HP heater level measurement shall be provided in dual redundant configuration.
s) Indication of feed-water temperature before and after each HP heater.
t) HP heater drain temperature measurement.

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u) LP heater level measurement shall be provided in dual redundant configuration. Guided wave radar type level transmitters shall be used for this application.
v) Indication of condensate temperature before and after each LP heater.
w) Indication of condensate temperature and pressure at the outlet header of LP heater.
x) LP heater drain temperature measurement.
y) Indication of condensate flow to each deaerator.
z) Deaerator level measurement shall be provided in triple redundant configuration.
aa) Indication of deaerator pressure.
bb) Indication of water temperature in deaerator.
cc) Indication of pegging steam pressure and temperature to each deaerator.
dd) Indication of make-up water pressure, temperature and flow to deaerator.
ee) Differential pressure measurement across the suction strainer of each BFP.
ff) Indication of suction and discharge pressure of each BFP. Pressure transmitter at the discharge of each BFP shall be provided in redundant configuration.
gg) Indication of suction and discharge temperature of each BFP.
hh) Condensate flow measurement at the suction of each BFP in redundant configuration.
ii) BFP discharge header pressure and temperature measurement. Pressure measurement shall be provided in redundant configuration.
jj) Differential pressure measurement across each feed-water control system in triple redundant configuration.
kk) Indication of feed-water flow to each economiser (before feed-water control station) in triple redundant configuration.
ll) Indication of temperature of feed-water to each economiser (before feed-water control station) in triple redundant configuration.
mm) Indication of pressure of before feed-water control station.
nn) Differential pressure measurement across the inlet and outlet of the condenser cooling water for each condenser.
oo) Temperature measurement at the outlet line of each condenser cooling water.
pp) Temperature measurement at the condenser cooling water return header.
qq) Temperature measurement at the condenser cooling water supply header.
rr) Flow measurement at the condenser cooling water supply header.
ss) Temperature measurement at each individual auxiliary cooling water return header.
tt) Pressure measurement at each individual auxiliary cooling water supply header.
uu) Pressure and temperature measurement at the auxiliary cooling water supply header.
vv) Flow measurement at the auxiliary cooling water supply header.

ii. Air Circuit(DDCMIS List of measurements and controls)

a) Differential pressure measurement across suction strainer of each blower.
b) Indication of temperature at the suction of each blower in triple redundant configuration for surge detection.
c) Blower suction chamber differential pressure and temperature indication in triple redundant configuration for surge detection.
d) Blower suction chamber differential pressure and temperature indication in triple redundant configuration for anti-surge control.
e) Pressure measurement at the blower immediate discharge in triple redundant configuration for anti-surge control.
f) Air (cold blast) flow measurement at the blower discharge after the blow off line in triple redundant configuration. These measurements shall be pressure and temperature compensated. Primary sensors for pressure and temperature compensation shall also be provided in triple redundant configuration.

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iii. Lube Oil and Jacking Oil Circuit (DDCMIS List of measurements and controls)

a) Indication of lube oil tank level of each turbine.
b) Indication of lube oil overhead/rundown tank level.
c) Indication of lube oil tank temperature of each turbine.
d) Indication lube oil pressure at the discharge header of lube oil pumps.
e) Indication of lube oil main supply header pressure of each turbine. Three nos. of pressure switches shall be provided for turbine emergency trip. Additionally, dedicated pressure switches shall be provided for turning gear interlock and DCEOP start-up as per turbine supplier standard.
f) Indication of lube oil main supply header temperature of each turbine.
g) Indication of temperature on each lube oil return line from each bearing and gearbox.
h) Indication of lube oil main return header temperature of each turbine.
i) Indication of lube oil temperature at the outlet of lube oil cooler.
j) Indication of test oil pressure.
k) Differential pressure measurement across lube oil strainer.
l) Jacking oil header pressure measurement. Additionally, one no. pressure switch shall be provided for interlocking facility.

iv. Hydraulic Oil Circuit(DDCMIS List of measurements and controls)

a) Differential pressure transmitter across hydraulic oil filter.
b) Indication of hydraulic oil header pressure. All signals leading to turbine trip due to very lowhydraulic oil pressure shall be generated using triple redundant pressure switches.
c) TCV and TSV/ESV position feedback.
d) Position feedback of steam extraction valves of the steam turbine.
e) Pressure measurement and interlocks for secondary oil, trip oil, control oil etc.

v. Turbo Supervisory Instruments (TSI)(DDCMIS List of measurements and controls)

a) Indication of differential temperature between inner & outer casing of turbine.
b) Indication of differential temperature between 50% & 100% of turbine casing.
c) Turbine metal temperature measurement.
d) Thrust pad metal temperature measurement at min. 04 points
e) Turbine and blower bearing metal temperature measurement.
f) Speed sensors in triple redundant configuration for turbine overspeed trip protection.
g) Speed sensor in triple redundant configuration for turbine governing system (DEHG).
h) Zero speed indication.
i) Reference Phase (Key Phasor) indication for each shaft.
j) Axial displacement measurement in triple redundant configuration.
k) Absolute and relative shaft vibration measurement (in X and Y axis) for turbine, blower and gearbox.
l) Casing overall expansion measurement.
m) Casing and rotor differential expansion measurement.
n) Shaft eccentricity measurement
o) Feedback of turbine barring (or ratcheting).
p) Absolute bearing vibration in ‘X’ and ‘Y’ direction for turbine and generator.
q) Casing vibration

NOTE: *Clause no. 6.3.4(v) shall be read along with Clause no. 6.9.8.1 if this TS.*

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vi. Vibration Monitoring System (VMS) for HT drives (DDCMIS List of measurements and controls)

a) Vibration measurement (along X & Y axis) of HT drives (i.e. pumps and motors) at the drive end and non-drive ends.
b) Gearbox casing vibration (wherever applicable)
c) Bearing temperature measurement of pumps driven by HT motors.

vii. Steam and Water Analysis System Measurements for each boiler, turbine and BOP systems(DDCMIS List of measurements and controls)

Superheated Steam	**:** pH, Cation & Specific Conductivity, Silica, Sodium
Saturated Steam	**:** pH, Cation & Specific Conductivity
Boiler Drum	**:** pH, Specific Conductivity, Silica, Chloride, Phosphate
Economiser inlet	**:** pH, Cation & Specific Conductivity, Hydrazine
Deaerator outlet	**:** DO_2
Deaerator Inlet	**:** DO_2
CEP outlet	**:** pH, Cation & Specific Conductivity, Silica, Sodium
Hotwell	**:** Specific conductivity (one for each side)
Make-up water	**:** pH, Specific Conductivity
COB steam (TOP)	**:** pH, Cation & Specific Conductivity, Silica, Sodium
ACW	**:** pH, Specific Conductivity
Condenser CW	**:** pH, Specific Conductivity

viii. Gas Analysers (DDCMIS List of measurements and controls)

a) Flue gas CO gas monitoring at each APH outlet
b) Flue gas O_2 monitoring at the inlet and outlet of each APH.
c) SO_X, NO_X, CO and CO_2 or O_2 monitoring in flue gas at stack for each boiler.
d) Unburnt hydrocarbon concentration monitoring in flue gas at stack for each boiler.
e) Dust and opacity monitoring in flue gas at stack for each boiler

6.3.5 Local Instruments and Gauges for CPP and its auxiliaries

a. Pressure gauge at the outlet of each pump.
b. Pressure gauge for all pressurised vessels
c. Differential pressure gauge across the suction strainer of each pump.
d. Level gauge for all tanks and vessels. Magnetic type level gauges shall be considered for LPH, HPH and hotwell.
e. Pressure gauge at the inlet and outlet line of cooling water to each equipment
f. Temperature gauge at the outlet line of cooling water to each equipment
g. Temperature gauge at the cooling water inlet header
h. Fuel gas header pressure and temperature
i. Fuel gas corner pressure
j. Accumulator pressure gauges
k. Lube oil header pressure and temperature
l. Lube oil tank temperature indication
m. Lube oil temperature at the outlet of lube oil cooler.

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6.3.6. ACW and CW System (DDCMIS List of measurements and controls)

a) Pressure measurement at the outlet of each CW pump.
b) Pressure measurement at the discharge header of CW pumps. This shall be provided in dual redundant configuration.
c) Differential pressure measurement across the suction strainer of each CW pump.
d) Flow measurement of CW to each condenser with totaliser.
e) Differential pressure measurement across the heat exchanger/condenser.
f) Level measurement of CW sump
g) Pressure measurement at the outlet of each ACW pump.
h) Pressure measurement at the discharge header of ACW pumps. This shall be provided in dual redundant configuration.
i) Differential pressure measurement across the suction strainer of each ACW pump.
j) Flow measurement of ACW at the discharge header of ACW pumps.
k) Level measurement of ACW sump/tank.
l) Make-up water flow measurement to ACW and CW system.
m) Vibration measurement (4-20 mA) of CT fans.
n) Vibration monitoring (along X & Y axis) of CW pump and motor on DE and NDE.
o) Vibration monitoring (along X & Y axis) of ACW pump and motor DE and NDE.
p) Gearbox casing vibration for CW and ACW pump, if required.
q) Bearing temperature measurement of ACW and CW pump.
r) Level interlock for CT fan lube oil level.

6.3.7. Compressed Air System

a) Compressed air discharge pressure and temperature measurement at the discharge of each compressor.
b) Compressed air discharge flow measurement at the discharge of each compressor with pressure and temperature compensation.
c) Compressed air pressure measurement at the common discharge header of compressor. This shall be provided in dual redundant configuration.
d) Online dew point analyser for each drier
e) Pressure and temperature measurement of the receiver.
f) Flow measurement with pressure and temperature compensation at the service air and instrument air header to the CPP and BOP packages.
g) Cooling water flow measurement to each compressor.
h) Vibration monitoring of compressor and motor.
i) Lube oil header pressure indication to each compressor.
j) Lube oil header temperature indication to each compressor.
k) Lube oil return header temperature from each compressor.
l) Pressure gauge at the outlet of each compressor.
m) Temperature gauge at the discharge header of each drier.

NOTE: *Compressor skid instrumentation shall be as per OEM standard.*

6.3.8. DM Plant

i. Measurement and Indication in DDCMIS

a) Flow measurement of clarified water to PSF feed tank.
b) Level measurement of PSF feed tanks.

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c) Dual media filter feed pump discharge header pressure measurement.
d) Differential pressure measurement across each dual media filter.
e) Flow indication with totalisation at the inlet and outlet of each dual media filter
f) Pressure measurement at the discharge header of the DMF air blower.
g) Turbidity analyser at the outlet of each dual media filter.
h) Differential pressure measurement across each Filter Media Trap (FMT).
i) Differential pressure measurement across each Resin Trap (RT).
j) Differential pressure measurement across each ACF.
k) Flow indication with totalisation at the inlet and outlet of each ACF.
l) Residual chlorine analyser at the outlet of each ACF.
m) Differential pressure measurement across each WAC.
n) Flow indication with totalisation at the inlet and outlet of each WAC.
o) Online conductivity comparator across each WAC outlet and its WAC bed inlet.
p) Online conductivity measurement of backwash dump (rinse outlet) of each WAC.
q) Differential pressure measurement across each SAC.
r) Flow indication with totalisation at the inlet and outlet of each SAC.
s) Online conductivity comparator across each SAC outlet and its SAC bed inlet.
t) Online conductivity measurement of backwash dump (rinse outlet) of each SAC.
u) Online sodium analyser at the outlet of each SAC.
v) Online pH analyser at the outlet of each SAC.
w) Pressure measurement at the discharge header of degasser air blowers.
x) Level measurement of each DG water storage tank using redundant level transmitters.
y) Pressure measurement at the discharge header of DG water transfer pump.
z) Differential pressure measurement across each WBA.
aa) Flow indication with totalisation at the inlet and outlet of each WBA.
bb) Online conductivity measurement at the outlet of each WBA.
cc) Online chloride analysers at the outlet of each WBA.
dd) Online conductivity measurement of backwash dump (rinse outlet) of each WBA.
ee) Differential pressure measurement across each SBA.
ff) Flow indication with totalisation at the inlet and outlet of each SBA.
gg) Online conductivity measurement at the outlet of each SBA.
hh) Online silica analysers at the outlet of each SBA.
ii) Online conductivity measurement of backwash dump (rinse outlet) of each SBA.
jj) Differential pressure measurement across each mixed bed.
kk) Flow indication with totalisation at the inlet and outlet of each mixed bed.
ll) Online conductivity measurement at the outlet of each mixed bed.
mm) Online conductivity measurement of backwash dump (rinse outlet) of each mixed bed.
nn) Online cation and specific conductivity analysers at the outlet of each mixed bed.
oo) Online pH analysers at the outlet of each mixed bed.
pp) Online silica analysers at the outlet of each mixed bed.
qq) Online sodium analysers at the outlet of each mixed bed.
rr) Pressure indication at the discharge header of mixed bed and N-pit air blower.
ss) Level measurement of each pressure break tank with dual redundant level transmitters.
tt) Pressure indication at the discharge header of UF feed pumps with dual redundant pressure transmitters.
uu) Flow measurement at the discharge header of UF feed pumps.
vv) Flow measurement of the feed to each UF skid.
ww) Pressure measurement of the feed to each UF skid.

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xx) Differential pressure measurement across prefilter / cartridge filter before UF skid.
yy) CIP tank level measurement with redundant level transmitters.
zz) UF cleaning pump discharge header pressure measurement.
aaa) Differential pressure measurement across CIP cartridge filter.
bbb) Flow measurement at the outlet of each stream of UF.
ccc) Pressure measurement at the outlet of each stream of UF.
ddd) Flow measurement of DM water to each DM water storage tank.
eee) Level measurement of each DM water storage tank in redundant configuration.
fff) Pressure measurement at the discharge header of DM pump for backwashing.
ggg) Pressure measurement at the discharge header of DM pump for regeneration.
hhh) Pressure measurement at the discharge header of each set of DM water transfer pump.
iii) Flow measurement at the discharge header of each set of DM water transfer pump.
jjj) Level measurement of each bulk acid storage tank.
kkk) Level measurement of each acid mixing tank.
lll) Level measurement of each bulk alkali storage tank.
mmm) Level measurement of each caustic mixing tank.
nnn) Level measurement of each alkali preparation tank.
ooo) Flow measurement at the outlet/s of each ejector.
ppp) Level measurement of each N-pit.

NOTE: Dedicated sodium, silica and chloride analyser with online sequencer (OEM make) shall be provided for SAC, WBA, SBA and mixed bed i.e one silica analyser with online sequencer shall be provided for SBA-1, SBA-2 & SBA-3 and a separate silica analyser shall be provided for MB-1, MB-2 & MB-3. Each analyser shall be provided with one spare stream.

ii. Local gauges and instruments

a) Level gauge for PSF feed tanks.
b) Pressure gauge at the inlet and outlet of each dual media filter feed pump.
c) Pressure gauge at the inlet and outlet of each dual media filter.
d) Pressure gauge at the inlet and outlet of each ACF.
e) Pressure gauge at the inlet and outlet of each WAC.
f) Pressure gauge at the inlet and outlet of each SAC.
g) Pressure gauge at the outlet of each degasser air blower.
h) Level gauge for each DG water storage tank.
i) Pressure gauge at the inlet and outlet of the DG water transfer pump.
j) Pressure gauge at the inlet and outlet of each WBA.
k) Pressure gauge at the inlet and outlet of each SBA.
l) Pressure gauge at the inlet and outlet of each mixed bed.
m) Pressure gauge at the outlet of each mixed bed and N-pit air blower.
n) Level gauge for each pressure break tank.
o) Pressure gauge at the inlet and outlet of each UF feed pump.
p) Pressure gauge at the inlet of each UF skid.
q) Pressure gauge at the outlet of each UF skid.
r) Level gauge for hypo dosing tank.
s) Pressure gauge at the outlet of each hypo dosing pump.
t) Level gauge for caustic dosing tank.
u) Pressure gauge at the outlet of each caustic dosing pump.
v) Level gauge for pH booster tank.

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w) Pressure gauge at the outlet of each pH booster pump.
x) Pressure gauge at the inlet and outlet of each DM pump for backwashing.
y) Pressure gauge at the inlet and outlet of each DM pump for regeneration.
z) Pressure gauge at the inlet and outlet of each DM water transfer pump.
aa) Pressure gauge at the discharge of each acid unloading pump
bb) Pressure gauge at the discharge of each alkali unloading pump
cc) Density indicator at the outlet of each CMT and AMT.
dd) Level gauge for each CMT and AMT.

6.4. Spares

6.4.1. 02 Years Operation and Maintenance Spares

Supply of 2 years operation & maintenance spares shall not be under package contractor's scope of supply, unless otherwise specified in commercial part of bid document. However, list of 2 years operation & maintenance spares indicating make & model no. of each instrumentation & control equipment shall be submitted by the Bidder.

6.4.2. Commissioning Spares

All the commissioning spares shall be supplied by the Bidder on 'AS REQUIRED' basis. The period up to which these commissioning spares & consumable shall be under bidder's scope of work & supply, shall be as per commercial part of bid document.

6.5. Training

For training requirement, refer clause no. 2.28 of the TS.

6.6. Digitization and Industry 4.0

1. The basic requirement for Digitalization and Industry 4.0 for Captive Power Plant has been indicated below. Further requirement has also been included in clause no. 6.10.7.1 of the TS.
2. Different simulation models of CPP shall be considered and provided. The models shall have to predict and suggest optimum operating parameters to achieve maximum possible efficiency of the power generating units and blowers.
3. Proper database management (MS SQL) with daily, monthly and yearly assessment of fuel gas consumption, DM water consumption, power generation, frequency monitoring, main steam generation, cold blast parameters, import steam from CDQ, water chemistry, emission data etc. shall be provided.
4. Mobile app with proper password security showing the real time parameters in five categories viz. Furnace Parameters, Turbine Parameters, Blower Parameters, DM Plant parameters etc.
5. Document management system. Drawings have to be accessed with QR codes attached in all equipment.
6. Predictive maintenance features shall be provided based on the realtime analysis of the of the stress levels encountered by the power generating equipment, running hours of the rotating equipment etc. The bidder shall also offer prescriptive maintenance module for the major equipment of the CPP like the turbine, generator, blower and all HT motors.

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6.7. Drawings and Documents

6.7.1 Drawings / Documents / Information to be submitted along with the Tender

Refer clause no. 12.3.

6.7.2. Drawings/ Documents to be submitted by the Bidder after placement of Order

Refer Clause No. 13.2.5.

6.8. List of Testing Equipment and Tools & Tackles to be Supplied

One airconditioned C&I laboratory for the maintenance and calibration of the C&I equipment shall be provided with the following typical facilities in the CCR floor of the turbine building:

- Aesthetic interiors
- Proper illumination
- Air-conditioning & fans
- UPS Power points with switchboard - 4 nos.
- 230V AC, 50Hz. single-phase non-UPS points with switch-boards – 4 nos.
- 415V, 3-phase, 50Hz power-point – 1 no.
- Compressed air supply with all required needle valves, ball valves etc.
- Wash basin (MOC : SS) with integral drain board (with water supply and drain connection)
- Telephone connection
- Steel almirah – 6 nos. minimum
- Work-tables (04 nos.), steel cabinets (02 nos.), furniture (08 modular chairs), office table (01 no.) etc.
- All the testing and calibration equipment/devices shall be supplied with all standard and necessary accessories like batteries, chargers, probes, cables etc.
- All the testing equipment shall be supplied with carrying case.

The space shall be partitioned into separate Electronics Laboratory and Calibration Laboratory.

List of Maintenance and calibration equipment for C&I Laboratory. Refer clause no. 6.11 for detailed specification.

1.	Electronic Test Bench with Computer aided Calibration	1 set
2.	Pneumatic Test Bench	1 set
3.	Test Station for DDCMIS module with atleast one type of each module/card, relay, PSUs used in the DDCMIS	1 set
4.	Hand-held HART configurator with lifetime license	4 sets
5.	Portable multi-function calibrator (HART based)	2 sets
6.	Portable Pressure Calibrator (-1 to 2 kg/cm^2) with hand pump	1 set
7.	Portable Pressure Calibrator (2 to 40 kg/cm^2) with hand pump	1 set
8.	Dead weight tester	1 set
9.	Standard Pressure gauges (10 nos.)	1 set
10.	Aneroid barometer	1 no.
11.	Digital Manometer	1 set
12.	Portable Vibration Analyser with Balancer	1 set

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13.	Proximity Probe Testing Kit	1 set
14.	Handheld Vibration Monitor with Simulator	1 set
15.	Portable Flue gas Analyser	1 set
16.	Portable Ultrasonic Clamp-on Meter (DN50 to DN1000)	1 set
17.	Flow simulator Magnetic Flow meter, vortex flow meter	1 set of each type
18.	Mercury Thermometer (10 nos.)	1 set
19.	Fluidized temperature bath	1 set
20.	Portable Dry Block Temperature Calibrator (Low temp., medium temp. & high temp.)	1 set each
21.	Thermocouple test furnace	1 set
22.	Ice point reference system for Thermocouple	1 set
23.	Handheld Pyrometer (0-300 ^{O}C)	1 set
24.	Handheld Thermal Imager with Software	1 set
25.	Digital Thermograph/hygrometer	1 set
26.	Pitot tube for air and water velocity measurement	Each 1 set
27.	Function generator	1 set
28.	Digital Oscilloscope	1 set
29.	True RMS Multi-meter	10 sets
30.	Portable Digital Multi-meter	2 sets
31	Digital Multi-meter (Table mounted) 5 ½ & 7 ½	1 set each
32.	Tong tester (3 ½ digit LCD, 0-30A AC/DC)	1 no.
33.	Continuity tester	2 nos.
34.	Digital Tachometer	1 no.
35.	LAN / Coaxial Cable tester	1 set
36.	Fibre Optic Testing toolkit	1 set
37.	Optical Time Domain Reflectometer	1 set
38.	Earth resistance Tester	1 set
39.	Portable Grinder/Cutter/Drilling/Portable welding Machine	Each 1 set
40.	Ferrule Printing Machine with cartridge, sleeve (0.5, 1.0,1.5 & 2.5 mm^2)	1 set
41.	Feeler Gauge of all sizes	Each 1 set
42.	Bench Wise 6,8 & 12’	Each 1 no.
43.	Test Lamp 24 V DC	5 nos.
44.	Cordless Torque Wrenches	2 nos.
45.	Crimping Tools	2sets.
46.	Tools & Tackles with Metallic Tool Box (Set-Ring Spanner, D-Spanner, Allen Key, wire stripper, cutter, Adjustable spanner, Pipe wrench, nose Pliers, Screw driver set, Slide Wrench, Socket Wrench set)	6 sets
47.	Soldering & De-Soldering Station	1 set
48.	Industrial Grade Vacuum Cleaner with control function & Blower	Each 1 set
49.	Tube bender & tube cutter for 1/4’ ,1/2’ & 1’ tube	Each 2 nos.
50.	Furniture (Almirah, Chair, Storage Rack, Table etc.)	1 lot
51.	QR code reader	1 no.
52.	Digital vernier caliper	1 no.
53.	Micrometer	1 no.
54.	Punch set	1 set
55.	TAP set	1 set

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56.	Speed and vibration probe simulator	1 set
57.	Regulated power supplies	2 nos.
58.	Resistance box	1 no.
59.	Variable resistance box	1 no.
60.	Analog multimeter	02 nos.
61.	Soldering iron with accessories	04 sets
62.	Portable drill machine	1 no.
63.	Pneumatic single acting and double acting actuator testing facility	1 set
64.	Flame scanner testing kit	1 set
65.	Portable pH detector	1 set
66.	Portable conductivity meter	1 set
67.	Portable Oil Condition Monitor	1 set
68.	Portable mA Injector	2 nos.
69.	Precision Digital Pressure Gauges (Accuracy – 0.05% of FS) (0-1000 mmWc, 0-40 Kg/cm^2, 100 Kg/cm^2 and 0-160 Kg/cm^2)	4 nos.
70.	Digital Temperature Gauges (different ranges)	4 nos.

6.9. Detailed Technical Specification for Instrumentation Equipment

Detailed specifications of each type of instrument shall be read along with clause no. 6.1.1 of the TS. The requirement specified in clause no. 6.1.1 is complementary to the detailed specification mentioned under this clause.

6.9.1. Pressure Measurement

6.9.1.1. Pressure and Differential Pressure Gauge

Manufacturing Standard	IS 3624:1987(R2018) / ANSI B40.100-2022 / BS EN 837-1:1998
Sensing Element	Bourdon / Diaphragm / Bellows
Dial Diameter & Color	150 mm
Dial & Pointer material	Aluminium dial with white background and black markings Black pointer of aluminium material
Bezel ring & Material	Bayonet & Stainless Steel
Window	Shatter proof glass
Diaphragm Material	SS316
Fill fluid for diaph. seal	Silicon oil (DC200 in general, DC704 for vacuum application)
Case & Element Material	Stainless Steel & SS316
Socket & Movement MOC	Socket : SS304 / SS316 & Movement : SS316
Accuracy	$\leq+$ 1.0% of span for Bourdon type $\leq+$ 1.6% of span for diaphragm & capsule type; $\leq\pm$2.0% of FSD for diaphragm seal / chemical seal type pressure gauges
Enclosure class	IP 65
Process connection	½” NPTM for direct type 1.5” ASME B16.5-2020 Flanged for diaphragm seal type
Zero adjustment	Micrometer pointer
Over range protection	125% of span
Blow out protection	Neoprene, to be provided at Back side
Tag plate and marking	SS tag plate with tag no. marking on dial also.

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Options :	
a) Syphon (for steam appl.)	CS, Pigtail, ASTM A106, Gr.B, Coil dia. 100mm, Sch80, ½" SW x ½" NPTM, IBR certified
b) Gauge cock (for direct type PG)	3-way, SS, ½" NPT(F) x ½" NPT(F) x ½" NPT(F) with plug for drain port
c) Snubber (Ext. adj.)	SS, ½" NPT(M) x ½" NPT(F) at pump discharge
d) Liquid filled casing	For process line in vibration or press. fluctuation, eg. Fan discharge/ pump discharge
e) 3 valve manifold	Yes for DP gauges, SS, ½" NPT(F) x ½" NPT(F) x ½" NPT(F)
General guidelines:- i. For skid / machine mounted applications, gauges with smaller dial sizes are also acceptable. ii. Liquid filled gauges or gauges with snubbers/pulsation dampeners shall be provided for vibration prone areas and pulsating services. iii. Solid front type pressure gauges shall be provided for process applications where the operating pressure is greater than 40 kg/cm^2 or temperature is greater than 280 ^{O}C.	

6.9.1.2. Pressure and Differential Pressure Transmitter

Type of transmitter	Microprocessor based 2-wire type, HART 7 compatible
Sensor	Capacitance/ Piezo-resistive/ Silicon resonant type
Accuracy	≤±0.040% of calibrated span ≤±0.1% of calibrated span for diaphragm seal type transmitters *≤±0.1% of calibrated span for draft range pressure transmitters*
Output signal	4-20 mA DC, superimposed with digital HART signal
Turn-down ratio	• 10:1 for vacuum/very low pressure applications • 100:1 for other applications
Stability	≤± 0.1% of URL for 5 years
Amb. Temp. & RH limit	-10 ^{0}C to + 60 ^{0}C & up to 90% (non-condensing)
Load impedance	500 ohm (minimum) at 24 VDC
Fill fluid	Silicon oil (DC200 in general service, DC704 for vacuum service); Inert fluid (eg. Fluorinated oil/ halocarbon oil) for oxygen service
Transmitter electronics Enclosure	Dual compartment type construction. Material: Low copper aluminium for non-corrosive area.
Wetted parts mat'l	SS 316L/ Hastelloy C, as per process fluid
Enclosure protection	Weather proof to IP 67 Intrinsically safe for lube oil, fuel gas and furnace applications
Over pressure	150% of maximum operating pressure
Response time	100 ms or better for analog output
Electrical conn.	½ inch NPT(F)
Process connection	½ inch NPT(F) through manifold. For diaphragm seal type the process conn. shall be 2" ASME B16.5-2020 Flanged. For viscous/dirty fluid or congealing service, diaphragm seal type shall be used.
Capillary for dia. seal tx.	Min. 3 mtr. for remote dia. seal. SS 316 armoured with PVC jacket
Span and zero	Continuous, temper proof, remote as well as manually adjustable

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	from instrument with zero suppression and elevation. Same shall be from outside, without any need to remove the cover for flameproof transmitters. Zero and span adjustments shall be non-interacting to each other.
Zero suppression/ Elevation	- 50% of lower range limit to + 100% of upper range limit.
Local indication	Integral backlit digital LCD with key pad calibrated in engineering units.
Square root extractor	Yes, inbuilt for flow applications
Diagnostics	As per manufacturer's standard
Power Supply	13-42 V DC for safe area and through barrier for intrinsically safe Tx.
IS electronics/ Approval	Yes, for hazardous area. All the transmitters for lube oil applications, fuel gas applications and for furnace area shall be provided with IS electronics.
Lightning protection	External, mandatory for all transmitters
Accessories	• For non-diaphragm seal type: 2 valve manifold for pressure measurement using PT, 3 valve manifold for pressure measurement using DPT. 5 valve manifold for DP/flow/level measurement using DPT. Manifold material: SS316. • Vent/ drain port if any of manifold shall be provided with SS plug • Mounting acc. eg. U bolts for 2" pipe mounting, SS dip ring alongwith SS plug for one port and SS isolation valve for 2nd port for diaphragm seal type. MOC for mounting accessories shall be SS.
Adjustment/configuration / maintenance	Through HART compatible handheld configurator or through AMS software in automation system

General guidelines:-

i. For pressure measurement application with operating pressure less than 500 mmWC, DP transmitters shall be used with one side plugged (SS), as desired accuracies cannot be achieved using normal PT. In such cases, 3 valve manifold shall be provided with the DP transmitters.

ii. Specially designed draft range pressure/DP transmitters shall be provided for draft or very low (less than 300mmWC) pressure or DP measurement.

iii. Valve manifold shall be integral type and shall be hydrotested along with the transmitters by the bidder before supplying to site.

iv. The make of diaphragm seal shall be same as that of the transmitter. Third party diaphragm seals shall not be accepted.

6.9.1.3. Electronic Pressure and Differential Pressure Switch

Type	Electronic type with LED display
Sensor Type	Piezo-resistive / Metallic thin film cell/ Piezo-electric
Setting	External (eg. push button)
Setting type	Set in field & Factory set initially
Differential	Adjustable (switching differential not to exceed 60 % of difference between set value and operating value)

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Scale accuracy	<+ 0.5 % of FS
Set point repeatability	<+ 1% of FS
Display	LEDs for switching status
Process Connection	½ ” NPTF, Bottom
Mounting	Local
Enclosure Class	Weather proof to IP 67
Power supply	24V DC
Reverse polarity protectio	Yes
Housing & Wetted part material	Stainless steel
Switch type & Load type	24V DC, PNP, NO / NC configurable & Inductive load
Calibration	Factory set
Cable connector	Required for pressure switch end

6.9.2. Temperature Measurement

6.9.2.1. Temperature Gauge

Manufacturing Standard	ASME B40.200-2008 (R2013)/ BS EN 13190:2001 or other international standards
Sensing Element	Bimetallic for ≤ 450°C, Gas filled type for >450°C to 800°C
Dial size	150 mm
Dial & Pointer	Aluminium dial with white background and black markings Black pointer of aluminium material
Bezel ring	Bayonet
Bezel Material	Stainless Steel
Window	Shatter proof glass
Case Material	Stainless Steel
Movement Material	SS316 / SS304
Accuracy	± 1.0% of span or better (including combined effect of linearity, hysteresis and repeatability)
Enclosure class	IP 65
Zero adjustment	Micrometer pointer
Over range protection	125% of span or better
Stem details	SS316, 8 mm dia., with adjustable (sliding type) 3 piece comp. fittings, ½” NPTM, Bottom entry or Back entry for every angle type dial
Thermowell & Material	Yes, for all cases. SS316, unless not suitable for the process fluid
Thermowell Construction	Single piece drilled bar stock for IL≤ 600mm; Drilled bar stock with joint for 600<IL≤ 1200mm. Fabricated (made of pipe) for IL> 1200mm. For joint type, all welded joints shall undergo 100% radiography testing. For joints where radiography is not possible dye penetration test may be carried out.
Thermowell Shape	Tapered up to 150mm for drilled bar stock type and Straight for Fabricated type
Thermowell Process Connection	¾” NPTM or 1.5” ASME B16.5-2020 Flanged. Welded for IBR lines
Thermowell Sensor Connection	½” NPTF

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IBR certification	Yes, for IBR process piping, form IIIC shall be mandatory
Thermowell dimensions	Bore : To suit stem dia.; Non-tapered end OD: 19 mm; Tapered end OD: 16 mm; Tip thickness: 5 mm

General guidelines:-

i. All the pipes with less than 4" diameter shall be expanded to 4" for the installation of the temperature gauge.
ii. The immersion length of the thermowell shall be approx. 50% of the line size.
iii. The Bidder shall justify the thermowell design selection using the calculations as per ASME PTC 19.3 TW-2016. Bidder shall submit the calculations for Reynolds Number, Strouhal Number, Vortex Shredding Frequency, Resonance Frequency, Inline Resonance Velocity, Cyclic Stress, Steady State Stress (LHS & RHS), Dynamic Stress (LHS & RHS), Pressure Limit etc. Wake frequency calculation shall be done for all thermowells as per ASME PTC 19.3 TW-2016 or latest. In case the thermowell design fails vibration analysis, an alternate design of T/W shall be considered by the supplier.
iv. Bimetallic type or direct filled type gauges shall not be used where excessive vibration is anticipated. Filled type gauges with SS 316 capillary with flexible SS armouring (with PVC covering) shall be considered in such application. The gauge shall be pipe/stand mounting type.
v. For skid / machine mounted applications, gauges with smaller dial sizes are also acceptable.

6.9.2.2. Resistance Temperature Detector (RTD)

Sensing Element	Pt-100 (α=0.00385/^{0}C) Grade A. Pt-1000 for differential temp. application & for high accuracy applications
Reference Standards	IS 2848:2023 / IEC 60751:2022 / ASTM 1652-21
Calibration and Accuracy	Class A as per IEC 60751:2022, Amd.2 or eqvt.
Element wire size	18 AWG
No. of Elements	Duplex
Connection	3 Wire (Ungrounded)
Sheath Material	SS 316 seamless tube
Sheath O.D.	8 mm
Insulation	Mineral Insulated - MgO (Purity > 99.4%)
Lead wire & Leads sealing	Tinned copper & Hermetically Sealed
Response Time	Better than 15 sec. without T/W & 40 sec with T/W
Head : Cover & Material	Screwed Cap (with SS chain) & Die Cast Aluminium.
Neck Ext. assembly	SS 316, Nipple-Union-Nipple (1/2" NPTM) with ½" Schedule 80 pipe.
Neck Extension Length	150 mm for bare process piping/equipment and 100 mm above insulation for insulated process piping/equipment.
Cable entry size & no.	½" NPT(F); Two (One plugged with Al. or SS plug)
Enclosure class	Weather proof to IP 65. Explosionproof head for hazardous area applications shall be provided as well as for all lube oil, fuel gas and furnace area irrespective of area classification.
Terminal block	Spring loaded high temperature ceramic terminal block with silver plated brass terminals. Terminals shall be screwed type.
Thermowell & Material	Yes, for all cases. SS316, unless not suitable for the process fluid

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Thermowell Construction	Single piece drilled bar stock for IL≤ 600mm; Drilled bar stock with joint for 600<IL≤ 1200mm. Fabricated (made of pipe) for IL> 1200mm. For joint type, all welded joints shall undergo 100% radiography testing. For joints where radiography is not possible dye penetration test may be carried out.
Thermowell Shape	Tapered up to 150mm for drilled bar stock type and Straight for Fabricated type
Thermowell Process Connection	¾" NPTM or 1.5" ANSI B16.5-2020 Flanged. Welded for IBR lines
Thermowell Sensor Connection	½" NPTF
IBR certification	Yes, for IBR process piping, form IIIC shall be mandatory
Thermowell dimensions	As per ASME PTC 19.3 TW-1026

General guidelines:-

i. All the pipes with less than 4" diameter shall be expanded to 4" for the installation of the temperature gauge.
ii. The immersion length of the thermowell shall be approx. 50% of the line size.
iii. The Bidder shall justify the thermowell design selection using the calculations as per ASME PTC 19.3 TW-2016. Bidder shall submit the calculations for Reynolds Number, Strouhal Number, Vortex Shredding Frequency, Resonance Frequency, Inline Resonance Velocity, Cyclic Stress, Steady State Stress (LHS & RHS), Dynamic Stress(LHS & RHS), Pressure Limit etc. Wake frequency calculation shall be done for all thermowells as per ASME PTC 19.3 TW-2016 or latest. In case the thermowell design fails vibration analysis, an alternate design of T/W shall be considered by the supplier.
iv. The RTDs shall be wired to the DDCMIS through temperature transmitters only. Directly wiring the RTDs to the DDCMIS shall not be accepted.
v. The specification of Pt-100 RTD for the winding and bearing temperature measurements of motors/rotating equipment shall be as per OEM standard of technological equipment supplier. However, the bidder shall submit the datasheet of the RTD for the information and record purpose of the Purchaser.

6.9.2.3. Thermocouple

Sensing Element	ISA type K(Chromel-Alumel) / R(Pt 13%Rh-Pt) / S(Pt 10%Rh-Pt)
Reference Standards	IEC 60584:1-2013 / ASTM E230/E230M-23a / ASTM 1652-21 / IS 7358:1984 (R2015)
Calibration and Accuracy	Class 1 as per IEC 60584:1-2013
No. of Elements	Duplex
Sheath Material	SS 316 for ≤ 800^0C, Inconel 600 from 800-1100^0C
Sheath O.D.	8 mm for process application. Special construction for S/R
Insulation	Mineral Insulated - MgO (Purity > 99.4%)
Element wire size	16 AWG for K-type and 24 AWG for R/S type, ungrounded
Leads sealing	Hermetically Sealed
Response Time	Better than 15 Sec. without T/W & 40 Sec with T/W
Head : Cover and Material	Screwed Cap (with SS chain), heat resistant & moisture proof gasket. Die Cast Aluminium.
Ext. assembly	Nipple-Union-Nipple (1/2" NPTM); Material : Cd plated CS
Cable entry size & no.	½" NPT(F); Two

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Enclosure class	Weather proof to IP 65. Explosionproof head for hazardous area applications shall be provided as well as for all lube oil, fuel gas and furnace area irrespective of area classification.
Terminal block	Spring loaded high temperature ceramic terminal block with silver plated brass terminals. Terminals shall be screwed type.
Thermowell & Material	Yes for all cases. SS316, unless not suitable for the process fluid
Thermowell Construction	Single piece drilled bar stock for IL≤ 600mm; Drilled bar stock with joint for 600<IL≤ 1200mm. Fabricated (made of pipe) for IL> 1200mm. For joint type, all welded joints shall undergo 100% radiography testing. For joints where radiography is not possible dye penetration test may be carried out.
Thermowell Shape	Tapered up to 150mm for drilled bar stock type and Straight for Fabricated type
Thermowell Process Connection	¾" NPTM or 1.5" ANSI B16.5-2020 Flanged. Welded for IBR lines
Thermowell Sensor Connection	½" NPTF
IBR certification	Yes, for IBR process piping, form IIIC shall be mandatory
Thermowell dimensions	As per ASME PTC 19.3 TW-1026

General guidelines:-

i. All the pipes with less than 4" diameter shall be expanded to 4" for the installation of the temperature gauge.
ii. The immersion length of the thermowell shall be approx. 50% of the line size.
iii. The Bidder shall justify the thermowell design selection using the calculations as per ASME PTC 19.3 TW-2016. Bidder shall submit the calculations for Reynolds Number, Strouhal Number, Vortex Shredding Frequency, Resonance Frequency, Inline Resonance Velocity, Cyclic Stress, Steady State Stress (LHS & RHS), Dynamic Stress(LHS & RHS), Pressure Limit etc. Wake frequency calculation shall be done for all thermowells as per ASME PTC 19.3 TW-2016 or latest. In case the thermowell design fails vibration analysis, an alternate design of T/W shall be considered by the supplier.
iv. The Thermocouples shall be wired to the DDCMIS through temperature transmitters only. Directly wiring the thermocouples to the DDCMIS shall not be accepted.
v. Interconnections to/from thermocouples to temperature transmitters/ automation systems shall be made via thermocouple extension cable or compensating cable of thermoelectric characteristics matching with the thermocouple.
vi. Incase if the extension cables, compensating leads etc. are to be laid on the top of furnace /hot surface, suitable high temperature insulation material of cable along with external heat insulation protection shall be provided. Use of asbestos shall not be permitted. Mineral insulated cables are also acceptable for such applications.

6.9.2.4. Metal Temperature Measurement Thermocouple

Sensing Element	ISA type K (Chromel-Alumel)
Reference Standards	IEC 60584:1-2013 / ASTM E230/E230M-23a / ASTM 1652-21 / IS 7358:1984 (R2015)
Calibration and Accuracy	Class 1 as per IEC 60584:1-2013
No. of elements	Duplex
Sheath Material	SS 321 or Inconel 600
Sheath O.D.	6 or 8 mm

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Min. bending radius	30mm
Weld pad and clamp	SS 310
Insulation	Mineral Insulated - MgO (Purity > 99.4%)
Element wire size	18 AWG or 16 AWG as per sheath O.D.
Flying leads	PTFE insulated flexible tail cable
Leads sealing	Hermetically sealed using SS seal pots
Protective sleeve	PVC sleeve for seal pots and flying leads
Response Time	Better than 15 Sec. without T/W & 40 Sec with T/W
End connector	SS 310, ½" NPT(M) or ½" BSP adjustable sliding type end connector compression fittings. If MTM thermocouple is provided for process application, then two sets of sliding end connectors shall be provided i.e. one for process connection and one for cold end side.
Engraving	Weld pad and clamps shall be engraved with sheath O.D. and process pipe O.D.
Tag plates	02 nos. SS tag plate with marking of length of MTM thermocouple
General guidelines:- i. All bearing metal temperature measurements shall be provided as per manufacturer's standard practice. ii. Manufacturer can also provide boiler tube metal temperature as per their standard practice. iii. For MTM thermocouples to be installed in the flue gas path, bidder shall provide protective tubes of suitable material to prevent direct exposure of thermocouple to flue gases.	

6.9.2.5. Temperature Transmitter

Type of transmitter	Microprocessor based 2-wire type, HART 7 compatible
Sensor type	Universal type, i.e. all types of RTD and all types of T/C
No. of input/ transmitter	Single input. Multi input acceptable only for equipment health monitoring (eg. Motor winding temp.)
Accuracy	RTD, For Pt 100 : ± 0.1 ^{0}C (A/D) ± 0.02 % of span (D/A) accuracy T/C, For K type : ± 0.25 ^{0}C (A/D) ± 0.02 % of span (D/A) accuracy
Output signal	4-20 mA DC, superimposed with digital HART signal
Calibration std.	As per sensor design standard
Stability (for 5 years)	RTD: ±0.25% of reading or ±0.25°C, whichever is greater T/C: ±0.5% of reading or ±0.5°C, whichever is greater
Vibration Effect	Testing with no effect on performance as per IEC 60770-1, 1999
Cold Junction	Compensation required for T/C sensor with Accuracy ≤± 0.5°C
Load impedance	500 ohm (minimum)
Amb. Temp. limit	-10 ^{0}C to + 60 ^{0}C
Enclosure type & material	Dual compartment type construction. Material: Low copper aluminium for non-corrosive area.
Enclosure protection	Weather proof to IP 67
Burn-out protection	Yes, Upscale
Electrical connection	½ inch NPT(F)

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Linearisation circuit	Yes, for T/C sensor
I/O isolation	The input, output & power circuit is to be isolated
Local indication	Integral digital LCD with keypad calibrated in engineering unit.
Diagnostics	Hardware Failure, Sensor Burn Out, RTD/TC short, etc
Range Adjustment	Freely programmable w.r.t type of element, range.
Power Supply	13-42 V DC
IS electronics/ Approval	Yes, for hazardous area
Mounting	2" pipe mounted type (not head mounting on TE)
Lightning protection	External, mandatory for all applications
Accessories	All mounting accessories required for 2" pipe mounting. MOC of the mounting accessories shall be SS.
Adjustment / calibration / maintenance	Through HART compatible handheld universal calibrators or through AMS software in automation system

6.9.3. Level Measurement

6.9.3.1. Gauge Glass type Level Gauge

Gauge Glasses Type	Transparent / Reflex
Chamber Connection a) Size & type	¾" NPTF
b) Location	Side & Side
c) Drain connection	Yes, ½" NPTF, Carbon steel Ball valve, Nipple & Cap
Material a) Chambers & Cover plate	ASTM A105
b) U bolts & Nuts	ASTM A193 Gr.B7 & ASTM A194 Gr.2H
c) Gasket	Spiral wound with non-asbestos filler, 3 mm
Glass Material	Toughened Borosilicate glass
Cocks	Offset, quick-closing type, Flanged, ANSI B16.5
a) Body & Trim Material	ASTM A105 & SS 316
b) Bonnet	Bolted
c) Hand wheel	Pressed Steel
d) Bolts & Nuts	ASTM A193 Gr.B7 & ASTM A194 Gr.2H
Options	
a) Illuminator	Yes, for transparent type Level Gauge
b) Vent & drain system	1/2" vent & drain valves - ball type, nipples, caps. All carbon steel
c) Mica Shield	Stained First quality
d) Heating Jacket	Internal/ External for congealing service
e) IBR certificate	Yes for IBR service
f) Expansion loop	Yes for high temperature
g) Safety ball & Mat'l	Yes, SS 316
h) Renewable Seat	Yes for gauge cock
Illuminator	Carbon steel
a) Enclosure	Carbon steel
b) Power supply	230 VAC, 1 ph. with ex-proof enclosure for hazardous area
c) Cable entry	½" NPTF
Scale	Minimum graduation- 10 mm engraved, Stainless Steel

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6.9.3.2. Float & Board type Level Gauge

Type	Float & Board type
Float & guide wire material	SS 316
Guide wire & Float cable	≥1.6 mm diameter. Multi-stranded
Anchor & Float cable material	SS 316
Tension assembly	Cd plated steel
Scale board	Epoxy painted aluminum, ≥150 mm width
Accuracy	<+ 5 mm
Marking on scale	Graduations in black colour (LC=5 mm) and numerals in red colour
Protection conduit assembly	GI pipe, class B
Instrument connection on tank	Flanged, ANSI B16.5, 150#
Pulley arrangement	MS pulley with SS shaft
Bolts & Nuts	ASTM A193 Gr.B7 & ASTM A194 Gr.2H
Gasket	Spiral wound with non-asbestos filler, 3 mm`
Switch Type (if required) & Rating	Microswitch, 2-SPDT. 5A at 230V AC

6.9.3.3. Magnetic Level gauge

Type	Magnetic level gauges (rolling magnet or hall follower type)
C-C Length	Max. 2 mtr. For higher range requirement, more no. of level gauges shall be considered
Chamber process connection	Flanged, ANSI B16.5
Connection location	Side & Side
Chamber material	Fabricated out of Carbon steel seamless pipe or SS (in case CS is not suitable). Forged or cast for high pressure/ temperature application
Accuracy	<+ 10 mm
Enclosure class	IP 65 or better
Drain & vent valve Body & Trim material	Ball type valve, ASTM A105 & SS 316
Drain & vent conn.	½” NPTM. Plug for drain valve.
Bolts & Nuts	ASTM A193 Gr.B7 & ASTM A194 Gr.2H
Gasket	Spiral wound with non-asbestos filler, 3 mm
Float material	SS316. PP/ PVC/ECTFE/ FEP coated for corrosive service
Scale	Stainless steel, engraved or itched markings
Indicator	Bi-color flapper (white & red)
Switch Type (if required) & Rating	Micro-switch, 2-SPDT. 5A at 230V AC

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6.9.3.4. Tubular Level Gauge

Type	Tubular level gauges
C-C Length	Max. 2 mtr. For higher range requirement, more no. of level gauges shall be considered
Chamber process connection	Flanged, ANSI B16.5
Connection location	Side & Side
Glass type	Borosilicate Conforming to BS 3463-1975. PFA, Acrylic or Vinyl tube wherever glass is not suitable. OD min. 16mm
Glass protection	C channel in powder coated SS-304 or SS-304 Tie rod – 4 nos.
Accuracy	<+ 10 mm
Top & Bottom fittings	Offset type Auto Ball check isolating valves (Globe, Screwed Bonnet) provided with Safety Ball Sealing Arrangement in the upper and lower valve to stop flow instantaneously in case of glass tube breakage.
Drain & vent valve Body & Trim material	Ball type offset valve, ASTM A105 & SS 316
Drain & vent connection	½" NPTM. Plug for drain valve.
Bolts & Nuts	ASTM A193 Gr.B7 & ASTM A194 Gr.2H
Gasket	Spiral wound with non-asbestos filler, 3 mm
Scale	Stainless steel, engraved or itched markings

6.9.3.5. Radar Level Transmitter

Type	Electronic microprocessor based
Transmitter/ control unit	Single channel type
Detection method	Pulse or Time of flight Radar / FMCW Radar
Operating frequency	≥76 GHz for bulk material &≥24 GHz for liquid
Process connection	Flanged, ANSI B16.5
Swivelling type mounting arrangement for focusing	Yes, for bulk material application
Temperature compensation	Built in
Blocking distance	* (Max. 200mm)
Beam Angle	* (Max. 8 Deg.)
Transmitter Location	Head mounted type.
Enclosure material	Aluminum/PVDF/Polyester powder coated
Antenna material	SS/ PVDF/ PTFE
Seal material	PEEK/ FKM etc.
Accuracy &Resolution	<+ 3mm & 1 mm
Repeatability & Linearity	≤ ± 1 mm &≤ ± 0.01% of calibrated range
Enclosure Protection	Weather proof to IP 67
Local display	Yes configurable & parameterizable for zero, span. LCD/ LED for reading, diagnostics with key pad
Ambient temp. & RH limit	60 ^{0}C max. & 90% (non-condensing)

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Signal output	4-20 mA DC with digital signal (HART 7) superimposed
Power supply	24 VDC – 2 wire system in general.
Electrical connection	½" NPT (F)
IS electronics/ Approval	Yes for hazardous area
Lightning protection	External, mandatory for all applications
Nuts, Bolts & Gaskets for flanged process connection	Nuts – ASTM A194 Gr. 2H; Bolts – ASTM A193 Gr. B7; Gaskets – Spiral wound with non-asbestos filler, 3 mm

6.9.3.6. Guided Wave Radar Transmitter

Type	Electronic microprocessor based
Probe type	Co-axial type/ twin rods/ twin cables/ single cable / rod type
Process connection	Flanged, ANSI B16.5
Mounting	Insertion type/ external chamber mounting type
Transmitter Location	Head mounted type.
Enclosure material	Aluminium
Probe material	Stainless steel. Non-metallic or SS with coating for corrosive service
Partial coating	Yes for adhesive/sticky in nature materials
Seal material	PEEK/ FKM/ Viton
Accuracy &Repeatability	$\leq +$ 3mm &$\leq \pm$ 1 mm
Enclosure Protection	Weather proof to IP 67
Local display	Yes configurable & parameterizable for zero, span. LCD/LED for reading, diagnostics with key pad
Ambient temp. & RH limit	60 ^{0}C max. & 90% (non-condensing)
Signal output	4-20 mA DC with digital signal (HART 7) superimposed
Output isolation	Galvanically isolated
Power supply	12-32 VDC – 2 wire system
Electrical connection	½" NPT (F)
IS electronics & Approval	Yes, for hazardous area
Lightning protection	External, mandatory for all applications
Nuts, Bolts & Gaskets for flanged process connection	Nuts – ASTM A194 Gr. 2H; Bolts – ASTM A193 Gr. B7; Gaskets – Spiral wound with non-asbestos filler, 3 mm

6.9.3.7. Electronic Water Level Indicator

Principle	Difference in electrical conductivity of steam and water
Quantity	02 nos. for each boiler drum
Sensing probe material	SS 316 alumina/zirconia ceramic insulator
Sensing probe pitch	Max. 50mm, placed at equal pitch
Probe cable	High temperature resistant
Electronics	Dedicated for each holding vessels, two sets per boiler drum
Enclosure rating	IP-65
Diagnostics	Self diagnostics features shall be provided. Process fault, hardware

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	fault, probe failure, electronics failure, shorted wire, cable fault etc.
Analog output	Isolated dual 4-20 mA DC
Alarm	Min. 03 contacts
Trip and alarm circuits	Shall be independent of each other
Display	01 no. inbuilt & 02 nos. dedicated, tricolour LED display. Displays shall be placed at drum floor, firing floor and CCR.
Time delay	Fully adjustable time delay feature to be provided for trip and alarm circuits
Power supply	2 x 100%, redundant power supply for detector and electronics. All converters, power packs, etc. shall be offered in redundant configuration
Failsafe	Yes
Fault tolerance	Failure of one electrode shall not affect the functioning of the other electrodes or components of the system
Electrode holding vessel	ASTM A105/A106
Approval	FM (USA), IBR (form IIIC required)

6.9.3.8. Conductivity/capacitance type Level Switch/Transmitter

Function	Switch/ Transmit
Probe Type w.r.t length	Rod for L≤ 2000 mm. Rope for L>1000 mm
Style	General Purpose / Heavy Duty (For high temp. service)
Probe Material	SS 316 unless otherwise it is not chemically suitable
Insulation	Full/ Part
Connection :	Screwed / Flanged
Electronics location	Probe Head
Accuracy & Repeatability	≤+ 1% of range &≤+ 0.5% of range
Cable Entry	½" NPTF
Enclosure	Weather proof to IP 65
2 wire/ 4 wire type	4 wire
Case Material	Cast Aluminium.
Power Supply	24 VDC
Output Signal	Potential free contact for switches & 4-20 mA DC for tx.
Switch details	SPDT, Contact Rating: 5A, 230 VAC for Inductive load
Dead Band for switch	Adjustable
Fail safe option for switches	Field selectable failsafe high & low
IS electronics/ Approval	Yes for hazardous area mounted transmitter
Display	LED : Green for normal & Red for alarm for switches and LED/ LCD with keypad for transmitter.

6.9.3.9. Displacer / Float type Level Switch

Body or Cage Material	Carbon steel (for external cage mounting type)
Flange Material	Carbon steel
Connection Type	Flanged, ANSI B16.5
Float/ displacer guide	Rod type / Rope cable
Rotatable Head	Yes
Displacer or Float	Displacer/ Magnetic Float

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Displacer or Float Material	SS 316
Rod/ rope & other wetted part mat'l	SS 316
Accuracy	<+ 5 mm
Differential	Adjustable, minimum
Enclosure	CS, Weather proof to IP 67
Switch type, Quantity & Form	Mechanical, Pot. Free contact, 2 SPDT / 1 DPDT
Contact rating	5A @ 230 VAC/ 3A @ 24 VDC
Cable Entry	1/2" NPTF
Nuts, Bolts & Gaskets	Nuts – ASTM A194 Gr. 2H; Bolts – ASTM A193 Gr. B7; Gaskets – Spiral wound with non-asbestos filler, 3mm

6.9.3.10. RF type Level Switch

Function	Switch/ Transmit
Sensor type	RF capacitance/ RF admittance type
Probe/ Disk Type	Rod (L up to 2000 mm). Rope L>1000 mm). Disk type for bulk material low level switching or for chute jamming switch
Probe/ Disk Material	SS 316 unless otherwise it is not chemically suitable
Insulation	* Full/ Part PTFE insulation
Connection :	Screwed / Flanged. Flanged type always for flush disk type.
Electronics location	Probe Head or separate mounting type
Switching time delay	Yes, 2-20 sec. selectable
Cable Entry	½" NPTF
Enclosure	Weather proof to IP 67
2 wire/ 4 wire type	4 wire
Case Material	Cast Aluminium.
Power Supply	24 VDC
Output	Pot. free contact for switch type, 4-20 mA DC (HART) for transmitter type.
Switch Quantity & Form	2 SPDT / 1 DPDT
Contact rating & load type	5A, 230 VAC; Inductive
Dead Band : Fixed/ Adjustable	Adjustable
Fail safe option	Field selectable failsafe high & low
Display	LED : Green for normal & Red for alarm

6.9.3.11. Vibrating Fork type Level Switch

Sensing technology	Vibrating fork/ rod type
Vibrating fork material	SS 316
Nuts, Bolts & Gaskets for flanged process connection	Nuts – ASTM A194 Gr. 2H; Bolts – ASTM A193 Gr. B7; Gaskets – Spiral wound with non-asbestos filler, 3 mm
Enclosure	Weather proof to IP 67
Case Material	Cast Aluminium

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Type : 2 Wire/3 Wire/4 Wire	4 wire
Power Supply	24 VDC
Output Signal	Pot. Free contact
Relay Form : SPST/SPDT/DPDT	2 SPDT / 1 DPDT
Contact Rating & Load type	5A @ 230 VAC/ 3A @ 24 VDC
Cable Entry	½" NPTF
Certification: FM/ CSA/ ATEX/CCOE	-

6.9.4. Flow Measurement

6.9.4.1. Orifice Plate Assembly

Type	Normally concentric, square edge. Quarter-circle/ quadrant edge type for viscous fluids where Reynolds no. do not permit concentric sq. edge orifice, conical entrance for high viscous (throat Reynolds no. ≤250) Eccentric or segmental type for dirty fluids. Integral orifice plate for line size <1".
No. or bore	Single for line size up to 1000NB. Multi-bore (4 nos.) for line size > 1000NB. For line sizes ≤1000NB multi-bore orifice shall be used if straight pipe line 15 D is not available for mounting of orifice.
Sizing as per	BS 1042/ BSEN ISO 5167-2; 2003 for line size ≥ 2" and ASME-MFC-14M-2003(R2018)-for line size 6mm to 40mm
Plate only/ Assembly	Assembly which includes orifice plate, flanges, stud-bolts, nuts, jackscrews, gasket. Orifice shall be made from single plate without any joint
Material	SS 316 in general unless process fluid does not permit it.
Plate Thickness (min.) w.r.t line sizes	3.18 mm for 2"-12"; 6.35 mm >12"≤24"; 8 mm >24"≤36"; 10mm >36"≤80"; 12mm for >80". For high press. application thickness as reqd.
Beta (β) ratio	Shall be between 0.5 to 0.7 in general and shall not exceed 0.78 in any case.
Tap type	Generally flange tapping for line size 2"-14". D & D/2 tapping for line size ≥16" and also for dirty/ contaminated fluids. Corner tapping for line size ≤1.5" and for conical entrance orifice. Carrier-ring type orifice plate with corner tapping for line size 1" to 2".
Vent/ Drain hole	As per ISA RP 3.2
Flanges as per standard & minimum rating	ANSI B16.36 & 300# for line size ≥ 1" to 8". ANSI B 16.5 & 300# for line size < 1". ANSI B16.5 & 150# for line size >8" to 24". IS 6392/DIN 2630 and of suitable rating for line size more than 24"
Number of taps per flange	2 nos. for flange or corner tapping. One out of which shall be plugged with SS plug.
Flange Material	Carbon steel in general unless process fluid does not permit
Flg. type, Facing & Finish	Slip-on/ Weld neck, RF, Serrated Finish

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Gasket material & thickness (mm)	Spiral wound type with suitable filler (non-asbestos) mat'l. for temp. ≤750 ^{0}C, thickness min. 3mm. Graphite coated ceramic rope for temp. >750 ^{0}C, thickness min. 8mm.
Stud Bolt & Nut Material	ASTM A-193, Gr.B7 & ASTM A-194, Gr.2H or better
IBR Certification	Yes for whole assembly for steam & IBR quality process application(form IIIC required)
Markings (engraved)	Tag no., bore dia., upstream (+) and downstream (-) on plate Tag no., flange size, rating & material on all flanges

6.9.4.2. Flow Nozzle

Type	Long radius, welded type as per ASME PTC 19.5 or BS 1042
Material	Min. SS 316. Superior material(matching with process piping) shall be provided if process piping of grade higher than SS 316 is provided
Accuracy	+/- 0.5% or better
Beta ratio	Approx. 0.7
Beta ratio calculation	To be submitted
Assembly drawing	To be submitted
Characteristics curve	To be submitted
No. of taps	03 sets
Certification	IBR (form IIIC required)

6.9.4.3. Venturimeter

Type	Classical welded construction
Sizing	As per BSEN ISO 5167-4 (Latest edition)
Material	ASTM A516 Grade 60 or matching process pipeline material
Tap size	3/4" NPT(F)
End connection	Butt welded
Piezometric ring	Yes to be provided (3/4")
Radiography	Yes for welded joints

6.9.4.4. Coriolis Flowmeter

Electronics	Microprocessor based SMART
Measurement	Volume & Mass
Tube Version	Dual tube design, Straight or U type.
Power Supply	12-45 V DC
Output	4-20 mA DC with digital signal (HART 7) superimposed
Accuracy (include combined effect of linearity, hysteresis)	≤ ±0.10 % of rate for liquid service ≤ ±0.35 % of rate for gas service.
Repeatability	≤ ±0.05 % of rate for liquid service. ≤ ±0.20 % of rate for gas service.
Electrical connection	½" NPT(F)
Ext. load at 24 V DC	Min. 500 Ω

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Ambient temp. & RH limit	60 ^{0}C & up to 90% (non-condensing)
Process connection	Flanged as per ANSI B16.5
Body, Flange & tube mat'l	Stainless steel
Converter housing material	Low copper aluminium.
Enclosure class	Weather proof to IP 67
IS electronics/ Approval	Yes, for hazardous area
Electrical connection	½" NPTF
Built in output indicator	Yes, 4 line LED/ LCD display. Flow rate & totalized flow in engg. unit
Totaliser value protection at power failure	Yes
Lightning protection	External, mandatory for all applications
Nuts, bolts & gasket material	Nuts:ASTMA194, Gr.2H. Bolts: ASTM A193, Gr. B7. Gasket: Spiral wound with non-asbestos filler, 3mm
Steam Jacketing	Yes for congealing service (eg. Coal tar)

6.9.4.5. Electromagnetic Flowmeter

Type of flow meter	In-line type. Insertion type shall not be used unless otherwise specified in TS
Type of field excitation	Pulsed DC/ Dual frequency
End connection	Flanged ANSI B16.5 for meter size ≤600mm, EN1092-1 /AWWA C207 for meter size >600mm
Material : Tube & Body	Stainless Steel & Carbon steel
Liner Material	PTFE/ PFA in general. Natural/ soft rubber liner for contaminated/ slurry water
Electrode Material	SS/ Hastelloy (For contaminated water / slurry), welded type in general and replaceable type for coating type fluid.
Flange Material	Carbon Steel - ASTM A 105
Accuracy (including velocity error) @ fluid velocity ≥ 1 m/sec.	≤+0.35% of flow rate. For matched pair application & high accuracy applications: ≤± 0.2 % of flow rate.
Enclosure Class	Weather proof to IP 67
Signal Output	4 – 20 mA DC & digital signal (HART 7) superimposed
Power supply	24 VDC or 230 VAC (from UPS)
IS electronics/ Approval	Yes for hazardous area
Electrical Connection	½" NPT (F)
Mounting (Integral / Remote)	Integral or Remote depending on application requirement
Output Isolation from input/ supply	Yes
Indication in transmitter	Yes, Digital, flow rate & totalized flow in engg. unit
Self-diagnostic capability	Empty pipe detection, Electrode scaling (for contaminated water / slurry application), Bubble detection, etc.
Transmitter compartment	Dual compartment with metallic separation

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Local configuration facility	Yes, through key pads/ switches/ external tool and HART configurator
Lightning protection	External, mandatory for all applications
Mounting Brackets	Required for remote transmitter version
Flange Type, Facing, Finish & Mat'l	Companion flanges: SORF, Serrated, Carbon steel
Nuts, bolts & gasket material	Nuts:ASTMA194, Gr.2H. Bolts: ASTM A193, Gr. B7. Gasket: Spiral wound with non-asbestos filler, 3mm
Grounding Rings	Required. Qty 2 Nos.
Flow simulator	Yes, to be provided for each make and model of the flowmeters supplied by bidder.

6.9.4.6. Electronic Flow Switch

Type	Thermal dispersion /piezo/ mechatronic / calorimetric type (insertion type)
Setting	External, Set in field (through push button) & Factory set
Dead Band	Fixed min./ Adjustable
Set point repeatability	≤ 5 cm/s
Response time	5s (Max.)
Power delay-on time	15s
Mounting	Local
Enclosure Type & material	Weather proof (IP67) for safe area & SS 316
Wetted part materials	SS 316
Power supply	24 VDC
Reverse polarity protection	Yes
Switch Form	24 VDC, PNP/ NPN, NO/ NC programmable
Switching cycle	10 million operations
Function display	By 3 color LEDs
Load	Inductive
Cable connection	½" NPTF. For integral cable version, min. 5 mtr. Cable & JB shall be provided

6.9.4.7. Rotameter

i. Online Glass Tube Rotameter

Type	Online. Glass tube for line size up to 1.5"
Mounting	Vertical, In-line mounting
Inlet direction	Bottom
Outlet direction	Top
End Fitting: Material	316 SS, Forged
Packing or 'O' ring material	Viton
Enclosure type	Weather proof (IP 55)
Frame & cover Material	Stainless steel
Glass type	Toughened Borosilicate glass

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Float	SS316 (unless it is not chemically compatible)
Meter scale: Length	150 mm. (min.)
Type & scale graduation	Linear, Detachable & LPM
Scale Accuracy	<+2% of FS
Repeatability & Rangeability	<+ 0.5% of FS & 1:10
End connection	Flanged (in general). Treaded type acceptable only for intermittent use.
Flange, nut, bolts & gasket details	Flange: ANSI B16.5, 150#. Nuts:ASTM A194, Gr.2H. Bolts: ASTM A193, Gr. B7. Gasket: Spiral wound with non-asbestos filler, 3mm

ii. Online Metal Tube Rotameter

Type	Online. Metal tube for line size up to 4".
Mounting	Vertical, In-line mounting
Inlet direction	Bottom
Outlet direction	Top
Tube, End flange & Float mat'l	SS316 (unless it is not chemically compatible)
Meter housing material	Epoxy coated aluminum
Packing or 'O' ring material	Viton
Enclosure type	Weather proof (IP 66)
Meter scale: Type & Graduation	Angular, 100 mm. (min.) & LPM or m3/hr.
Scale Accuracy	<+ 1.6% of FS
Repeatability & Rangeability	<+ 0.25% of FS & 1:10
End connection	Flanged (in general). Treaded type acceptable only for intermittent use.
Flange, nut, bolts & gasket details	Flange: ANSI B16.5, 150#. Nuts:ASTM A194, Gr.2H. Bolts: ASTM A193, Gr. B7. Gasket: Spiral wound with non-asbestos fill.

iii. Transmitter/Switch for Rotameter

Transmitter	
Accuracy	<+0.2% of Full scale including linearity, hysteresis & repeatability
Enclosure Class & material	IP 66 or better & die cast aluminum. SS for corrosive area
Signal Output	4 – 20 mA DC & digital signal (HART) superimposed
Power supply	24 VDC, 2 wire
IS electronics/ Approval	Yes for hazardous area
Electrical Connection	½" NPT (F)
Mounting	Rotameter body mounted
Indication	Yes, Digital, flow rate in engg. Unit
Lightning protection	Yes, external mandatory for all applications
Switch	
Enclosure Class & material	IP 66 or better & die cast aluminum. SS for corrosive atmosphere
Signal Output	Potential free contact; 1NO+1NC; Rating: 1A, 230 VAC
Ex-proof Approval	Yes for hazardous area
Electrical Connection	½" NPT (F)

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Mounting	Rotameter body mounted

iv. Glass Tube Rotameter (Purge type)

Rotameter Type	Glass tube Purge Rotameter with flow adjustable knob, DP regulator
Mounting	Vertical, In-line mounting
Inlet direction	Bottom
Outlet direction	Top
End Fitting: Material	316 SS, Forged
Packing or 'O' ring material	Viton
Enclosure type	Weather proof (IP 55)
Frame & cover Material	Stainless steel
Glass type	Toughened Borosilicate glass
Float	SS316 (unless it is not chemically compatible)
Meter scale: Length	100 mm. (min.)
Type & Graduation	Linear, Detachable & LPM
Scale Accuracy & Rangeability	+6% of FS & 1:10
Flow controller-cum-DP regulator	Yes, SS 316
Protective shield with safety glass	Yes
Needle valve	Yes, SS 316
Float stop	To be provided to suit float guide

6.9.4.8. Vortex Flowmeter

Sensor	Capacitance/ Strain gauge/ Piezoelectric/ Ultrasonic
Electronics	Microprocessor based smart
Power Supply	12-45 V DC
Output	4-20 mA DC with digital signal (HART 7) superimposed
Accuracy	≤ ±1.0 % of rate for Gas & steam, ≤ ±0.65 % of rate for liquid including effect of linearity, hysteresis & repeatability
Repeatability	±0.2% of reading
Transmitter type	2 wire, remote mounting type
Electrical connection	½" NPT(F)
Ext. load at 24 V DC	600 Ω
Ambient temp. & RH limit	60 ^{0}C & up to 90% (non-condensing)
Process connection	Flanged as per ANSI B16.5
Flow meter body & flange mat'l	Stainless steel
Vortex shedder material	Stainless steel /Hastelloy C as per process application
Converter housing material	Low copper aluminium. SS for corrosive atmosphere.
Enclosure class	Weather proof to IP 67
Self-diagnostics	Empty pipe detection (output shall be zero in such cond.)
IS electronics/ Approval	Yes for hazardous area
IBR certification	Yes for steam service
Special cleaning	Yes for oxygen service flow meter.

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Built in output indicator	Yes, 4 line LCD/ LED display. Flow rate & totalized flow in engg. Unit
Totaliser value protection at power fail.	Yes (Value shall be protected when there shall be no power)
Lightning protection	Yes, external mandatory for all applications
Nuts, bolts & gasket material	Nuts:ASTMA194, Gr.2H. Bolts: ASTM A193, Gr. B7. Gasket: Spiral wound with non-asbestos filler, 3mm
Flow simulator	Yes, to be provided for each make and model of the flowmeters supplied by bidder.

6.9.5. Gas Analysers

6.9.5.1. Oxygen Analyser (LT)

Analyzer system	Set complete with analyzer, power supply unit, mounting accessories, calibration kit and gas cylinders etc.
Principle	Zirconia oxide cell (In Situ)
Type	Heated in-situ type
Temperature compensation	Yes, with T/C
Temperature control	Automatic through thermostat
Range	0-25%
Accuracy	≤ ±1% of full scale
Probe material	SS 316
Probe protector	To be provided
Filter	Yes, to be provided
Protection class	IP 54 or better for detector
Process connection	Flanged, ANSI B16.5
Flange material	SS 316
Electronics	Microprocessor based, separate from probe
Enclosure	Aluminium
Analyser mounting panel	Wall or floor mounted. Analyser mounting panel shall be provided with glass front.
Display	Backlit LCD with key pad
Electronics protection	IP-65
Repeatability & Linearity	≤ ±0.5 % of FS & ≤ ±1 % of FS
Response time (T_{90})	10 seconds or better
Output signal	Isolated 4 – 20 mA DCHART
Communication	RS-485 TCP/IP, Ethernet
Alarm Facility	2 SPDT potential free contacts
Load driving capacity	500 ohm minimum
Operation/Setting-up	Through front panel
Power supply	240 V AC ± 10%, 50 Hz ± 5%, single phase UPS
Calibration facility	Automatic, complete with solenoid valve, check valve, SS 316 tubes and fittings
Enclosure	MS – suitable for field mounting
Tubing mat'l & size	Stainless steel, ¼" or 6 mm
Calibration gas cylinders (10 ltr. each)	Zero gas & Span gas (for range <0-25%) cylinders. Aluminum or SS. NIST trace. For range ≥0-21%, ambient air can be used.

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Pressure reducers cum regulator (SS or brass)	Yes, for span gas & zero gas cylinders. Dual Stage.
Pressure gauges	At the inlet and outlet of pressure reducers cum regulator
Certification	US EPA, TUV, MCERTS

6.9.5.2. CO Analyser

Type	Insitu
Principle	Laser Absorption Spectroscopy (TDLS)
Electronics	Microprocessor based
Output	Isolated, 2x4-20mA DC HART
Analog Input	Yes, if dynamic normalization signals are received from external sensors
Alarm facility	2 SPDT potential free contacts
Communication	RS-485 TCP/IP, Ethernet
Power supply	230V AC UPS or 24V DC
Response time	Less than 5 seconds
Display	Backlit LCD/LED with key pad
Enclosure material	Aluminum or SS
Analyser panel	SS
Enclosure	IP-65 or alternatively the analyser can be installed in an analyser panel.
Range	Programmable, as per process requirement
Measuring units	ppm and mg/Nm^3
Zero and span adjustment	Yes, to be provided
Calibration	Automatic and manual. Automatic calibration interval shall be fully adjustable.
Diagnostics	To be provided
Compensation	Yes, for pressure and temperature
Accuracy	±2% of span or better
Repeatabilty	±2% of measuring range
Linearity	Better than 1% of full scale
Probe material	SS 316L
Flange material	SS 316
Purging arrangement	Automatic purging facility be provided, all the blowers, filters, pipes, fittings and accessories for the same shall be provided by the bidder. The lenses shall be automatically isolated using the shutter mechanism on purge air failure.
Purge failure alarm	Automatic
Dynamic Input Normalisation	Pressure and temperature compensation shall be provided. All required sensors, if any shall also be provided. Additionally, provision of manual entry of the process data shall also be provided.
Calibration Gas Cylinders	Yes, to be provided with zero and span gas. Capacity shall be 10 litres each. Each cylinder shall be supplied with pressure gauges, pressure regulators and all other accessories/fittings.
Accessories	Junction boxes, sensor cable, stubs, matching flange, cable glands, tubes/pipes, mounting brackets etc.

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6.9.5.3. Calorific Value Analysers

Type	Online direct calorimetric combustion OR Residual O2 measurement (by zirconia oxide sensor) in exhaust gas after combustion OR Gas chromatograph based. Microprocessor based controller
Sampling line from tapping point to analyzer panel	½" SS. Heat traced type shall be considered for CO gas, BF gas, BOF gas.
Tubing & fitting inside panel	6mm SS tube with double compression type fittings of Swagelok/ Parker make
Analyser & sampling system mounting	Self-standing mounting frame/ Panel
Mounting location	In AC room or panel to be provided with AC. Calibration gas cylinders - outside room
Power Supply	230 VAC, 50 Hz
Accuracy	±1.5 % of full scale or better
Repeatability	±0.5 % of full scale or better
Calibration facility	Auto & Manual
Output signal	4-20 mA DC - 3 nos. isolated signal for CV (Heating and combustion), Wobbe index/ Combustion Air Requirement (CARI) & Sp. Gravity/density. Additionally: RS485 /RS 232C/ Profinet bus comm.
Alarm output	Yes, 3 nos. relay output (2A, 230 VAC, SPDT, non- inductive); Individual alarm setting adjustable
Response time (T_{90})	$\leq$ 30 sec.
Display	Min. 7" TFT/LCD display for measuring data and diagnostic
Exhaust fan	Yes to exhaust harmful gas from analyser room
Sampling system	
Booster pump	Yes for low sample line press. 1 working + 1 standby.
First stage filter	Yes, particle filter
Self-actuating press. control valve	Yes for sample line & combustion airline as required.
Second stage filtration	Yes, Coalescing filter, including needle valve & flow indicator
Diesel pot/ water pot	Diesel pot for Coke oven gas/ water pot for other gases for dissolving impurities
Pressure gauge & Pressure switch	Yes for sample line
Isolation valve	Yes, sample isolation at panel end, SS
Solenoid valve	Yes for sample gas line & calibration gas line
Exhaust hood (≥100mm aluminum/GI)	Yes, combustion gas to be piped from room to safe height, outside room.
Calibration gas cylinders	Yes, 10 ltr. along with dual stage pressure regulator & press. gauge, Aluminum/ SS (NABL/NPL traceability). 2 sets shall be supplied. One set before testing & commissioning and one set after commissioning as per client's directive.

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Ceramic Burner, Safety pilots for burner, Thermopile	Shall be provided as per the requirement
Commissioning spares	Filters – 1 set, Fuses – 1 set, Solenoid valve – 1 each type

6.9.6. Steam and Water Analysis System (SWAS)

The bidder shall provide centralised Steam and Water Analysis System (SWAS) for the continuous online analysis and monitoring of the water and steam circuit of the Captive Power Plant and BOP Packages associated with the CPP.

The complete steam and water sample drawing, sample conditioning and analysis system shall conform to the following standards and requirements specified in this TS.

Standard	Description
ASME PTC 19.11-2008 (R2018)	Steam and Water Sampling, Conditioning and Analysis in the Power Cycle
ASTM D1066-18e1	Standard Practice for Sampling System
ASTM D1192-1998	Standard Guide for Equipment for Sampling Water and Steam in Closed Conduits
ASTM D3370-18	Standard Practices for Sampling Water from Flowing Process Streams
ASTM D5540-13(2021)	Standard Practice for Flow Control and Temperature Control for On-line Water Sampling and Analysis
ASTM D5128-14 (2022)	Standard Test Method for On-line pH Measurement of Water of Low Conductivity
ISO 5667-7	Guidance on Sampling of Water and Steam in Boiler plants

6.9.6.1. Sample Conditioning System

The sample conditioning system shall provide samples at 25 Deg. C or at a preset temperature required by the analyser within tolerance of 1 Deg. C, at a pressure of about 2 kg/cm^2 and at flow rates as required by individual analysers/streams. Sample line to analyser elements shall incorporate an anti-siphon design to prevent possibility of running dry because of a broken or plugged sample line.

Sample conditioning system shall be designed and constructed to receive and condition all samples as required by the respective analysers connected to the sample streams. This shall include all conditioning as specified herein and shall cover the following:

i. Primary sample cooling in the field.
ii. High pressure reduction in the field.
iii. Three nos. racks shall be provided by the bidder for mounting primary coolers and high pressure reducing elements in the field along with all required piping, fittings, and accessories. The exact grouping and location of these racks shall be as finalised during detail Engineering stage.
iv. Sample Filtering.
v. Secondary sample cooling and temperature control.
vi. Pressure reduction and control and measurement as required.

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vii. Flow rate control and measurement.

viii. Other treatment as required by individual analysers or as specified herein.

6.9.6.2 Primary Sample Cooler

All samples having a temperature in excess of 45 deg. C shall be cooled using primary sample cooler. Primary sample coolers shall be part of SWAS system only and shall not be shared with any other system. Field sample coolers specified for grab sample of boiler area anywhere in the specification shall be separate from SWAS system. Inconel 625 coil primary coolers shall be supplied for each high pressure and high temperature sampling lines. All the components i.e blowdown valves, isolation valves, coolers, thermowells, pipes, tubes etc. of the primary coolers shall be IBR certified.

Condensate quality plant auxiliary cooling water shall be used as cooling medium in the primary sample coolers in field. Auxiliary cooling water temperature of 40 deg. C shall be considered for design of primary sample coolers. Capacity of primary sample coolers shall be adequate to cool the sample within 5 deg. C of auxiliary cooling water inlet temperature considering the combined flow of each analyzer connected to sample cooler and one manual grab sample at flow rate of 500 cc per minute and assuming adequate fouling factor of 0.2. Primary cooler capacity calculations shall be submitted by bidder during detailed engineering. Temperature switches shall be provided in the sample lines at the primary sample cooler outlets for sample outlet temperature high annunciation and Thermal shut-off valve shall be provided in the sample lines at the primary sample cooler outlets for shut down of high temp. sample to secondary cooler. Annunciation of high temperature sample at primary cooler outlet shall be provided in the SWAS Room and DDCMIS.

Provision shall be provided for adjusting the temperature of each sample individually at desired temperature. Provision shall be provided for draining (with drain valve) the shell of the primary sample cooler and the drain shall be hooked up to the nearest plant drain.

Sample cooler shall be of submerged Helical coil type of shell and tube design with removable shell. The sample tube shall be of seamless construction with no welds and other joint inside the cooling jacket. Unions shall be provided to facilitate removal of coils. All of sample coolers shell, tubing and fittings, other components shall be constructed of type 316 stainless steel or better as per process requirements. The coil material of the primary cooler shall be Inconel 625. Cooler design shall conform to requirements of ASTM D1192-1998. The shell pressure relief valve shall be built in type.

6.9.6.3 Secondary Sample Cooler

Dedicated secondary sample cooler shall be provided for each sample stream before passing the sample to respective measuring cells and each analysers. The secondary sample cooler shall have capacity to cool required flow of sample stream to 25 deg. C or to a preset temperature required by the analyser through an individual secondary sample cooler before passing the sample to the respective measuring cells and analyser even in case, the corresponding analyser is rated for higher sample temperature. The capacity calculation (considering fouling factor of 0.2) shall be subject to Purchaser's approval during detailed engineering. The secondary sample cooler shall use condensate quality chilled water at 20 Deg. C. Chilled water shall be arranged from packaged refrigeration unit (chillers) to be provided by the bidder. All samples shall be passed through cartridge type filters before being cooled in respective secondary sample coolers. The secondary sample coolers shall be of submerged helical coil type of shell and tube design meeting the requirements of ASTM D1192-1998. All sample coolers shell, coil, tubing and fittings, other components shall be constructed of type 316 stainless steel or better as per process requirements. Secondary cooler shall be protected by a pressure relief valve on the cooling water jacket of each cooler

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in addition to a pressure relief valve at the cooling water header. Provision shall be provided for draining (with drain valve) the shell of the secondary sample cooler and the drain shall be hooked up to the nearest plant drain.

Temperature switches shall be provided in the sample lines at the secondary sample cooler outlets for sample outlet temperature high annunciation and Thermal shut-off valve shall be provided in the sample lines at the secondary sample cooler outlets for shut down of high temp. sample to the measuring cells and Analysers. Annunciation of high temperature sample at primary cooler outlet shall be provided in the SWAS Room and DDCMIS.

The sample conditioning system of the SWAS shall consists of the following major equipment and sub-systems:-

i. Redundant Chiller System

a) 2x100% capacity water cooled chillers shall be provided.
b) Each chiller unit shall be designed with sufficient refrigeration capacity to ensure that each sample stream temperature is maintained at 25±1^{O}C at the outlet of secondary sample coolers when all streams/measuring cells/analysers are simultaneously operating at maximum flow rate and maximum temperature. Each chiller shall have 30 % spare capacity for any expansion in future.
c) Suitable temperature monitoring and control systems shall be provided for maintaining the chilled water temperature at chiller outlet at 20 Deg. C or at a designed preset value and within the desired band.
d) The compressor shall be readily accessible for service and shall include low noise hermetically sealed motors. Compressor assembly shall also include crank case heaters, suction and discharge valves, oil sight glasses, forced feed lubrication system and an integrated motor protection system along with the necessary instruments.
e) The condenser shall be water cooled, cleanable shell and tube with water regulating valve. The cooling water shall be arranged by the bidder from ACW system of the CPP. All the pipes, fittings & valves required to take the water from ACW system to the chiller shall be in bidder's scope.
f) Chiller shall be of direct expansion type with refrigerant tube inside a shell, completely insulated and to be constructed in accordance with the ASME code for unfired pressure vessels.
g) Refrigerant circuit shall be complete with a thermostatic expansion valve.
h) Liquid line solenoid valve, sight glasses, filter dryer, refrigerant shut off and charging valves.
i) The chiller water pump shall be of the centrifugal type, close coupled, bronze fitted construction, complete with motor. Pump & motor shall be designed for continuous operation.
j) Vibration dampeners shall be mounted between the packaged chiller and the channel base.
k) Cooling water and chilled water piping shall be provided with block valves.
l) The bidder shall provide detailed calculation for chiller capacity and other technical particulars like foundation details/mounting etc. and the same shall be subject to Purchaser's approval.
m) The chiller system be provided with 100% redundant chilled water pumps with suction and discharge pressure gauges and temperature gauges, chilled water circulation pump with 100% standby facility; storage tank automatic water make up with manual by-pass facility, temperature indicator, level gauge and drain and

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overflow connection. In addition to any other instrumentation/equipment required for smooth, convenient operation of the system, which shall also be furnished by the bidder.

ii. Valves

The steam and water Analysis system shall be provided with the sample shut off valves, blow down valves, solenoid actuated valves, thermal shut off valve, pressure reducing valves, safety relief valves, back pressure regulating valves, high pressure reducing valves etc. The valves shall be provided with the following technical requirements:-

a) The sample shut off valves, blow down valves and pressure reducing valves shall have stellite spindle tip and shall be suitable for an operating pressure of 300 bars and an operating temperature of 400 Deg C.
b) All critical components like sample coolers, PRV, HPRE, sample shutoff valves, blow down valves, thermal shutoff valve, sample relief valves, shell relief valves and all type of fittings on sample lines etc.
c) The back pressure regulating valve shall be globe type and shall be suitable for a pressure range of 0-50 psi. The back pressure regulating valve shall consist of a range spring and a diaphragm assembly. The back pressure of the regulating valve is adjusted to the required set point by the range spring. In case of any excess pressure the diaphragm shall be lifted to release the excess pressure to maintain back pressure equal to the set value. SS trim with linear flow characteristics shall be provided. Bidder shall submit the data sheet of these valves and these shall be subject to Purchaser's approval during detailed engineering stage.
d) All the valves shall be sized for the maximum sample flow.
e) The cooling & chilled water header shall be provided with pressure gauges, temperature gauges, Temperature switches, flow switches, safety relief valves, flanges, isolating valves etc.

iii. Gauges

a) Temperature gauges shall be of 100 mm inert gas type thermometers with SS316 capillary of length required for installation.
b) Pressure Gauges shall be of 150 mm diameter.
c) Level Gauges shall be tampered, borosilicate transparent type of minimum pressure rating 300 psig.
d) Each gauge shall have a dial engraving or separate phenolic name plate to identify the service. Service engravings make model, ranges and other technical features shall be subject to Purchaser's approval. Gauges shall be located on the front of the sample conditioning panel.
e) Instruments shall also meet the technical specification requirements mentioned in this TS.

iv. Switches

a) Electronic flow indicator cum switches shall be provided, on the primary cooling water outlet and on the chilled water. Make & model of electronic flow indicator cum switch shall be as per Purchaser's approval.
b) Electronic temperature switches shall be provided on the sample lines.
c) All the electronic flow switches and temperature switches shall be wired to the DDCMIS by the bidder.

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d) Potential free contact shall be provided for annunciating loss of cooling/chilled water.
e) Instruments shall also meet the technical specification requirements mentioned in this TS.

v. Grab Samples

Grab samples valves on the front of SWAS panel shall be provided to direct grab samples to trough through grab sample nozzles or to the drain header. Each grab sample line shall be provided with Flow restricting Element (FRE) to maintain constant flow at a preset sample pressure. Approximately 300mm of flexible tubing shall be provided for each sample for grab sample collection and prevent splashing. Grab sample nozzles shall be provided with adapter and panel mounting flanges. MOC of the valves, flanges and tubing shall be SS 316.

vi. Sample sink

A continuous sink with drain board, located at the place of grab sample analysis, shall be provided. The MOC of the sample sink shall be SS 316. The sample sink shall be connected to waste drain header. DM water connection shall be provided for cleaning of sample containers.

6.9.6.4. SWAS Panels

The SWAS Panels shall have two sections namely sample conditioning section (wet panel) and analyser section (dry panel). The first section shall be the wet section of SWAS which shall be called as the "Sample Table". The second section shall be the dry section housing the analysers, signal conditioning devices and other requisite accessories.

The wet panels and dry panels of the SWAS system shall be placed in the SWAS rooms of the CPP and DM Plant. Two SWAS rooms are envisaged for this project one in CPP area and another one at DM Plant area. The SWAS rooms shall be fully airconditioned. All the furniture for SWAS rooms i.e. tables (2+1 nos.), chairs (4+2 nos.), steel almirah (2+1 nos.) and steel rack (1+1 no.) shall be provided as a minimum.

The wet panel and dry panel of SWAS shall physically separate from each other and shall be mounted in separate partitions of the air-conditioned SWAS room. Sample conditioning panel shall be corridor type with walkway construction with side doors and removable type plate at the back. The analyser panel shall be free standing and totally enclosed type with doors at the back of the panel. The wet panel shall be constructed of 3 mm thick steel sheets except for doors. which shall be 2.0 mm, thickness. The dry panel shall be constructed of 2.5 mm thick steel sheets except for doors. which shall be 2.0 mm, thickness. The panel floor shall be made of SS 316 stainless Steel sheet of 5 mm thickness with central flat portion for walk way and slightly sloping sections towards front and rear side and a panel drain. 15mm anti-vibration pads shall be provided for the wet and dry panels. The waste water/sample from panel drain shall be piped to the nearest plant drain. All piping shall be concealed/through trenches. All SWAS panels shall be furnished with 100 mm base angle for bolting to 100 mm high concrete curb furnished by the Purchaser.

All monitoring instruments and controls for sampling system shall be located on the front panel and shall be grouped accordingly to function in a logical and orderly fashion. There shall be a general progression of flow from top-to-bottom and left-to-right to minimize sample line length, purge times and material exposed to sample. Similarly, the conditioning

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components for each stream shall be grouped together wherever possible.

Each sample inlet shall be provided with bulkhead type tubing connection and an isolation valve or block valve suitable for sample operating conditions. A blow down connection and suitable blow down valve shall be provided at upstream of each isolating valve. Blow down valves shall be manifold into a suitable blow down header. Strainers, filters, relief valves etc. shall be provided as required to properly protect the coolers, valves, analyser elements etc.

Sample conditioning, analyser, panels shall be designed for ready access of components. Panel design shall ensure that:-

i. Individual components or groups of components mounted on sub-panels can be removed for replacement or repair without the need of prior removal of components of other healthy streams.
ii. Flow meters, pressure gauges and temperature indicators can be removed for repair or replacement from the front of the panel without disturbing any piping, etc.

Information and alarm signal from SWAS system including analysers/monitor output signals, chiller system etc. shall be hooked up to DDCMIS for monitoring purposes as well as for control of dosing systems through remote input/output modules.

Power distribution board with external surge protection devices for distribution of Redundant UPS power supply with auto changeover circuitry & 230 V AC utility power supply for all individual consumers as individual analyzers, auxiliary equipment inside and around the wet panel and dry panel. Lighting receptacles and redundant fans shall be provided in each section of Dry panels. Each of the main systems shall have an individual isolation circuit breaker 2 pole type mounted nest to the individual power users. Panel fan failure, UPS feeder failure and 230 V UPS feeder failure alarm shall be provided to DDCMIS.

6.9.6.5. Sample Piping Requirement

Sample Line	MOC
Process tapping to primary sample cooler including all valves and fittings	As per process piping
Sample piping after the primary sample cooler	ASTM A213 TP316H seamless tube
Blowdown header and misc. drain receiver holder	ASTM A312 TP304 seamless pipe
Closed CW piping except grab sample and water purge line, sample through drain piping and waste header piping	ASTM A53 Gr. A seamless
Purge air piping/tubing, valves and fittings	SS 316

Size, temperature rating and pressure rating of sample pipes/tubes shall be suitable for particular application. Pressure reducing valves, Isolation valves before the primary sample cooler and all the isolation valves for pressure and flow indicators shall be needle valves. Cooling water and chilled water supply and return valves shall be block valves.

All the samples coming to primary coolers from process pipes/vessels where pressure is greater than 40 kg/cm2 or temperature is greater than 280 OC shall be provided with double isolation valves before the primary sample coolers in addition to mechanical double isolation valve at the sample tapping location.

All sample piping shall be ¾”NB seamless type of material ASTM A213 TP 316H, conforming to ANSI B36.19. The pressure rating shall be suitable for the particular

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application. All fittings shall be socket welded type and of material ASTM A182 F316H confirming to ANSI B16.11.

The valves to be used in sample piping shall be of globe type, forged construction and stainless steel confirming to ASTM A182 with pressure and temperature ratings as per ANSI B16.34. The valve design shall be such that the seats can be reconditioned and stem and disc can be replaced without removing valve body from the line.

All the components, piping, tubing, fittings, valves, filters and other wetted parts in the sampling and analyzing system shall be designed to handle the over range of One Fifty (150) percent of operating process parameters.

No PVC/ UPVC, other plastic material or rubber shall be permitted in sample piping except within analysers as furnished by the manufacturer.

All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B31.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

6.9.6.6. Material for other piping and headers

Piping	MOC
Piping from the sample inlet bulkhead fittings to shut-off valve for low pressure samples	ASTM A213 TP316H seamless tube
Piping from the sample inlet bulkhead fittings to pressure reducing valves for high pressure samples and sample blow-down piping	ASTM A213 TP316H seamless tube
Blow-down header	ASTM A312 316, 2” NB Sch. 160 min., pipe header flanged to ANSI B16.5 #3000 RF SS316
Piping from shut-off valves for low pressure samples and from the pressure reducing valves for high pressure samples to the terminal points including branch piping.	ASTM A213 TP316H seamless tube

6.9.6.7. Technical Specification of Analysers and Measuring Cells

i. pH Analyser

Type (Electrode & Transmitter)	Cell – flow through type OR submersible type (for measurement in tank) & Microprocessor based transmitter
Mounting	Insertion (Threaded)
Ambient temp. & RH limit	5-55^{o}C & Upto 95 %
Reference electrode	Gel filled combination type
Electrolyte	Ag/ AgCl
Flow through chamber material	Stainless steel
Transmitter housing Material	Epoxy Coated Cast Aluminum or Polycarbonate
Transmitter Mounting	Panel / 2” pipe
Power Supply	24 V, DC (2 wire)

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Accuracy & Repeatability	≤ ±0.01pH &≤±0.02pH
Output signal	4 – 20 mA DC (isolated signal), HART signal superimposed. Additionally: RS485 or RS 232C bus comm.
Temperature compensation	Automatic 0 to 100°C with Pt – 100 Manual 0 to 100°C in steps 1°C
Alarm output	Yes (contact rating : 48V DC / 1A)
Display	Min 4 digit LCD/LED meter for measuring data & diagnostic
Zero & span	Transmitter built in adjustment
Calibration & adjustment	Through transmitter front facia soft keys & by HART calibrator; 3 point calibration
Remote configuration	Through hand held configurator (HART) or from automation system (through HART signal)
Calibration/configuration data store	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP-66 or better
Connecting Cable length	Min. 3 mtr. For sensor to transmitter
Buffer solution/ tablet	Required for 3 pt. calibration and shall be supplied for testing, calibration& commissioning. Qty. for the period up to 6 months after commissioning.

ii. Conductivity Analyser (Specific and Cation)

Type (Sensor & Transmitter)	Toroidal, Electrode less sensor flow through type OR submersible type (for measurement in tank) & Microprocessor based transmitter
Insulation Material	Glass Filled PEEK
Mounting	Insertion (Threaded)
Ambient temp. & RH limit	5-55°C & Upto 95 %
Insertion rod & Subassembly material	Stainless steel
Transmitter housing Material	Epoxy Coated Cast Aluminum OR Polycarbonate
Transmitter Mounting	Panel / 2" pipe
Power Supply	24 V, DC (2 wire)
Accuracy & Repeatability	≤±1%ofreading &≤±1%ofreading
Output signal	4 – 20 mA DC (isolated signal), HART signal superimposed. Additionally: RS485 or RS 232C bus comm.
Temperature compensation	Yes, Automatic 0 to 100°C with Pt – 1000. Manual 0 to 100°C in steps 1°C
Alarm output	Yes, 2 nos. relay output (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Display	Min 4 digit LCD meter for measuring data and diagnostic
Zero & span adjustment	Transmitter built in adjustment
Calibration & adjustment	Through transmitter front facia soft keys and by HART calibrator; 3 point calibration

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Remote configuration	Through hand held configurator (HART) or from automation system (through HART signal)
Calibration/configuration data storage	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 66 or better
Connecting Cable length	Min. 3 mtr. For sensor to transmitter
Conductivity electrode assembly shall meet the following technical requirements: a) The conductivity cell shall be fail safe construction with guarded electrode. b) Cell constant of the offered conductivity cell shall be selected based on the range of fluid conductivity. c) Conductivity solution for calibration shall be provided.	

iii. Turbidity Analyser

Sensor	Reference type
Operating Principle	Alternating light source or near IR LED
Cleaning	Self cleaning
Electrode holder-type	Flow through
Body material	CPVC
Process connection	½" NPT (F)
Preamplifier	Built-in
Transmitter	
Type	Microprocessor Based with self diagnostic
Enclosure Protection	IP65 Or NEMA 4X IP66
Enclosure Material	Polycarbonate / Beige Polycarbonate
Electrical connection	½" NPT (F)
load indicator	Provided (LCD Display)
Accuracy	<+ 0.2 NTU or <+ 2% of reading Or <+ 0.001 FNU/NTU or <+ 1% of reading
Repeatability	<+0.1ofspan or<+0.1%of range Or<+ 0.001FNU/NTU or<+1%ofreading
Temperature compensator	Built – in
Cable between transmitter & Sensor	To be provided
Zero & span adjustment	Transmitter built in adjustment
Lighting protection	External, mandatory for all applications
Parameter adjustment	Through transmitter front facia soft keys / display menus; 3 point calibration

iv. Dissolved Oxygen (DO_2) Analyser

Measuring principle	Galvanic cell
Transmitter	Microprocessor based
Number of channels	One
Mounting	Local – Frame or wall mounting type
Ambient temp. & RH limit	5-55ºC & Upto 95 %
Enclosure Material	Epoxy Coated Cast Aluminum or Polycarbonate

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Power Supply	24 V, DC (2 wire)
Accuracy	≤±0.5 ppm or ± 0.8 % of FS whichever is more
Temperature compensation	Yes, Automatic 0 to 100°C with Pt – 1000. Manual 0 to 100°C in steps 1°C
Output signal	4 – 20 mA DC (isolated signal), HART signal superimposed. Additionally: RS485 or RS 232C bus comm.
Alarm output	Yes, 2 nos. relay output per channel (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Display	Min 4 digit LCD meter for measuring data and diagnostic
Zero & span adjustment	Transmitter built in adjustment
Calibration & adjustment	Through transmitter front facia soft keys; 3 point calibration
Sample line connection size	½" NPTF through flow through chamber (SS316)
Calibration bottles	Required for 3 pt. calibration and shall be supplied for testing, calibration& commissioning. Qty. for the period up to 6 months after commissioning.
Calibration/configuration data store	In non-volatile memory OR in battery backed RAM
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 66 or better
Lighting protection	External, mandatory for all applications
Mounting kit	Required
Connecting Cable length	Min. 3 mtr. For sensor to transmitter

v. Silica Analyser

Measuring principle	Colorimetric type
Transmitter	Microprocessor based
Number of channels	Multi-channel with sequencer, each analyser shall have at-least two spare channels without sequencer Sequencer make shall be same as that of analyser OEM.
Mounting	Local – Frame or wall mounting type
Ambient temp. & RH limit	5-55°C & Up to 95 %
Enclosure Material	Epoxy Coated Cast Aluminum or Polycarbonate
Power Supply	230 VAC, 50 Hz
Accuracy	≤±1%ofreading or ± 0.5 µg/L whichever is more for range upto 500µg/L
Repeatability	≤±1%ofreading or ± 1 µg/L whichever is more
Output signal	4 – 20 mA DC (isolated signal) for each channel.
Alarm output	Yes, 2 nos. relay output per channel (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Display	Min 4 digit LCD meter for measuring data and diagnostic
Zero & span adjustment	Transmitter built in adjustment
Calibration & adjustment	Through transmitter front facia soft keys; 3 point calibration
Sample line & bypass line size	¼" /6 mm

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Calibration bottles	Required and shall be supplied for the testing, calibration& commissioning. Qty. for the period up to 6 months after commissioning.
Calibration/configuration data storage	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 56 or better
Mounting kit	Required

vi. Sodium Analyser

Type	Sensor: Continuous flow through sample type with sodium responsive electrode and reference electrode having pH adjustment facility Transmitter: Microprocessor based (Max 3 streams/ parameters) Sequencer: Yes, make shall be same as that of analyser OEM.
Ambient temp. & RH limit	5-55ºC & Upto 95 %
Transmitter housing Material	Epoxy Coated Cast Aluminum OR Polycarbonate OR Stainless Steel
Transmitter Mounting	Wall / 2" pipe
Power Supply	230 V AC, 50 Hz
Accuracy	<+5%ofreadingor0.01ppb– whichever is greater
Repeatability	<+5%ofreadingor0.01ppb– whichever is greater
Sensitivity	0.1ppb/0.01ppb based on range
Response time	< 2 minutes for a 90% step change
Temperature compensation	Yes, Automatic 5 to 55ºC with Pt–1000
Output signal	4 – 20 mA DC (isolated signal), 2 nos.
Alarm output	Yes, 2 nos. relay output (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Display	Min 3" VGA TFT display, backlit LCD meter for measuring data and diagnostic
Zero & span adjustment	Transmitter built in adjustment
Parameter adjustment	Through transmitter front facia soft keys/ display menus; 3 point calibration
Calibration	Auto-calibration. Frequency programmable
Remote configuration	Possible from automation system, in case bus communication used.
Calibration/configuration data storage	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 66 or better for transmitter and IP-54 or better for sample cabinet/ wet section.

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Chemical & reagents	Required and shall be supplied for the testing, calibration& commissioning. Qty. for the period up to 6 months after commissioning.
Sampling system	The sample handling system shall include: i) Flow regulator, ii) Flow gauges, iii) Sample rate set valves, iv) Reagent dosing system and other accessories as required.

vii. Chloride Analyser

Type	Sensor: Continuous flow through sample type. Or The chloride monitor shall measure chloride concentrations using ion selective, solid state sensing electrodes. Transmitter: Microprocessor based
Ambient temp. & RH limit	5-55ºC & Upto 95 %
Transmitter housing Material	Epoxy Coated Cast Aluminum OR Polycarbonate OR Stainless Steel
Transmitter Mounting	Wall / 2" pipe
Power Supply	230 V AC, 50 Hz
Accuracy	≤ ±5%of readingor±5ppb, whichever is greater, within ±5°C of calibration temp.
Sensitivity	≤+4% of full scale or 0.1 ppb from 5 to 999.9 ppb range
Response time	< 3 minutes for a 90% step change
Temperature compensation	Yes, Automatic
Output signal	4 – 20 mA DC (isolated signal), 2 nos.
Alarm output	Yes, 2 nos. relay output (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Zero & span adjustment	Transmitter built in adjustment
Parameter adjustment	Through transmitter front facia soft keys/ display menus; 2 point calibration
Calibration	Auto-calibration. Calibration frequency programmable
Remote configuration	Possible from automation system, in case bus communication used.
Calibration/configuration data storage	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 66 or better for transmitter and IP-54 or better for sample cabinet/ wet section.
Chemical & reagents	Required and shall be supplied for the testing, calibration & commissioning. Qty. for the period up to 6 months after commissioning.
Sampling system	The sample handling system shall include: i) Flow regulator, ii) Flow gauges, iii) Sample rate set valves, iv) Reagent dosing system and other accessories as required.

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viii. Residual Chlorine Analyser

Sensor	
Method	Amperometric
Electrodes	Gold Cathode/Silver Anode
Cell Material	PVC
Electrolyte	Potassium Bromide / Potassium iodide
Transmitter	
Type	Microprocessor Based with self diagnostic features
Output signal	4 – 20 mA DC (isolated signal), 2 nos.
Enclosure Protection	IP65 / NEMA 4X IP66
Enclosure Material	Polyester coated Al./ Polycarbonate
Electrical Connection	½" NPT (F)
Transmitter Mounting	Wall / 2" pipe
Display Details	Digital, backlit LCD matrix with keypad
Diagnostics	Required
Resolution	0.001 ppm or 0.01 ppm – selectable
Sensitivity	+/- 0.01 ppm
Parameter adjustment	Through transmitter front facia soft keys/ display menus; 2 point calibration
Calibration	Auto-calibration. Calibration frequency programmable
Electromagnetic compatibility	Required
Temperature compensation	Yes, Automatic with Pt – 100/ 1000
Power Supply	230 V AC, 50 Hz
Zero & span adjustment	Transmitter built in adjustment
Lighting protection	External, mandatory for all applications
Parameter adjustment	Through transmitter front facia soft keys/ display menus; 3 point calibration

ix. Phosphate Analyser

Type	Continuous flow through type
Measuring principle	Calorimetric
Transmitter	Microprocessor based
Display	Backlit LCD with keypad
Transmitter housing Material	Epoxy Coated Cast Aluminum OR Polycarbonate OR Stainless Steel
Ambient temp. & RH limit	5-55ºC & Upto 95 %
Transmitter Mounting	Wall / 2" pipe
Power Supply	230 V AC, 50 Hz
Accuracy	≤ ±5%of reading or +/-0.005ppm
Resolution	0.1 ppm
Response time	<10 minutes for a 90% step change
Temperature compensation	Yes, Automatic
Output signal	4 – 20 mA DC (isolated signal), 2 nos.
Alarm output	Yes, 2 nos. relay output (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Zero & span adjustment	Transmitter built in adjustment

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Parameter adjustment	Through transmitter front facia soft keys/ display menus; 2 point calibration
Calibration	Auto-calibration. Calibration frequency programmable
Remote configuration	Possible from automation system, in case bus communication used.
Calibration/configuration data storage	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications
Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 66 or better for transmitter and IP-54 or better for sample cabinet/ wet section.
Chemical & reagents	Required and shall be supplied for the testing, calibration & commissioning. Qty. for the period up to 6 months after commissioning.
Sampling system	The sample handling system shall include: i) Flow regulator, ii) Flow gauges, iii) Sample rate set valves, iv) Reagent dosing system and other accessories as required.

x. Hydrazine Analyser

Type	Sensor: Continuous hydrazine measurement using electrochemical cell Transmitter: Microprocessor based (max. 3 streams/parameter)
Ambient temp. & RH limit	5-55ºC & Upto 95 %
Transmitter housing Material	Epoxy Coated Cast Aluminum OR Polycarbonate OR Stainless Steel
Transmitter Mounting	Wall / 2" pipe
Power Supply	230 V AC, 50 Hz
Accuracy	<+3%of reading or2 %or+1ppbwhicheverisgreater
Repeatability	<+3%of reading or2 %or+1ppbwhicheverisgreater
Sensitivity	1.0microgram/litre/2ppb/1ppb/0.1ppb
Response time	< 2 minutes for a 90% step change
Temperature compensation	Yes, Automatic 5 to 55ºC with Pt–1000
Output signal	4 – 20 mA DC (isolated signal), 2 nos.
Alarm output	Yes, 2 nos. relay output (2A, 230 VAC, SPDT, non-inductive); Individual alarm setting adjustable
Display	Min 3" VGA TFT display, backlit LCD meter for measuring data and diagnostic
Zero & span adjustment	Transmitter built in adjustment
Parameter adjustment	Through transmitter front facia soft keys/ display menus; 3 point calibration
Calibration	Auto-calibration. Frequency programmable
Remote configuration	Possible from automation system, in case bus communication used.
Calibration/configuration data storage	In non-volatile memory OR in battery backed RAM
Lighting protection	External, mandatory for all applications

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Electrical connections	½" NPT(F), Ni-plated brass or SS double comp. cable glands & SS plug for spare entry.
Enclosure Classification	IP – 66 or better for transmitter and IP-54 or better for sample cabinet/ wet section.
Chemical & reagents	Required and shall be supplied for the testing, calibration& commissioning. Qty. for the period up to 6 months after commissioning.
Sampling system	The sample handling system shall include: i) Flow regulator, ii) Flow gauges, iii) Sample rate set valves, iv) Reagent dosing system and other accessories as required.

6.9.7. Gas Detector

6.9.7.1. Online ambient hazardous gas/LEL detector

Gases to be detected	Carbon monoxide, CBM, Propane, Hydrogen (COG)
Sensor Type	Electro-chemical with shelf-life min. 5 yrs. for Methane and Hydrogen (COG) IR for Methane and Propane
Cross sensitivity for other gases	There should not be any cross sensitivity with hydrocarbon & other gases present
Response time	response time <30 sec.
Local display	LED/LCD (backlit) display on transmitter
Power supply	10-24 VDC (from IS interface/barrier if sensor installed in hazardous area)
Lightning protection	External, mandatory for all applications
Signal output	4- 20 mA DC (isolated), HART
Auto calibration	Yes, Test gases are to be fed and pots to be adjusted.
Operating condition	50 ^{0}C max. and 95% RH max.
Transmitter enclosure	Die cast aluminium, Weather proof to IP 54 & Ex-proof for hazardous area
Intrinsically safe approval	Required (FM/UL/BASEEFA/ATEX approval) for hazardous area
Transmitter Type	Microprocessor based, 2" pipe mounting type
Alarm output	2 NO/NC contacts per channel for alarm and 1 NO/NC contact for common fault
Alarm setting	To be decided during detailed engineering considering the hazard/LEL limit of the gases
Alarm limits	Programmable (adj. throughout the range)
Accessories	Flasher Lamp & Hooters :- For field mounting, Ex-proof, Shall be suitable for outdoor mounting. Hooters shall be electronic type with volume adjustment, 100 dB min., 24 VDC operated. Hooter Control Room mounted:- Weather proof, suitable for indoor mounting. Hooters shall be electronic type with volume adjustment, 24V DC operated, driven by DDCMIS.

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Testing calibration kit	Yes(02 sets), including Span gas & zero gas cylinders for all the gases to be detected.
Portable gas detector	20 sets

i. Portable Calibrator (02 sets)

a) Portable calibrators consisting of a volume bottle containing a known gas/air mixture, a pressure regulator, a flexible hose, adapter cap (to fit the sensing head) and carrying case shall he supplied to enable calibration of the sensors in the field without dismantling the gas detector.

b) Sufficient quantity of calibration gas cylinders (2 sets) shall be supplied to enable calibration of all sensing heads at least thrice considering minimum 1 minute for each detector. Vendor to ensure that the composition and stability of the calibration gas provided in the gas cylinders shall be suitable for minimum one year.

c) All detectors shall be supplied pre-calibrated at vendor's works either with the gas to be used or by applying cross sensitivity factors.

ii. Portable Gas Detectors (20 sets)

a) The portable gas detectors shall be supplied for the use of operating/ maintenance personnel.

b) It shall have audio-visual alarm, vibration alarm and shall be suitable to use in specified hazardous area.

c) Built-in indication (back light LCD/LED display) for the measured value shall be available. It shall have intrinsically safe electronics and shall be certified by FM/UL/BASEEFA/ ATEX.

d) These units shall be battery powered and shall be supplied with rechargeable battery and 240 VAC, 50 Hz battery charger, if available.

e) These units shall be supplied with its accessories such that carrying case, maintenance kit, calibration kit etc.

f) Portable gas detector shall have the facility to detect leakage of BF Gas, BOF Gas, Coke Oven Gas, Propane and CBM.

6.9.8. Condition Based Monitoring System (CBMS)

Artificial Intelligence based Condition Based Monitoring System shall be provided for all the Steam Turbine Generators, Steam Turbine driven Blowers and all other HT rotating equipment. The bidder shall offer 19” rack based API 670 compliant microprocessor based continuous, on-line CBMS that shall automatically acquire data related to the mechanical health of rotating equipment and display vibration and other machine data for Steam Turbine Generators, Steam Turbine driven Blowers and all other HT rotating equipment under this package. The CBMS shall exchange data with the DDCMIS for viewing, trending, alarming of machine parameters and system diagnostic.

The CBMS system shall be broadly classified into the following two categories:-

i. Turbine Supervisory Instrumentation(TSI) for Steam Turbine Generators and Steam Turbine driven Blowers
ii. Vibration Monitoring System(VMS) for all other HT equipment

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The CBMS shall be complete including probes/sensors, anti-corrosive mounting pads, driver/transducers/conditioner, extension cables, converters, monitors, measuring and amplifier modules, power supplies, networking hardware, application/configuration software etc. with the required accessories including twisted and shielded instrumentation cables, compensating cables, junction boxes etc. The TSI system for each STG and STB shall be provided with dedicated hardware, no hardware sharing shall be allowed. Any failure or upset in one TSI system shall not affect the functioning of the other TSI system.

6.9.8.1. System Requirement

The AI based CBMS system shall be used for monitoring the following equipment parameters and provide the supervisory functions:-

i. Axial shift of the rotor with min. 03 sensors for each measuring points.
ii. Turbine speed sensors for Governing System. Speed sensors shall be provided in triple redundant configuration.
iii. Turbine speed sensors for Turbine Overspeed protection. Speed sensors shall be provided in triple redundant configuration.
iv. Zero speed Indication
v. Absolute shaft vibration in 'X' and 'Y' direction for turbine, blower and generator
vi. Relative shaft vibration in 'X' and 'Y' direction for turbine, blower and generator
vii. Absolute bearing vibration in 'X' and 'Y' direction for turbine, blower and generator
viii. Casing vibration
ix. Shaft eccentricity measurement
x. Reference phase measurement (Key Phasor) for steam turbine, generator and blower.
xi. Differential expansion of rotor and cylinder for turbine
xii. Overall expansion of turbine
xiii. Emergency stop and control valve position
xiv. Stator blade position indication for blower
xv. Thrust pad metal temperature measurement (min. 04 nos.)
xvi. Turbine and generator bearing metal temperature detection
xvii. Turbine and generator drain oil temperature detection
xviii. Generator winding temperature measurement
xix. Vibration monitoring (along X & Y axis) of all HT drives (both pump and motor) on DE and NDE.

The bidder shall offer eddy current proximity sensors for the measurement of shaft vibration, position, key phasor, axial shift, eccentricity and overspeed detection of the turbines, generators and blowers. Hall effect speed sensors shall be used for DEHG (turbine governing) control. The operating temperature of the probe and their extension cable shall be atleast 177 ^{O}C and if required sensors with higher operating temperature shall be provided based on process requirement.

The turbine casing expansions hall be monitored using linear variable differential transformer (LVDT) sensors to measure casing growth relative to the machine foundation. LVDT sensors shall also be used for monitoring valve position. Eddy current sensors shall be used for monitoring continuous differential expansion (both magnitude and direction) of the turbine assembly.

For measurement of the turbine, generator and blower bearing housing vibration, piezoelectric velocity type sensors shall be used. Piezoelectric velocity type probes shall be used for measurement for vibration measurement of all other HT drives also. The operating temperature of the probe and their extension cable shall be atleast 120 OC and if required

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sensors with higher operating temperature shall be provided based on process requirement.

All the field sensors/probes for the CBMS system shall be provided with SS 304/316 casing. All the filed sensors shall be weatherproof to IP-67. The sensors/probes shall be hermetically sealed. The terminals of the extension cables shall be gold plated.

Transducers shall be furnished in weatherproof (IP-65) housing(junction box) suitable for field conditions. Cables/cabling from transducers local JB to Vibration Monitoring system in Control Room/Control Equipment Room shall be provided by the Bidder.

The system shall be provided with suitable hardware for necessary signal processing. The system should be capable of signal distribution and interfacing with the DDCMIS. The system shall provide 02 nos. of isolated 4-20 mA DC analog output signals against each measurement. Each measurement point shall be provided with 02 nos. of relay contacts(potential free) to generate alarm & trip contact signals to the DDCMIS. The alarm and trip set points shall be continuously adjustable throughout the measurable range. A redundant soft connectivity with the DDCMIS and A&D system shall also be provided.

Microprocessor based monitor modules shall not have more than 4 Channels per module. Online removal and replacement of monitor module shall be possible without causing any process upset. The monitors shall have provision for broken sensor failure detection without system causing process upset or system shutdown. LED indication shall be provided on the front of each module to indicate alarm conditions and circuit faults. Any failure in one channel shall not affect the functioning of other channels. Redundant sensor shall be wired to different monitors using separate field cables.

All the monitor modules provided by the bidder for this project shall be suitable for undertaking the analysis and diagnostics functionality using the Analysis and Diagnostics system of AI based CBMS system. Any additional hardware or software required for carrying out analysis and diagnostics shall be provided by the bidder. Facility shall be provided to acquire and transfer the ‘RAW’ data to the A&D system.

Each CBMS shall be fed from redundant 230V AC power supply feeders from the UPS. The conversion of the power supply shall be carried out inside the CBMS cabinet as per the requirement of the system by the bidder. All the necessary power supply packs and other devices required to convert the above supply to the levels required by monitors / transducers / other electronics shall be redundant & shall be provided by the Bidder.

Panel mounted min. 10” touchscreen based Graphic User Interface (backlit display unit) or a panel mounted laptop (14”) shall be provided for monitoring, configuration and testing purpose of the monitors. The display unit shall be used for the programming and configuration of the CBMS system. The bidder shall provide a project specific application/configuration software for this application with perpetual licence. Additionally, one Laptop with all required software and hardware including communication cable between laptop and rack shall be provided by the bidder. The bidder shall ensure seamless interface/connectivity between the laptop and rack for programming and configuration of the Rack. The software licences for the laptop shall be separate from rack mounted display license and shall come with perpetual validity. The bidder shall also install the antivirus software on the laptop and rack mounted display unit (if applicable) with perpetual license. Hard key shall be provided at rack to prevent unauthorized access to the system configuration.

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Potential free contacts shall be provided to DDCMIS for annunciation of the system failure and power supply failure. System failure shall be annunciated either on rack basis or unit basis (i.e. STG, STB, BOP etc.) as per the bidder's standard practice.

All the modules, transducers and sensors for CBMS system shall be conformal coated to G3 rating as per IEC 60068.

The bidder shall provide one CBMS workstation with 27" dual monitors. 01 no. colour laser printer for printing facility upto A3 sheets shall also be provided.

Test calibration instruments/jigs, shakers table etc., for site calibration of all sensors of CBMS shall be provided by Bidder.

The CBMS shall have provision for time synchronisation with GPS based Master Clock System.

6.9.8.2. Analysis and Diagnostics(A&D) System

The A&D system shall automatically acquire & analyse static, dynamic and transient machine data for detection and diagnosis of machine fault or malfunction. A&D system shall take care of predictive maintenance of machine/equipment and guide (prescriptive maintenance) the plant maintenance personnel regarding the nature of fault and the maintenance action required.

The A&D system offered by the bidder shall be based on the open platform. It shall be able to accept machine data from third party machine health monitoring systems for the analysis of the machine data for the predictive maintenance of the equipment.

The A&D system shall have dual redundant interface with the TSI racks and DDCMIS and monitoring systems to acquire raw data for further analysis and alarms.

The bidder shall provide redundant A&D server with 27" monitor. 01 no. multifunction colour laser printer for printing facility upto A3 sheets shall also be provided. Analysis and Diagnostics(A&D) server shall be capable of running several software including client software, on single platform and interfacing with multiple machinery protection racks using communication link. A&D server shall adequate memory to store the machine data for a period of atleast 05 years. Configuration and downloading of programs for different modules shall be executable from this server with at least two levels password protection.

The A&D system shall have include the following analysis and display features with decision support system as a minimum:-

i. Graphical plant and machine area presentation with location of sensors and their current value
ii. Analysis of the transient machine data
iii. Machine malfunction, fault and failure root cause analysis
iv. Bar graph and point display indicating the set points
v. Multiple Trends - transient and historical including process value for data correlation
vi. Bode / Polar / Nyquist / Cascade plots
vii. Waterfall plot
viii. Diagnostic of the system and machine data
ix. Spectral band and waveform plotting including Lissajous waveform
x. Online Spectrum / Harmonic analysis
xi. Orbit and time base plotting
xii. FFT analysis

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xiii. Shaft centreline plot indicating position of a machine, for the Turbine, Generator& Blower.
xiv. Storage and comparative analysis of the machine health data with decision support system
xv. Automatic audit of the machine health periodically or on request.
xvi. System and machine diagnostics
xvii. Current and historical trends
xviii. Date and time stamped alarm/trip list

The system shall have capability for Log & Report generation and there shall be provision for alarm annunciation.

The A&D System shall utilize both vibration and process information from the Data Acquisition software plus programmed rules to provide clear analysis and recommendations for effective machinery management. Rule generator shall reject any rule, which is not syntactically correct. It shall be an extensive and accurate knowledge base to enable quick determination of the condition of a machine by providing alarm notification or advisories of the machinery malfunction. It shall also have the capability to send advisories through e-mails and messages.

Presence of the frequently occurring machine malfunctions / occurrence to be detected by the system shall be, but not limited to, High synchronous vibration, Misalignment, Unbalance, Shaft bow / crack, Fluid induced instability (Whirl and Whip), Radial pre-load forces (including misalignment), Vector change, Rotor rub, Looseness of rotating parts, Gear mesh problems, pump cavitation, resonance with critical speed etc. for Turbine, Generator, Blower and all HT machines.

Data collected in the system shall also be accessed on the plant wide area network for condition based predictive maintenance.

Bidder shall supply the licensed version of all the applicable software in run & edit mode for the system and for integration of his system with third party system such as DDCMIS & Analysis system. All the software required for the A&D system shall be supplied with project specific perpetual licence, the bidder shall note that software with machine specific licenses is not acceptable. Redundant Bi-directional OPC connectivity with DDCMIS shall be provided.

6.9.8.3. Vibration Transmitters (for HT drives)

Type	With LCD/LED display, Microprocessor based
Input Transducer	Velocity sensor or Acceleration sensor
Measured values	Peak or RMS value for velocity; Peak to peak value for acceleration
Unit of measurement	mm/sec for velocity; microns for acceleration
Number of channels	One or two
Location of mounting	In JB at field or remote panel mounted type
Output	4-20 mA DC for each channel. Two relay contacts for each channel, pre-trip alarm and trip alarm per ch.
Accuracy	<+ 2 % of full scale
Power supply	24 VDC or 230 VAC, 50 Hz
Communication port	RS 485 for remote panel mounted version
Operating temp. & Humidity	50 ^{0}C & 95% RH non-condensing
Parameter setting	Possible

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Lightning Protection	Yes, external mandatory for all applications
Broken sensor failure detection	Yes, for both the channel

6.9.8.4. Remote Service Centre

The bidder shall offer IoT based remote analysis and diagnostics service of the CBMS system. This shall also include the remote service facility for the CBMS system. The CBMS OEM remote assistance centre shall be able to access the plant CBMS system to acquire, analyse and carry out fault diagnostics of the CBMS and rotating machinery. Upon the diagnosis of the fault, the remote service centre shall provide the operator with guidance for further action to be taken for addressing fault and further maintenance of the CBMS or rotating equipment.

The connectivity between the Remote Service Centre and the plant CBMS/A&D System shall be on a secure network with state of the art network security features. No data shall be compromised during the data transmission between the Remote Service Centre and the plant CBMS/A&D System. Remote service facilities shall be provided upto the commissioning of the CPP, with a facility for further extension of the service 'ON DEMAND' by the Purchaser.

All the hardware or software requirement for the implementation of remote service facility shall be provided by the bidder. The bidder shall provide dedicated workstation for remote service facility, if required. However, it is desirable to access this facility from CBMS workstation and A&D servers.

6.9.8.5. Spare Philosophy

The bidder shall provide adequate installed spares (hot spares) in the CBMS for future requirement or expansion:-

i. 01 no. channel shall be kept as spare in each monitor.
ii. 02 nos. of channel shall be kept as spare in each relay module.
iii. 01 no. monitor of each type shall be kept as spare for each system i.e. Steam Turbine Generator and Steam driven turbo blower. Bidder shall note that TSI system of each STG and STB shall be considered as a separate system.
iv. Wired space shall be for installing one monitor module of each type in each TSI system.

6.9.8.6. Portable Vibration Analyzer cum Balancing Unit

One set of easy to carry microprocessor based Portable Vibration Analyzer cum Balancing Unit shall be provided by the bidder for the CPP. The Vibration Analyzer cum Balancing Unit shall preferably be offered from the same make from which the CBMS is being proposed by the bidder. This is required for seamless integration of A&D system and CBMS for data transfer and analysis. The vibration analyzer cum balancing unit shall be offered with the following minimum specifications:-

i.	Type	:	Portable
ii.	No. of channels	:	04 channel
iii.	User Interface	:	Keypad or touchscreen
iv.	Compatibility with A&D system	:	Yes, required
v.	Diagnostics & analysis	:	Yes, software required
vi.	Sensors with cable and magnets	:	Triaxial sensor – 02 nos.

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			Accelerometers – 02 nos. Velocity probes – 02 nos. Tachometer probes – 02 nos. Phase sensor – 01 no. Temperature sensors – 02 nos.
vii.	Frequency range	:	DC to 80 kHz
viii.	Display	:	Colour LCD
ix.	PC connectivity	:	through USB or ethernet with cables
x.	Bluetooth	:	Yes
xi.	Wireless connectivity	:	Yes
xii.	Memory	:	min. 1 GB internal
xiii.	Lines of resolution	:	12800
xiv.	Balancing facility	:	Yes, 2 plane
xv.	Battery type	:	Rechargeable
xvi.	Battery charger	:	To be provided
xvii.	Protection	:	Weatherproof to IP-65
xviii.	Hazardous area approval	:	CCOE, ATEX etc.
xix.	Carry case	:	Yes, required

Acceleration, Velocity, Displacement, Phase, FFT, CPB, HFD spectrum, Temperature, Thrust, Axial position etc. with auto ranging in RMS, peak to peak, bearing fault analysis feature, balancing kit for in situ dynamic balancing and required software for 1 plane, 2 plane balancing, route generation and maintenance facility with off route data collection and analysis shall be provided.

The Analyser shall be provided with data collector as an integral part of the instrument, which shall be capable of collecting various user defined data. The Analyser cum data collector shall also be provided with predictive maintenance software which shall store and manipulate data. Also, user defined upload communication and down loading data to A&D system shall also be provided.

6.9.9. Continuous Emission Monitoring System (CEMS)

PC based continuous emission monitoring system (CEMS) shall be provided by the bidder for the flue gas from each boiler. Boiler/stack emission monitoring system shall monitor, record and report SO_X/NO_X, CO, Opacity, Un-burnt Hydrocarbon, stack gas flow, stack gas temperature, stack gas pressure & moisture (for in-situ and sampling based without moisture removal) in flue gas. Dedicated CEMS with separate gas analysis system shall be provided for each boiler by the bidder.

The flue gas analysers shall be mounted at elevations suggested by prevailing CPCB/SPCB guidelines. The analysers shall be easily accessible for maintenance and bidder shall ensure that maintenance platform is provided for each analyser.

A dedicated CEMS PC (common for all 03 boilers) with calculations software, application

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software, report generation software packages, diagnostics and data logging features & A4 colour LJP and laptop for site calibration shall be provided. Complete furniture as required for CEMS local control rooms shall also be provided by Bidder. Each Analyser shall be provided with RS232C/RS485/Ethernet TCP/IP output required to connect with CEMS PC, and port for calibration from Laptop.

All output signals of all stack monitoring analyzers shall be hardwired and connected to plant DDCMIS & CEMS PC for monitoring, archiving and report generation as per the requirement of CPCB/SPCB or any other statutory body. DDCMIS & CEMS OWS shall be equipped/loaded with necessary CEMS application software packages for performing calculations and generation of report for submission to CPCB/SPCB or any other statutory body. The CEMS application software with perpetual license shall be provided by the bidder. 03 nos. of licenses shall be provided by the bidder for CEMS application software i.e. 01 no. for DDCMIS, 01 no. for CEMS PC and 01 no. CEMS Laptop. Application software shall have the following minimum capabilities:-

i. Visualization of acquired values of data from all analysers.
ii. Average computation of data (programmable time like 30min, 1hour, 48 hours or 1 week).
iii. Trend representation of raw, and averaged data (trend time period shall be freely selectable).
iv. Archiving in simple formats like MS Excel etc.
v. Alarm setting and annunciation.
vi. Calibration procedures.
vii. Normalization of emission data.
viii. Annual cumulative mass of pollution using flue gas flow and emission values.
ix. Capabilities of comparison of data w.r.t. standard /threshold values.
x. Providing remote access to calibration and configuration.
xi. Channel configuration for range, unit etc.
xii. Data storage capacity.
xiii. Auto Report generation.
xiv. Diagnostics.
xv. Data transmission.
xvi. All the necessary algorithms shall be provided to achieve system capability.

Communication link shall be provided between the CEMS PC and DDCMIS for the monitoring and analysis of the CEMS data in DDCMIS. Facility to send data to Central servers of CPCB/SPCB shall also be provided; the complete responsibility of interfacing with CPCB/SPCB servers shall be in the scope of the bidder.

Each analyser shall be independent and shall not share power supply, processor etc. with other analyser except compressor for purging air. Separate compressor shall be provided as a part of CEMS.

In addition to continuous emission monitoring system, manual sampling provision for flue gas monitoring should be provided as per prevailing regulations of CPCB in each stack along with necessary provision of platform, illumination, safety rails and ladders etc. complete in all respect.

A programmable logic controller shall be provided for signal output, alarms, calibration cycle timers and measurement indication for each analyzer. The controller shall be placed in

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the airconditioned CEMS room. The controller shall be panel or rack mounted and furnished with interconnecting cable to the field-mounted analyzer. Calibration cycle time shall be set over fixed internals and automatically sequenced by the controller. Alternatively, Bidder may use the control system with integral operating station in lieu of a programmable controller, provided the CEMS meets full certification criteria.

The flue gas analyzers shall be compliant to the latest norms of CPCB/SPCB. The analysers shall also conform to EPA, TUV, MCERTS or equivalents regulations.

Output of CO, CO2, SOX/NOX, Dust monitors, Stack flow analyser etc. shall be normalized for Temperature, Pressure, moisture etc. This facility should be provided in the respective gas analyzers by the bidder. Any additional accessory or instrument required for normalization or compensation shall be provided by the bidder.

All the analysers shall be suitable for the operating pressure and temperature at the Stack. Weather protection canopies against exposure to direct sunlight, rains etc. for CEMS equipment shall be provided.

Continuous Emission Monitoring system consisting of the following min. equipment (Analysers/monitors) shall be provided for measurement of emissions in stack of each boiler:-

i. SO_X analyser
ii. NO_X analyser
iii. CO analyser
iv. CO_2 analyser or O_2 analyser
v. Unburnt Hydrocarbon
vi. Stack Opacity Monitor
vii. Flue gas flow
viii. Flue gas temperature
ix. Flue gas pressure
x. Flue gas moisture (if required as per CPCB guidelines)

Any other analyser or equipment required for the completeness of the CEMS as per SPCB/CBCB guidelines shall be in the scope of bidder.

6.9.9.1. Combined Flue Gas Analyser

Measurements	Simultaneous measurement of SO_x, NO_x, CO & CO_2 or O_2concentration in flue gas at stack
Type of sensor	Microprocessor based Non-dispersive Infrared (NDIR) for all other than O_2. O_2 sensor shall be paramagnetic or zirconia based.
NO to NO_2converter	Required
Range	Programmable, as per process requirement
Location of measuring point	As per prevailing CPCB guidelines
No. of Probes	Dual
Probe MOC	SS316 with coating, shielding or tube for protection
Probe back purge facility	Yes including outside probe purging
Sampling pipe size	SS316, 12 mm OD (self-regulating, duplex tube type heat tracer) line up to analyzer panel (one of the duplex tube shall be kept spare). ¼”OD tube from cooler to analyzer unit.
Sampling gas filter (near probe)	SS 316 housing, SS outlet filter, 5 µm, 100% retention

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	capability for particle size ≥ 5 µm.
Sampling gas cooler:	Yes, with moisture free sample through cooler &automatic condensate discharge facility. Redundant cooler (each with dual path) & redundant peristaltic pump & vessel for discharge. Cooler selection through 3 way solenoid valve. Individual path shall have sample pump & venting pump.
Sample gas pumps	Yes, Redundant for sample line. Selection thro' 3 way SOV
Diaphragm filter	Yes, Redundant filter system, manual selection through 3 way valves, SS housing
Pressure reducers cum regulator	Yes, for each gas cylinder, Dual stage
Gas tubing for calibration gas	6mm, Stainless Steel for outside & PTFE for inside panel
Condensate monitor	Required with membrane filter &alarm unit
Flow meter	Rotameter with s/w contact for low sample flow to analyzer
Press. Gauge with switching contact	Required in sample line to analyzer
Temperature controller with contact	Required for heat tracer control &failure indication
Air filter regulator	Yes, for air purging, wherever required.
Pressure safety valve	Yes, at the outlet of sample pump
Calibration gas cylinders	Zero gas, Span gas &gas for intermediate point
Linearity deviation (% of span)	<+ 1% for each component
Drift (for zero &span)	<+ 1% of span for each component
Performance accuracy	<+ 10% for each component
Output signal	Isolated 4–20mADCfor the measuring range (for each component), linear scale
Communication	Digital communication between the analyzer PLC & CPCB/SPCB server shall be provided for the measured parameter, diagnostic signals &auto-calibration (remote).
Alarms	02 nos., setting freely adjustable
Normalisation	Dynamic, for pressure, temperature and moisture
Display	Min. 7" touch screen based HMI display for the measured value and self-diagnostics
Power supply	230VAC, 50Hz, 1 phase from UPS for analyzer system and Non-UPS power for heat tracing & panel fan & lights
Gas inlet & purging connection	¼" or 6 mm tube for inside analyzer cabinet
Analyzer vent connection	Yes, with necessary piping (3mtr.) & fittings (incl. isolation valve)
Material of gas conducting parts	PTFE fittings &tubing's inside analyzer cabinet
Case protection	By vendor
Type of mounting	Panel mounting
Calibration	Auto calibration (with initiation from CPCB/SPCB & also manual initiation from analyzer PLC)
Certification	MCERTS or TUV or USEPA
NOTES:	

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i.	Redundant sampling handling and conditioning system shall be provided from probe to analyser
ii.	Capacity of calibration gas cylinders shall be 30 ltrs. each for mixed gas and 10 ltr. each for component wise gas cylinder.
iii.	Calibration gas cylinder material of construction shall be SS or Aluminium.
iv.	Two sets of Calibration gas cylinders shall be provided with each set of analyser.
v.	One set of industrial double stage SS pressure regulator shall be provided for zero, span gas and intermediate gas
vi.	Pressure regulators shall be provided with inlet and outlet pressure gauge.
vii.	Purging/scavenging system with all accessories shall be provided.

6.9.9.2. Dust and Opacity Analyser

Type	In-situ, micro-processor based, Double by-pass system based on visible opacity
Measurement variables	Dust concentration and Opacity
Temperature compensation	Yes, dynamic.
Range	Programmable, as per process requirement
Light (LED) source life	≥ 5 years
Performance Accuracy	<+ 10% of compared reference measurement
Zero drift between 2 servicing intervals	<+ 2% of full scale range
Ref. point drift bet. 2 servicing intervals	<+ 2% of full scale range
Analyzer's linearity	The diff. bet. the actual value & ref. value <+ 2% of full scale range
Response time	90% in 5 seconds or better
Measurement averaging	Fully selectable from 10 sec. to 30 days
Calibration facility	In built automatic zero & span calibration
Automatic path length setting	Yes
Automatic misalignment detection	Yes, with warning signal
Span and Zero Check/ interval	Automatic with manual override. User selectable interval between 1 hour and 72 hours in steps of 1 hour
Operating temp range	60 ^{0}C for Transceiver & Control Unit
Field Electronics	50 ^{0}C
Electrical Failure	Automatic shutter operation/ window protection to protect lenses and reflectors
Purge air failure	Same as electrical failure
Alarm facility	02 nos., setting freely adjustable
Readout	Digital indicating meter/bar graph on the control unit.
Output	Isolated 4-20 mA DC linear, 2 Nos., one configured for opacity and another for dust concentration. RS 485 digital comm. also.
Enclosure class for In-situ analyzers/Field Instruments.	IP-65/NEMA-4X
Power Supply	240 VAC, 50 Hz, 1 phase from UPS
Mounting	Directly on the stack
Process connection	Flanged, ANSI B16.5

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Special cable	As required between trans-receivers and between sensor & control unit
Certification	MCERTS or TUV or USEPA
Accessories:	
Field Termination Box	For mounting control unit, Power supply and output terminations and control electronics of Fail-Safe Shutters.
Purge air system	Purge air blower (1 each for transceiver & reflector with 10 mtr. hose). Power supply for blowers 240 VAC,50 Hz, 1Φ
Automatic Fail Safe Shutter	Required (complete for measuring head and reflector)
Weather Protection Cover	For measuring head, for reflector and for purge air blowers

NOTES:

i. The continuous Particulate Matter monitoring system (PM-CEMS) shall ideally be calibrated at three operational loads against isokinetic sampling method (triplicate samples at each load) nine samples in three loads at the time of installation and thereafter.

ii. Adjustment of Calibrated Dust Factor (CDF) shall be allowed only after full-scale calibration of PM CEMS. Change of CDF permitted only after approval by SPCB/ PCC or after one week of submission of request to SPCB/PCC whichever is earlier.

iii. Field calibration of dust monitor shall be done at site during commissioning of the plant, using iso-kinetic sample and K factor compensation shall be done accordingly.

iv. It shall be bidder's responsibility to do the isokinetic sampling from a certified agency.

6.9.9.3. Hydrocarbon Analyser

Principle	Fluid Ionisation Detector
Type	Microprocessor based
Measurement variable	Total hydrocarbon in flue gas
Range	Adjustable, as per process requirement
Minimum detectable limit	1 ppm
Response time (T90)	< 60s
Accuracy	1.0% of full scale
Repeatability	1.0% of full scale
Linearity	1.0% of full scale
Output	Isolated 4–20 mA DC for the measuring range (for each component), isolated, linear scale
Alarm facility	02 nos., setting freely adjustable
Communication	RS-485, Ethernet
Power Supply	240 VAC, 50 Hz, 1 phase from UPS
Display	Backlit LCD with key pad
Electronics	19" rack mounted
Calibration	Automatic, with required hardware and software
Calibration cylinder	Yes, for zero and span gas
Span & zero check	Automatic
Probe	Yes, SS 316
Probe filter	Yes

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Sample Handling System (SHS)	Heated sample handling system shall be provided.
SHS components	Converters, filter, flow indicator, flow control valve, pressure regulator, pressure gauge, five way valve, fine filter, gas suction pump, sample cooler, condensate separator, sample line with electrical heat tracing, thermostat control, sample distribution valve, sample blowing line, vent header with isolation valve, dryer etc. *Any other accessory required for achieving the full functionality of the analyser shall also be provided by the bidder.*
Probe Mounting	Flanged
Other features	Diagnostics Automatic fuel shut-off Automatic flame out indicator Pressure and temperature compensation
Certification	TUV or EPA

NOTES:

i. It is bidder's responsibility to offer a fully functional Hydrocarbon analyser.
ii. Any additional hardware/accessory required for achieving the desired functionality shall be provided by the bidder.
iii. Software and all cables/connectors required for the diagnostics, configuration, calibration and communication shall be provided by the bidder.
iv. Capacity of calibration gas cylinders shall be 30 ltrs. each.
v. Calibration gas cylinder material of construction shall be SS or Aluminium.
vi. Two sets of Calibration gas cylinders shall be provided with each set of analyser.
vii. 02 nos. of fuel gas cylinders along with 02 nos. of carrier gas cylinder shall be provided. The capacity of each fuel gas cylinder shall be 50ltr
viii. One set of industrial double stage SS pressure regulator shall be provided for zero, span gas and each type fuel gas
ix. Pressure regulators shall be provided with inlet and outlet pressure gauge.
x. The HC analyser shall be mounted on a dedicated free standing type panel (IP-54).

6.9.9.4. Ultrasonic type Stack Gas Flowmeter

Probe	
End connection type	Flanged, ANSI B16.5, 150#
No. of probe	Cross duct or one sided. For cross duct, access platform /stair landing shall be provided for both the probes.
Probe material	SS 316 or better
Purging/ cooling	Yes, to be provided using blowers
Trans-receiver units	
Operating principle	Transit time ultrasonic
Measuring parameters & units	Velocity: m/sec, Flow: m3/hr. & Temperature: ^{0}C
Ambient temperature limit	Upto 60 ^{0}C
Accuracy	$\underline{<+}$ 0.1 m/s for Vel. >3 m/s
Resolution	0.05 m/sec or better for Vel. >3 m/s

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Repeatability	≤ 0.2 m/sec
Calibration	Factory calibrated
Electrical Connection	½" NPTF
Enclosure Class	IP 65 or better
Enclosure material	Epoxy coated aluminum/ SS
Power Supply	230 VAC, 50 Hz from UPS
Display/ control unit:	
Enclosure Class	IP 65 or better
Electrical connection	½" NPT (F)
Indication	Yes, LCD/LED Display, flow rate, vel. & temp. in engg. Unit
Analog output	3 nos. 4-20 mA DC, flow, velocity & temp.
Digital output	4 nos. potential free contacts
Parameter setting	Through keypad
Communication protocol	RS 485 MODBUS/ RS 232C
Electrical Connection	½" NPTF

6.9.9.5. Portable Flue Gas Analyser

Sensor type	Electrochemical for O_2, CO, SO_2 and NO K-type thermocouple for temperature measurement NO_X and CO_2 shall be calculated
Parameters &Range	Oxygen (O_2): 0 to 21 % (By volume) Carbon monoxide (CO): 0 to 10000ppm (Max) Nitric oxide (NO): 0 to 1000ppm (Max) Sulphur dioxide (SO_2): 0 to 2000ppm (Max) Carbon dioxide (CO_2): 0 to 20% calculated NOx calculated Combustion efficiency Flue gas temperature Ambient temperature Flue gas draft measurement Range extension facility shall be provided for all parameters.
Accuracy	Oxygen (O_2): ± 0.2 vol- % Carbon monoxide (CO): ± 5% of reading upto 2000ppm, ± 10% of reading in the 2000ppm-4000ppm range Nitric oxide (NO): ± 5% reading upto 1000ppm Sulphur dioxide (SO_2): ± 5% of reading upto 100ppm, ± 10% of reading in the 100ppm-2000ppm range
Resolution	Oxygen (O_2): 0.1 % Carbon monoxide (CO): 1 ppm Nitric oxide (NO): 1 ppm Sulphur dioxide (SO_2): 1 ppm Carbon dioxide (CO_2): 0.1 % NO_x: 1 ppm
Display	Backlit LCD display unit. Provision for configuration shall be provided from the display.
Connectivity	Wi-Fi, Bluetooth
Communication	USB, connecting cable shall be provided

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Software	Application software for calibration, configuration, data storage and communication with PC shall be provided.
Sensor life	Atleast 12 months, with residual life indication/detection
Diagnostics	Self diagnostic facility shall be provided
Calibration	Self calibration with ambient air for O_2 Manual calibration for O_2, CO, SO_2 and NO using calibration cylinder and software application
Data logging	Data logging facility shall be provided with minimum storage for 1000 points
Battery capacity	Shall be suitable for continuous operation of 08 hours with suction pump in operation.
Battery charging	Online, without removal of battery from device. Power adaptor shall be provided alongwith spare battery.
Input power	230V AC
Probe	Yes, to be provided. MOC shall be SS 316. Length shall be finalized during detailed engineering
Suction pump	Built-in suction pump with ability to create 1500mmWC suction pressure. The pump should be capable to operate on battery.
Process connection	As per OEM standard.
Moisture removal	Yes, integrated facility shall be provided.
Filters	To be provided at probe inlet and after suction pump before the sensor inlet
Purging	Purging facility to be provided for all gases
Safety feature	High CO cut-off and alarm facility shall be provided
Carry bag	Yes, waterproof preferably leather.
Calibration report	Yes
O&M manual	To be provided

6.9.10. Online Electronic Dew Point Monitor

Type	Microprocessor based
Sensor	Ceramic metal oxide or capacitive thin film polymer
Display	Digital
Analog output	4-20 mA
Digital output	MODBBUS
Power supply	24V DC
Accuracy	±2 ^{O}C
Range	-60 ^{O}C to +60 ^{O}C
Filter	Stainless steel sintered
Enclosure	SS
Enclosure protection	IP-65 or better
Autocalibration	Yes
Temperature compensation	Yes
Condensation	Insensitive to condensation
Calibration certificate	Yes, to be provided

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6.9.11. Furnace Temperature Probe

Bidder shall provide two numbers of furnace temperature probes before platen super heater region and shall be electrically operated, fully retractable type. The furnace temperature probes shall be furnished with complete actuating mechanism and all the logics required for the actuating mechanism. The probe shall be provided with position transmitters, limit switch & indicator for remote indication. Each temperature probe shall have a duplex thermocouple suitable for the measurement range. Bidder shall furnish complete details of the temperature probe along with all the technical catalogues including the details of the actuating mechanism, position transmitters and limit switch which shall be subject to Purchaser 's approval. The logics for furnace temp. Probe shall be implemented in the DDCMIS.

6.9.12. Control Valves

The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the “Federal Occupational Safety and Health Standards, USA” or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Sub-section shall be fully suitable and compatible with the modulating loops covered under the Specification.

6.9.12.1. Control Valve Sizing Criteria

The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.

The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA handbook on control valves. While deciding the size of valves, Bidder shall ensure that valves trim exit outlet velocity as defined in ISA handbook does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which shall be subject to Purchaser’s approval during detailed engineering.

Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti cavitation trim shall be provided. Detailed calculations to establish whether cavitation shall occur or not for any given application shall be furnished.

Control valves for application such as Feed water control valve, main steam dumping spray control valves, APRDS control valves, Soot blower control valve, SH Spray Control, HP/LP heater Emergency level control, Emergency Make-up to condenser hotwell, GSC minimum flow, Deaerator Drain to Condenser Hotwell, condenser normal make- up and valve gland sealing supplying pressure control, CEPs minimum recirculation control, BFP minimum

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recirculation control valve shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV

The control valve induced noise shall be limited to 85 dba at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.

The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services. Feed Water Control Valve, Super heater Spray Water Control valves, LP/HP heater emergency & normal level control valve, main steam dump control valves, main steam dumping spray control valves and Deaerator Overflow control valve shall be considered for Severe Flashing/ cavitation service by bidder. The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.

6.9.12.2. Control Valve Construction

All valves shall be of globe body design & straightaway pattern with single or double port, unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drop permits.

Valves with high lift cage guided plugs & quick-change trims shall be supplied.

Valve control (inherent flow characteristics) characteristic shall be as per the process requirement.

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Purchaser's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of the control valve body. Flanged valves shall be rated at no less then ANSI press class of 300 lbs.

Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Purchaser. Bonnet joints of the internal threaded or union type shall not be acceptable. Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.

Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

All valves connected to vacuum on down stream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing)

Each valve shall have an arrow permanently fixed on the valve body to indicate the correct direction of flow. Each valve shall have a stainless steel name plate permanently fastened to the yoke which shall be visible when the valve is in service. The name plate shall include

a. Tag No. and Valve Serial No.
b. Body material, size and pressure rating
c. Trim material, size characteristics
d. Action on air failure
e. Spring range
f. Stem travel
g. Valve action, etc.

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6.9.12.3. Valve Material of Construction

S. No.	Service	Body Material	Trim Material
1.	Non-corrosive, non-cavitation and non-flashing service except DM water	ASTM A216 Gr. WCB for process temp. below 275 ^{o}C ASTM A217 Gr. WC9 for process temperature between 275 ^{o}C and 550 ^{o}C	SS 316 stellied with stellied faced guide post and bushings
2.	Severe flashing/cavitation services	ASTM A217 Gr. WC9	AISI Grade 440C
3.	Low flashing/cavitation services	ASTM A217 Gr. WC6	17-4 PH SS
4.	DM water services	SS 316	SS 316 / AISI Grade 440C
5.	Main Steam Application	ASME SA182 F92	Inconel 718 with SS 316 stellied seat material

NOTES:

i. Cast iron valves are not acceptable.
ii. Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.
iii. Cage material may be different from the trim/plug material, however the cage material shall be superior to trim/plug material.
iv. Bidder may offer valves with body and trim materials better than specified materials and in such cases. Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-a-vis the specified material for Purchaser's consideration and approval.

6.9.12.4. Valve Actuator

All control valves shall be furnished with pneumatic actuators. Pneumatic actuators shall be designed to operate at minimum air supply pressure of 3.5 kg/cm^2. The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg.C continuously. The travel time of the pneumatic actuators shall not exceed 10 seconds. All the actuators shall be provided with handwheel, local position indicator, air lock relay, air filter regulator, volume boosters, junction box, solenoid valve (as applicable), SMART positioners etc.

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 Kg/sq.cm. per linear millimeter of seating surface shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.

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6.9.12.5. SMART Positioner

Positioner	
Type	Electro-pneumatic SMART, HART based
Enclosure material	Aluminum OR Stainless steel
Enclosure class	IP 65 or better
Operating temperature	-30 ºC to 80 ºC
Humidity	0-95%
Indicator	Backlit LCD display with key pad
Mounting	Side-mounted on the control valves with corrosion-resistant linkages and rugged brackets
Air supply pressure	3.5 kg/cm^{2}g (min.)
Air failure action	As per process requirement
Volume boosters	To meet travel time requirement as per TS
Input signal	4-20 mA DC
Power supply	24V DC loop powered
Repeatability	Within 0.5% of stroke, for a given input signal
Valve signature test	Shall be available with analyzed data of seat load, bench set and valve friction.
Cable entry	½" NPTF for input signal & position transmitter output signal
Position transmitter	In built with positioner, 4-20 mA DC output, 2 wire type. Contact type for general purpose applications and non-contact type for high temperature applications.
Bypass option	Required
Pressure gauges	Required for input air supply & output signal to actuator, SS
Calibration	Remote or Local calibration in Auto or Manual mode
Lightning protection	Yes, external mandatory for all applications.
Diagnostics	Advanced diagnostics, configuration and calibration features shall be provided. If a software application is required for the same, it shall also be provided by the bidder.

NOTES:-

i. The specification of the SMART positioners indicated above shall also be application for the positioners of the SADC and auxiliary air dampers.
ii. All the positioners for lube oil applications and fuel gas applications shall be intrinsically safe type with intrinsic safety barriers irrespective of hazardous area classification.

6.9.12.6. Test and Examination

All valves shall be tested in accordance with the quality assurance program agreed between the Purchaser and Bidder, which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. The tests shall include but not be limited to the following:

i. Non Destructive Test as per ANSI B-16.34.
ii. Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.
iii. Valve closure test and seat leakage test in accordance with ANSI-B 16.34 and as per the leakage class indicated above.
iv. The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.
v. CV test(type test) as ISA75.02

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6.9.13. Instrumentation Cable

6.9.13.1. Instrumentation Signal Cable (Pair & Triad)

Applicable Standard	Latest revision of IS 1554, BS 5308, IEC 60092-376, IS 8130, IS 5831, IS 3975
Type	Individual and Overall screened pair & triad cable
Voltage Grade	660 V or higher
Conductor	1.0 mm^2, Annealed, Tinned, Stranded (7/0.43) Electrolytic grade Copper IS 8130. Max. rated conductor temp. 85 ^{0}C and Max. short circuit temp. of conductor 160 ^{0}C
Primary Insulation	Extruded HRPVC (Type C) to IS:5831-1984, Cores twisted to form pair / triad with 50mm lay staggered. Thk. (nom.): 0.6mm
Drain wire	Annealed tinned copper. 0.5 mm^2 / 7 strands/continuously in contact with the shield for each pair/triad/quad.
Shielding on Conductor	Individual pair shielded by aluminum Mylar tape, Helical, 0.06 mm, 100% coverage with 25% overlapping
Inner Sheath	Extruded, HRPVC Type ST2 (IS:5831-1984), FR-LSZH. Thickness as per table below. Color: black.
Drain wire	Annealed tinned copper. 0.5 mm^2 / 7 strands/continuously in contact with the shield
Overall Shield	Aluminum Mylar tape (for more than 1 pair/ triad), Helical, 0.075 mm, 100% coverage with 25% overlapping
Rip cord	Non-metallic under sheath
Armouring	One layer of galvanized round steel wire conforming to IS:3975-1999. Thickness as per table below.
Outer Sheath	Material same as inner sheath. Thickness as per table below. Color: blue
Pair Identification	Numbered at regular interval of min. 1 mtr. or as per BS 5308
Electrical Characteristic:	
Resistance at 20 ^{0}C	18.5 Ohm.
Mutual capacitance : Core to core & Core to screen	<250 pF/mtr. &<400 pF/mtr.
Mutual Inductance & L/R	<1 mH/km &<25 µH/Ω
Insulation resistance	> 25 MΩ/km of complete cable @20 ^{0}C
Tests : General	According to IS:1554 (Part I) 1988
Insulation test	IS:5831-1984 except insulation resistance, Voltage and Spark test as per BS 5308 Part II (1986)
Armor & Armor Galvanization	IS:3975-1999 & IS:2633
FRLS Properties:	
a) Oxygen Index	Min. 29%, According to ASTM D2863
b) Temperature Index	Min. 250 ^{0}C, According to ASTM D2863
c) HCl Emission	Max. 20% by weight, According to IEC 754-1
d) Smoke density	Max. 60%, According to ASTM D2843
e) Flame Retardant test	Test shall meet requirement as per IEC-60332 Part III Cat A

i) Table for minimum thicknesses of inner sheath, armour & outer sheath for signal (pair /triad) cables shall be as follows:

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Type of pair cables	Type of triad cables	Inner sheath thk.	Dia. of armour	Outer sheath thk.
Up to 4P x 1.0 mm^2	1T to 2T x 1.0 mm^2	1.1 mm	0.9 mm	1.5 mm
5P to 9P x 1.0 mm^2	3T to 6T x 1.0 mm^2	1.2 mm	1.25 mm	1.6 mm
10P to 14P x 1.0mm^2	7T to 9T x 1.0 mm^2	1.3 mm	1.6 mm	1.8 mm
15P to 19P x 1.0 mm^2	10T to 12T x 1.0 mm^2	1.5 mm	1.6 mm	1.9 mm
20P to 24P x 1.0 mm^2	13T to 16T x 1.0 mm^2	1.7 mm	2.0 mm	2.0 mm
Up to 4P x 1.5 mm^2	1T to 2T x 1.5 mm^2	1.2 mm	1.25 mm	1.6 mm
5P to 9P x 1.5 mm^2	3T to 6T x 1.5 mm^2	1.3 mm	1.6 mm	1.8 mm
10P to 14P x 1.5mm^2	7T to 9T x 1.5 mm^2	1.5 mm	1.6 mm	1.9 mm
15P to 19P x 1.5 mm^2	10T to 12T x 1.5 mm^2	1.7 mm	2.0 mm	2.0 mm
20P to 24P x 1.5 mm^2	13T to 16T x 1.5 mm^2	1.7 mm	2.0 mm	2.1 mm

6.9.13.2. Thermocouple Extension Cable

Applicable Standard	ANSI MC 96.1, IS 1554, IS 5831, IEC 60584
Type	Single and multipair twisted and shielded ***For High temperature*** applications, SS braided cables shall be provided.
Voltage Grade	660 V
Conductor	***KX type*** – 16 AWG Chromel(Yellow)-Alumel(Red) ***SX/RX type*** – 16 AWG Copper(Black)-Copper Nickel(Red) Alloy
Primary Insulation	Extruded-FRLS PVC Type C as perIS5831/1984, Thk. (nom.): 0.4 mm, Cores twisted to form pair / triad with 50mm lay staggered. ***For High temperature*** applications, sintered TEFLON
Inner Sheath	Extruded, HRPVC Type ST2 (IS:5831-1984), FR-LSZH. Thickness (nom.): 1.0mm . Color as per selected standard ***For High temperature*** applications, Sintered Teflon with fiber glass covering
Outer Sheath	Material same as inner sheath. Thickness (nom.): 1.24mm. Colour : Yellow for KX and Green for SX/RX ***For High temperature*** applications, Glass Mica tape with Ceramic Glass and Fiber Glass yarn Braided Silicone impregnated
Armoring	One layer of galvanized round steel wire conforming to IS:3975-1999. 0.9mm dia. ***For High temperature*** applications, SS wire braided mesh. 38 SWG min.
Electrical Characteristic:	
EMF at 100 ºC	***KX type*** – 4.095mV ***SX/RX type*** – 0.646/0.647mV

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EMF at 200 °C	***KX type*** – 8.137mV ***SX/RX type*** – 1.441/1.469mV
Tolerance	***KX type*** – ± 2.2 °C from 0 to 200 °C ***SX/RX type*** – ± 1.5 °C from 0 to 200 °C
Conductor loop resistance at 20 °C as per ANSI MC96.1	***KX type*** – 746 Ohm/km ***SX/RX type*** – 95 Ohm/km
Insulation resistance (min.)	100 Mohm/km
Mutual capacitance at 0.8KHz (max.)	200 nF/km
FRLS Properties:	
a) Oxygen Index	Min. 29%, According to ASTM D2863
b) Temperature Index	Min. 250 ^{0}C, According to ASTM D2863
c) HCl Emission	Max. 20% by weight, According to IEC 754-1
d) Smoke density	Max. 60%, According to ASTM D2843
e) Flame Retardant test	Test shall meet requirement as per IEC-60332 Part III Cat A

6.9.13.3. Control Cable (for Instrumentation Usage)

Applicable Standard	Latest revision of IS 1554, BS 5308, IEC 60092-376, IS 8130, IS 5831, IS 3975
Type	Multi-core, Armoured, overall screened
Voltage Grade	660 V or more
Conductor	1.0 mm^2, Annealed, Tinned, Stranded (7/0.43) Electrolytic grade Copper IS 8130-1984. Max. rated conductor temp. 85 ^{0}C and Max. short circuit temp. of conductor 160 ^{0}C
Primary Insulation	Extruded HRPVC (Type C) to IS:5831-1984, Cores twisted with 60 mm to 80 mm lay staggered. Thickness (nom.): 0.8 mm.
Inner Sheath	Extruded, HRPVC Type ST2 (IS:5831-1984), FR-LSZH. Thickness (min.): 0.3mm for dia. under sheath upto 25mm, 0.4mm for dia. under sheath >25mm≤35mm, etc. as per IS 1554. Color: black.
Drain wire	Annealed tinned copper. 0.5 mm^2 / 7 strands/ continuously in contact with the shield
Overall Shield	Aluminum Mylar tape, Helical, 0.075 mm, 100% coverage, 25% overlap
Rip cord	Non-metallic under sheath
Armouring	One layer of galvanized round steel wire conforming to IS:3975-1999. Dia. (min.): 1.4 mm for dia. under armor upto 13mm, 1.6 mm for dia. under armor >13mm<25mm, etc. as per IS 1554
Outer Sheath	Material same as inner sheath. Thickness (min.): 1.24mm for dia. under outer sheath upto 15mm; 1.4mm for dia. under outer sheath >15mm≤25mm, etc. as per IS 1554-1. Color: black
Core Identification	Numbered at regular interval of min. 1 mtr. or as per IS 1554
Electrical Characteristic:	
Resistance at 20 ^{0}C	18.5 Ohm.
Mutual capacitance : Core	<250 pF/mtr. &<400 pF/mtr.

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to core & Core to screen	
Mutual Inductance & L/R	<1 mH/km &<25 µH/Ω
Insulation resistance	> 25 MΩ/km of complete cable @20 ^{0}C
Tests : General	According to IS:1554 (Part I) 1988
Insulation test	IS:5831-1984 except insulation resistance, Voltage and Spark test as per BS 5308 Part II (1986)
Armor & Armor Galvanization	IS:3975-1999 & IS:2633
FRLS Properties:	
a) Oxygen Index	Min. 29%, According to ASTM D2863
b) Temperature Index	Min. 250 ^{0}C, According to ASTM D2863
c) HCl Emission	Max. 20% by weight, According to IEC 754-1
d) Smoke density	Max. 60%, According to ASTM D2843
e) Flame Retardant test	Test shall meet requirement as per IEC-60332 Part III Cat A

6.9.13.4. Instrumentation Power Cable

Applicable Standard	Latest revision of IS 1554, BS 5308, IEC 60092-376, IS 8130, IS 5831, IS 3975
Type	Multi-core, Armoured
Voltage Grade	1100 V
Conductor	1.5 mm^2 or 2.5 mm^2 as per power rating, Annealed, Tinned, Stranded (7/0.53 or 7/0.67) Electrolytic grade Copper IS 8130-1984. Max. rated conductor temp. 85 ^{0}C and Max. short circuit temp. of conductor 160 ^{0}C
Primary Insulation	Extruded HRPVC (Type C) to IS:5831-1984, Cores laid up together. Thickness (nom.): 0.8 mm for 1.5 mm^2 & 0.9 mm for 2.5 mm^2.
Inner Sheath	Extruded, HRPVC Type ST2 (IS:5831-1984), FR-LSZH. Thickness min. 0.3 mm as per IS 1554. Color: black.
Rip cord	Non-metallic under sheath
Armouring	One layer of: Galvanized round steel wire conforming to IS:3975-1999. Dia. min. 1.4mm as per IS 1554.
Outer Sheath	Material same as inner sheath. Thickness min. 1.24mm as per IS 1554. Color: black
Core Identification	R, Y, B colored as per IS 1554
Electrical Characteristic: Resistance at 20 ^{0}C	12.5 Ohm.
Tests : General	According to IS:1554 (Part I) 1988
Insulation test	IS:5831-1984 except insulation resistance, Voltage and Spark test as per BS 5308 Part II (1986)
Armor & Armor Galvanization	IS:3975-1999 & IS:2633
FRLS Properties:	
a) Oxygen Index	Min. 29%, According to ASTM D2863
b) Temperature Index	Min. 250 ^{0}C, According to ASTM D2863
c) HCl Emission	Max. 20% by weight, According to IEC 754-1
d) Smoke density	Max. 60%, According to ASTM D2843
e) Flame Retardant test	Test shall meet requirement as per IEC-60332 Part III Cat A

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6.9.13.5. Optic Fibre Cable (Single Mode)

Fiber optic design	Glass fibre in multi tube loose fibres with thixotropic jelly fill or gel free with super absorbent polymer
Fiber type & size	Single mode, 9/125 microns
Attenuation	$\leq$ 0.4 dB/Km @1310 nm. $\leq$ 0.25 dB/Km @1550 nm
Dispersion (ps/ (nm-km))	$\leq$ 3.5 @1310 nm. $\leq$ 18 @1550 nm
Loose tube material	Polybutylene Teraphthalate (PBTP)
Temperature range	- 20 ^{0}C to +70 ^{0}C as per IEC 60794-1-F1
Tensile strength	1800 N as per IEC 60794-1-2-E1
Crush resistance	4000 N for 60 sec. as per IEC 60794-1-2-E3
Torsion resistance	As per IEC 60794-1-2-E7
Minimum bending radius	20 D (D=Cable OD) as per IEC 60794-1-2-E11
Impact resistance	50 Nm as per IEC 60794-1-2-E4
Water penetration	As per IEC 60794-1-F5
Armouring	High quality electro-chromium coated corrugated steel tape
Outer jacket material & thickness	Polyvinyl chloride/ UV stabilised HDPE black & 2 mm
Ripcord	Polyester based yarn
Colour code	Different colour for tubes (eg. Blue, Orange, Green, Natural, Brown & Slate)
NOTES: i. Each Optic Fibre Cable shall be provided with 100% spare cores. ii. For continuous run of distance greater than 500 mtrs., multimode OFC shall be used.	

6.9.13.6. Optic Fibre Cable (Multimode)

Fiber optic design	Glass fibre in multi tube loose fibres with thixotropic jelly fill
Fiber type & size	Multi-mode, 62.5/125 OR 50/125 microns
Attenuation	$\leq$ 3.5 dB/Km @850 nm. $\leq$ 1.5 dB/Km @1300 nm for $\geq$6 fibre
Loose tube material	Polybutylene Teraphthalate (PBTP)
Temperature range	- 20 ^{0}C to +70 ^{0}C as per IEC 60794-1-F1
Tensile strength	1800 N as per IEC 60794-1-2-E1
Crush resistance	4000 N for 60 sec. as per IEC 60794-1-2-E3
Torsion resistance	As per IEC 60794-1-2-E7
Minimum bending radius	20 D (D=Cable OD) as per IEC 60794-1-2-E11
Impact resistance	50 Nm as per IEC 60794-1-2-E4
Water penetration	As per IEC 60794-1-F5
Armouring	High quality electro-chromium coated corrugated steel tape
Outer jacket material & thickness	Polyvinyl chloride/ UV stabilised HDPE black & 2 mm
Ripcord	Polyester based yarn

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Colour code	Different colour for tubes (eg. Blue, Orange, Green, Natural, Brown & Slate)

NOTES:

i. Each Optic Fibre Cable shall be provided with 100% spare cores.
ii. For continuous run of distance greater than 500 mtrs., multimode OFC shall be used.

6.9.14. Furnace and Flame Viewing Camera System

Bidder shall include in his proposal a Furnace and Flame Viewing Camera System. The flame cameras shall be suitable for direct online continuous viewing in the central control room of the gas flame and condition of the furnace internals including slagging of the water walls and any other deterioration in the furnace condition. The nos. and type of such flame cameras to be included in the proposal shall be selected by the bidder appropriate to his boiler design subject to minimum 4 nos. camera. Separate set of cameras shall be provided for viewing flame and furnace internals based on proven technology for the intended application. The system shall comply to NFPA requirements.

Furnace and Flame viewing camera system with all equipment and accessories shall be supplied for the purpose of monitoring flame from all the burners and igniters of the fuel gas fired boiler supplied by the bidder. Cameras shall be installed in the furnace wall for viewing the flames through suitable lens tubes and resulting images shall be displayed in a monitor located in control room. The cameras shall be of robust design and are expected to withstand the temperature in the furnace of boiler, which shall not be less than 1600º C. The cameras shall also be protected against ingress of dust and moisture, varying temperature and humidity and high vibration levels. The cameras and the total system shall be suitable for the furnace design as being offered by the bidder. Cameras shall be suitable for viewing of furnace flame at a straight line of view.

The camera system shall consist of the following facilities/ components as a minimum:

i. OWS with 40” full HD colour LED monitor (wall mounted).
ii. Facility for zooming and adjustment of iris from the monitor for viewing furnace internals.
iii. Proper cooling arrangement (preferably air) and protection against cooling medium failure (with automatic advance/retract facility mounted).
iv. Weatherproof IP 65 local control box for mounting of electronics.
v. All necessary remote/ local programming tool.
vi. All interconnecting cable, armoured video cables and termination device.
vii. All necessary software.
viii. Automatic withdrawal of camera in case of pneumatic air supply failure, temperature exceeding the design set point at camera tip, camera control electronics failure and power supply failure.
ix. Automatic shutter/gate mechanism at the camera port to be supplied by bidder, so that port shall be closed once camera is withdrawn from the furnace.
x. The system shall be capable of transmitting the video signal to the OWS (including LVS based OWS) for viewing and operation. The operation of the camera shall also be possible from the LVS. It shall be possible to display one / multiple flame viewing camera system inputs in the monitor simultaneously at operator discretion.

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xi. All accessories like interfacing cables, Remote control unit, Video signal distributors, video amplifiers etc. to make the system complete. All the necessary interface hardware, cables, items, software, accessories to be provided by Bidder for same.

xii. Camera Local/Remote operation selection along with advance/ retract / reset provisions and indications (Camera IN, Camera OUT, Camera Fault) shall be provided.

xiii. Video recording facility shall be available in the system. Sufficient memory (atleast 1TB) shall be available in the system for recording video. Facility to transfer recorded video portable memory devices shall be provided.

The viewing angle of the camera shall be commensurate with the furnace size, the camera location and the positioning of the burners.

The lens, viewing tube and the associated equipment shall be designed to ensure settlement of dust and debris on the lens is minimized. Compressed air shall be used for keeping the camera lens clean. Provision shall be available to clean the lens tip to prevent any ash/dust accumulation.

6.9.15. Online Early Tube Leak Detection System

Microprocessor based 19" rack mounted Acoustic Online Steam Leak Detection system with Air Borne Sensors including all Signal amplifiers, calibrators, test unit, loudspeaker unit, signal processing hardware and application software, PC with printer, power supply distribution cables, Instrumentation cables for the entire system including special cables, junction boxes, all other required erection hardware etc. shall be provided by the bidder. The number and location of the sensors shall be as per Bidder's standard practice subject to Purchaser's approval during detailed engineering. However minimum number of sensors shall be twelve (12) nos. The bidder shall ensure optimal placement of sensors, so that the entire furnace internals are covered without leaving any blind spots. The facility of online calibration of the sensors shall be provided without disconnecting the sensor. The system shall be expandable to accommodate additional 30% sensors over the originally installed quantity of the sensors.

Sensor head shall be protected from hot gas, particulate matter, and corrosive elements in the flue gas by suitable protective tube and enclosure which shall however not block the sound waves. The probes shall have a minimum life of 20,000 hours of operation. All the parts coming into contact with hot gas shall be designed to withstand the high temperature. Air purging arrangement for sensors including solenoid valves, piping, SS-tubing, hoses, root valves, isolation valves, air filter regulators shall be provided.

Online Tube Leak Detection system shall monitor steam tube conditions for the possible tube leakages by online monitoring of various tube zones in the boiler continuously on real time basis and provide feedback to plant operation personnel regarding the occurrence, location and extent of tube leakage at the initial stage itself, to enable the plant personnel to take necessary remedial measures. The system shall perform the following functions:-

i. Intelligent system using FFT analysis for early and accurate detection of the tube leak.

ii. The system shall continuously collect and analyse the acoustic data to monitor and detect the tube leakage at the earliest occurrence so as to prevent secondary damages to furnace internals due to steam leakage.

iii. Capable of Real time detection and identification of the accurate location of the steam tube leak across the boiler.

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iv. The system shall be able differentiate between the background noise generated by combustion & fuel gas injection and the steam/water leak from the waterwall.
v. Alarm annunciation at a predetermined sound level
vi. Independent and adjustable alarm settings for each channel.
vii. Monitor tube leakage continuously and showing the leak frequency spectrum.
viii. Following the leak growing trends.
ix. Real time monitoring noise in the boiler.
x. Recording the trend of the leak history.
xi. Monitoring operation condition of all types of soot blowers.
xii. Digital Filtering of sound signals, Frequency spectrum analysis, trends analysis, bar graph and mimic.
xiii. Self diagnostics features for healthiness of each channel and associated sensor.
xiv. Automatic air purge system.
xv. 4-20mA signal from each channel. Alarms to DDCMIS in case of system failure.
xvi. Interfacing with DDCMIS on OPC/UA compliant protocol.

The detection system PC shall be provided with the software utility with following features:-

i. 3D mimics of the furnace shall be provided indicating the location of the sensor and location of the leak, whenever detected.
ii. Sound spectrums, Bar graph and trend display shall be provided for each sensor noise and frequency with respect to time. Trend graph for each individual channel with data and time stamping on a single display. Display shall be refreshed every 5 seconds.
iii. The system shall have facility to store and display the historical data pertaining to the signal amplitude and frequency of each sensor. The historical data shall be displayed in bar graph and trend form. The data storage shall be with adjustable duration of 1 minute to 1 hour. It shall be possible to retrieve and display historical data concurrently with real time monitoring. The system shall have facility to store data for 1 year.
iv. The system shall have facility to store bulk data for 5 years duration with facility for retrieval of same. Facility to transfer the data to portable storage devices like SSD or any other bulk medium shall also be provided.
v. Facility to listen the real time sound detected by each sensor shall be provided.

All the required sensors, tube leak detection PC, colour laserjet printer (A4), purging system for sensors, stub pipe, wave guide, brackets, all types of cables, junction boxes, valves, monitoring panel (complete in all respect), application software etc. shall be supplied of the bidder. The bidder shall provide one portable sensor calibrator for the tube leak detection system.

6.9.16. Erection materials

The Bidder shall supply all required material for completeness of Impulse Piping System and Air Piping System as per the requirements furnished in this technical specification. The process connection piping, tubes, fittings etc. shall be supplied by the bidder as per actual site requirement. All material, furnished under this chapter and the installation there of shall conform to the latest editions of American National standard Code for pressure piping, power piping ANSI B 31.1, ANSI B16.11, ASME Boiler and pressure Vessel codes, IBR and other applicable ASME, ANSI and state standards.

All material supplied under this chapter shall be suitable for intended service, process,

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operating conditions and type of instructions used and shall fully conform to the requirements of this specification. The bidder is responsible for the performance of equipment furnished under this specification on system basis. The bidder may offer suggestions for improvement based on his experience, during detailed engineering, which shall be subjected to the Purchaser's approval.

6.9.16.1. Impulse Piping, Tubing, Fittings, Valves and Valve Manifolds

All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The size of impulse pipe shall be ½" for steam and water applications and ¾" or 1" for air, fuel gas and flue gas applications. The material of impulse pipe shall be same as that of main process pipe.

Seamless SS tubes shall be provided inside enclosures& racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications the material shall be ASTM A213 TP 316H it and for other applications material shall be ASTM A213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D.

All fittings shall be forged steel and shall conform to ANSI B16.11. The material of forged tube fittings for shaped application (e.g. tee, elbow etc) shall be ASTMA 182 Gr 316 H for high pressure/temperature applications (as defined above) and ASTMA 182 Gr 316 L for other applications. The material for bar stock tube fitting (for straight application) shall be SS 316. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with they are to be used.

The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air, fuel gas and flue gas service wherein the source shut-off valve shall be 3/4 inch size gate valve to avoid frequent chocking. The disc and seat ring materials of carbon steel and alloy steel valves shall be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be re-conditioned and stem and disc may be replaced without removing the valve body from the line.

The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2 valve manifold and 3 valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and differential pressure transmitters/ switches respectively. 5 valve manifold shall be used for remaining applications like DP, flow and level measurements.

For Pressure/D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in air/flue gas application two way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three way gauge cock provided alongwith the pressure/D.P gauges.

The rating of material of impulse pipes, tubes, fittings, valves and their installation thereof shall conform to the latest edition of standards as per following table:

Impulse pipe and tube (material & rating)	ANSI 31.1, ANSI 31.1a, ANSI/ISA 77.70
Valves (material, pressure class & size)	ASTM A182 / ASTM A105 as per ASME 16.34
Fittings (material, size & rating)	ANSI 31.1, ANSI 31.1a, ASME B16.11
Installation scheme	BS 6739, ANSI/ISA 77.70

Two root/isolation valves and two drain valves are to be used wherever pressure is >/= 40

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Kg/cm^2 or Temp>/=280 deg C. The end connections of valves shall be of socket welded type.

6.9.16.2. Air Supply Piping

All pneumatic piping, fittings, valves, air filter cum regulator, purge rotameter and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided. This shall include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging/scavenging requirements etc.

Instrument air and service air shall be provided by the Purchaser at the battery limit and the bidder shall have the responsibility to provide the distribution network for the same.

The Bidder shall also provide pneumatic tubing for actuators/positioners. For individual supply line and control signal line to control valve, 8mm size SS tubing conforming to ASTM B75 shall be used. It shall be at least 0.065 inch and shall be PVC coated. The fittings to be used with SS tubes shall be of cast SS, screwed type. All other air supply lines shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. Fittings for air supply line shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs. Air supply piping shall be adequately sloped to prevent accumulation of condensed water within the pipe. The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports.

The instrument/service air supply to each equipment/devices requiring air supply shall be provided by a well designed air distribution scheme comprising of 2” GI Pipe Header with isolation valve from the instrument air and service air terminal points. In the boiler/turbine area the 2” head shall be provided upto most elevation of boiler/turbine floor and from this 2” header, 1 inch sub header shall be branched off at each floor with isolation valve. From this 1” sub-header, branch line of ½”, with isolation valve shall be provided upto various devices. Similar system is to be followed for service air required for intermittent purging in the local instrument enclosures (LIEs) Instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10 kg/cm2 max. Inlet pressure. The filter size shall be 5 microns and of material sintered bronze. The air set shall have 2 inch size pressure gauge and built in filter housing blow down valve. The end connection shall be ¼ inch/1/2 inch / 3/4 inch NPT as per the requirement to be finalised during detailed engineering. The 1 inch Sub Header shall be of SS316.

All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.

6.9.16.3. Purge Air Connection for Air and Flue Gas Applications

The continuous purging with instrument air shall be done, for all air and flue gas measurements (except instrument air and service air), at the process source connection end. Necessary arrangements required for continuous purging shall be provided inside all instrument enclosures and instrument racks for air and flue gas applications.

For intermittent purging with service air, necessary arrangements inside al the air and flue gas enclosures shall be provided. The SS316 four ways valve provided in the SS316 tubing

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shall be used for isolating the transmitter and connecting the service air quick disconnect line. Purge air lines shall be of mild steel hot dipped galvanised inside and outside as per IS1239, heavy duty with threaded ends.

Provision for steam purging and nitrogen purging(and cooling) facility shall be provided for BF gas line and coke oven gas line instruments. Steam and nitrogen piping and alignment shall be planned accordingly.

6.9.16.4. Installation and Routing

For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instruments shall be installed above source point and impulse pipe should slope upwards.

Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent and drain lines along with isolation valves and other accessories including drain pipes this drain is to be connected to plant drain through open funnel also. Horizontal must have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope and to prevent sag in piping.

All impulse piping shall be installed to permit free movement due to thermal expansion, wherein required expansion loops hall be provided.

Special accessories such as condensing pots/reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services and all flow measurements in steam and water services above 120 Deg. C. For drum level measurement required balancing chamber shall be provided and installed.

6.9.16.5. Piping and Tubing Support

Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminum supports.

Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.

6.9.16.6. Local Instrument Enclosure

All transmitters, switches etc. (except for all fuel gas applications) shall be suitably grouped together and mounted inside Local Instrument Enclosures or closed canopies or transmitter boxes. Bidder shall note that open installation of instruments shall not be accepted and instruments shall be fully covered (360^{o} coverage) after the erection. The transmitter boxes and LIE shall be provided with solid front and no glass front/viewing window is envisaged.

These local instrument enclosures and canopies shall be furnished as per the actual requirements finalised during detailed engineering. The exact grouping of instruments in a

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particular LIE shall be as finalised during detailed engineering subject to Purchaser's approval.

Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of six (6) transmitters are envisaged to be grouped in one enclosure.

The internal layout shall be such that the impulse piping/ blow down lines are accessible from back side of the enclosure and the transmitters etc. are accessible from front side for easy maintenance. Bulkheads, especially designed to provide isolation from process line vibration shall be installed on instrument enclosures to meet the process sensing line connection requirement. Vibration dampeners shall be installed for each enclosure / rack. The Degree of Protection of LIE shall be IP-55.

The LIE shall be constructed of 1.6 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Cable glands, Channel and frame shall be 3 mm thick. Double inter locking doors shall be provided. The doors shall be the three point locking type constructed of not less than 1.6 mm thick steel. Doors shall have concealed quick removal type pinned hinges and locking handles. Door locks shall accept the same key. Neoprene/Polyurethane Gaskets shall be used between all mating sections to achieve protection class of IP-55. Each LIE shall have an integral junction for cable termination with IP-65 rating. LIE shall be provided with universal 6A/16A utility power socket with switch, door switch operated LED lights and earthing connection. Transmitter boxes with canopy shall be fabricated using 1.5mm SS sheets.

Each Transmitter enclosure housing instruments requiring purge air for continuous air purging, shall be provided with common purge air header, redundant air filters regulators of sufficient capacity, required pressure gauge, valves, fittings, SS tubing and individual purge meters for each purge line etc. as required.

A 15 mm NB service air header shall be furnished in each instrument enclosure housing air and flue gas instruments. The header shall be furnished complete with a pressure regulating valve, pressure gauge and quick disconnect connections. A hose for connecting each header to the draft instrument line four way valves shall be furnished. The hose shall be self storing nylon tubing having a burst pressure of 15 Kg/sq Cm the size of the hose shall be ½ " min. The service air header shall originate at a bulkhead penetration or fitting located on one of the bulkhead plates.

The bidder shall prepare the piping drawings and the general arrangement layout drawings for each of the enclosures and racks. The special attention shall be given in the piping layout to avoid air traps liquid filled piping or water pockets in piping intended to be dry. Drawings shall indicate the arrangement of all equipment, piping, valves and fittings within the enclosures/racks and shall be subject to Purchaser's approval.

All liquid Filled Blow down lines, except those measuring vacuum shall be connected to a 2" header which is extended through one end of the enclosure and turned downward for directing the blow down into a drain. The material of the blow down header shall be carbon steel as per ASTM A 106 Gr C.

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6.10. Technical Specification for Digital Distributed Control, Monitoring and Information System (DDCMIS)

The microprocessor based Digital Distributed Control, Monitoring and Information System (DDCMIS) shall be provided for the safe, efficient and reliable operation of the Captive Power Plant under all regimes of operation. Bidder shall also refer the DDCMIS System Configuration Drawing, MEC/11/E5/M/0033/TS/27/101.

Bidder shall be responsible for engineering, selection and connection of all the components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual components since the bidder has the complete responsibility for engineering and furnishing the system.

6.10.1. Plant Control System

The bidder shall ensure that a functionally distributed unified DDCMIS is offered for the CPP. The operation & monitoring of the entire CPP shall be undertaken from the Central Control Room (CCR) through DDCMIS under all regimes of operation. If a proprietary control system is offered for any technological equipment, bidder shall ensure that such proprietary control system is seamlessly integrated with Station C&I DDCMIS for its operation from Station C&I DDCMIS HMI under all regimes of operation.

The DDCMIS shall basically consists of the following systems and sub-systems:-

i. Functionally distributed Unified Control System for CPP
   a) SG-C&I DDCMIS
   b) TG-C&I DDCMIS
   c) TB-C&I DDCMIS
   d) Station-C&I DDCMIS including ACW, CW and CAS
   e) DM Plant DDCMIS

ii. Human Machine Interface & Plant Information System (HMIPIS)

iii. Historian & Sequence of Event (SOE) recording system

iv. Redundant GPS based Master Clock System

6.10.2. General Requirement

i. Reliability and Availability

Each component and system offered by the Bidder shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. shall be established by the Bidder, considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete DDCMIS is assured for 99.7%.

When more than one device uses for a measurement or control signal, the transmitter and other components/ module shall be fully equipped to provide all signal requirements. All the 4-20 mA output signals from transmitters/other control system shall be able to drive minimum 500 Ohms load resistance. The system shall be arranged so that the failure of any monitoring device or control components or spurious intermediate grounding in the signal path shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the same signal.

The design of the control systems and related equipment shall adhere to the principle of

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'Fail Safe' Operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal, loss of excitation or failure of any component shall not cause a hazardous condition. However, it shall also be ensured that occurrence of false trips are avoided / minimized.

The types of failure that shall be taken into account for ensuring operability of the plant shall include but not be limited to:

a. Failure of sensor or transmitter.
b. Failure of main and/or redundant controller/other modules.
c. Loss of motive power to final control element.
d. Loss of control power.
e. Loss of instrument air.

ii. Redundancy

DDCMIS redundancy at the following equipment/level shall be provided:-

a) Dual redundant CPU along with its memory in hot standby mode. Redundant CPU shall be installed in separate backplane/rack.
b) Dual redundant communication bus at all levels including the communication bus up to RI/O or ring topology. Each CPU rack shall also have redundant communication bus.
c) Dual redundant communication cards / interface module for the communication bus and remote I/O and also for communicating with Level-2 system (if applicable). Each CPU rack shall also have redundant communication cards/interface modules. If communication is through CPU modules, it shall also have redundancy at each CPU.
d) Four sets of servers shall be provided in hot redundant mode, additionally 03 nos. emergency OWS shall be provided if DDCMIS based on Client-Server architecture is offered.
e) In case client-server based engineering station considered by supplier, redundant server with full capability engineering license shall be provided for each server based ES.
f) Redundant managed network switches.
g) Power supply module redundancy for CPU rack as well as for I/O rack, if rack-based power supply module is required.
h) Power supply unit redundancy. Separate set of PSU for CPU rack and I/O racks.

iii. System Scalability

Fully modular system design shall be adopted to facilitate easy system expansion. The system shall have the capability and provision for online expansion through addition of controller modules, I/O cards, communication modules, drive control modules, workstations, printers etc. without affecting the normal operation of the DDCMIS and the plant process. The DDCMIS shall have facility for online addition and configuration additional control loops, functional groups, sub-groups etc. without disturbing the DDCMIS and plant process.

iv. Functional grouping

Functional grouping of various controllers shall be decided during detailed engineering which shall be subject to purchaser's approval. Functional grouping shall meet following general requirements:

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a) Stream based controller grouping concept shall be followed. For example, BFP-A shall be accommodated with feed water control station-1 in common controller while the other BFPs and FCSs can be accommodated in other controllers.
b) Redundant equipment i.e. BFP-A, BFP-B and BFP-C shall not be controlled from the same controller.
c) Controller grouping shall not be done in such a way that failure of one controller group shall cause a major process upset or unit shutdown.
d) Each functional group shall be provided with its dedicated set of hardware i.e. controllers, I/O modules, power supplies, communication cards, etc. Hardware sharing between the functional groups shall not be accepted.
e) Any hardware failure in one functional group shall not affect the working of any other functional group, data communication, HMIPIS etc.
f) Redundant field signals (analog or digital) shall be wired to different I/O modules in different racks.

v. Online Configuration, Testing and Maintenance

The control system shall have on-line simulation and testing facility. Further, it shall be possible to on-line configure and tune controllers through the engineering workstations.

The system shall have the flexibility to easily reconfigure any controller at any time without requiring additional hardware or system wiring changes and without disabling other devices from their normal operation mode. Modifications shall not require switching off power to any part of the system.

The facility for online removal and replacement of the one of the redundant controller modules, I/O modules, communication modules etc. shall be provided. All this shall be accomplished without switching off the power supply to the corresponding rack or panel. System design shall ensure that while doing this online maintenance activity, any stray or undefined signalling and releases do not occur and controller operation is not affected in any way. The online removal and replacement of one the redundant controller module shall not result in the system disturbance or loss of controller functions of the other controller module. The complete process of online maintenance of the DDCMIS shall not jeopardize the safety of the plant and the personnel.

vi. Fault Diagnostics

The DDCMIS shall include continuous online self-surveillance, monitoring and diagnostics facility for automatic detection and reporting of failures/malfunctions on the HMI. Automatic fault detection and annunciation shall be provided up to the I/O channel level. Faults/failures of the following DDCMIS components shall be reported:-

a) Module (controller, I/O module, communication module, synchronisation module, power supply module etc.) failure/fault, Power supply feeder's faults (overvoltage, under voltage and loss of power)
b) Network failure i.e. system bus, I/O bus or communication bus
c) HMIPIS faults such as failure of power supply, network module etc.
d) Sensor, transmitter, temperature element failure
e) All the faults and failures shall be reported on DDCMIS workstations and local indication on the faulty channel/module and corresponding rack/cubicle.

vii. Fault Tolerance

No single failure in either of the equipment or power source shall render any

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part/system/sub-system of DDCMIS inoperative to any degree. No single failure in HMIPIS shall lead to non-availability of more than one workstation at a time. In an event where a single failure/fault has led to non-availability of one workstation, it shall be possible to operate the plant under all regimes of operation including emergency conditions from any of the available workstations.

If the bidder offers Server based DDCMIS, 03 nos. of Emergency Work Stations shall be provided. The technical specification of the emergency workstations shall be equivalent to the servers.

viii. Signal Exchange

All the signal exchange between the various functional groups of a control group (SG, STG, STB & BOP) shall be implemented through redundant main system bus and redundant local bus within the sub-system. In case a controller utilizes some inputs generated/processed by any other controller/functional group and the requirement of controller response time is not met due to system limitation, then hardwired signal exchange shall be provided for such signals.

All control and protection signal exchange between the functional groups shall be hardwired only. Protection signals to MFT, STG protection and STB protection shall necessarily be hardwired even within the same sub-system.

Signal / Data exchange between different control systems for SOE, annunciation, control, interlock & protection and critical information shall be through galvanically isolated 4-20mA hardwired input/output or potential free contact input/output.

ix. Cyber security

Securing DDCMIS from online threats is vital to the safe and efficient functioning of the CPP, as well as the protection of sensitive data and intellectual property. With DDCMIS controlling critical infrastructure such as CPP, a cyber-attack on these systems could not only cause financial losses but may lead to physical harm to the equipment and personnel.

The bidder shall offer complete suite of robust cyber security features for DDCMIS and other control systems to be supplied by the bidder. A comprehensive cyber security system developed using multi-layered defence techniques shall be offered. This shall protect the OT network of the CPP from various kinds of online threats like cybercriminals, crypto currency miners, hackers, hacktivists, terrorist groups, rogue states, ransom ware, phishing etc.

The cyber security system offered by the bidder shall be fully compliant to IEC 62443. ***The bidder shall arrange conformity assessment of the DDCMIS/other control system to IEC 62443 by a certified third party.***

x. Environmental Conditions

The system shall work satisfactorily in harsh (hot & dusty) environment of steel plant without any deterioration in desired performance or any type of failure. The DDCMIS equipment shall be designed considering the environmental conditions indicated below and suitable for continuous operation in the operating environment of an Integrated Steel Plant and also during periods of air conditioning failure without any loss of function or departure from the specification requirements covered under this specification.

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Sl. No.	Ambient Temp. Outside Cabinet	Pressure	Relative Humidity	Atmosphere	IP Class(NOTE #5)
A	**Outdoor areas**				
1	55 deg.C (max.)	Atmospheric	100% (max.)	Dusty Area	IP-65(NOTE #1)
2	55 deg.C (max.)	Atmospheric	100% (max.)	Dirty Air	IP-55
3	4 deg.C (min.)	Atmospheric	5% (min.)	Dirty Air	IP-55
B	**Indoor areas**				
1	55 deg.C (max.)	Atmospheric	95% (max.)	Dirty Air	IP-65(NOTE #1)
2	55 deg.C (max.)	Atmospheric	95% (max.)	Air	IP-54(NOTE #2)
3	4 deg.C (min.)	Atmospheric	5% (min.)	Air	IP-54(NOTE #2)
C	**Air-conditioned areas**				
1	24+/-5 deg.C (normal)	Atmospheric	95% (max.)	Air	IP-32/42(NOTE #1)
2	50 deg.C (max.)(NOTE #3)	Atmospheric	5% (min.)	Air	IP-32/42(NOTE #1)

NOTES:-

1. Panels shall be provided with canopy to prevent ingress of dripping water.
2. For non-ventilated enclosures. For ventilated enclosures, protection class shall be IP-42.
3. During air-conditioning failure.
4. For Remote I/O panels mounted in non airconditioned areas, panel mounted AC shall be provided.
5. As per IEC 60529.

xi. System Spare Capacity

a) Approx. 20% spare channels fully wired up to terminal blocks shall be provided in each I/O module. Each, 4 channel I/O card shall have 1 spare channel, 8channel I/O card shall have 2spare channels, 16 channel I/O card shall have 3 spare channels, 32 channel card shall have 6 spare channels.

b) 10% (or min. 01 no., whichever higher) of total no. of installed I/O modules shall be provided as spares. These I/O modules shall be fully wired up to the terminal blocks. These spare I/O modules shall be uniformly distributed across the control system.

c) Wired-in "USABLE" space for 20% (or min. 01 no., whichever higher)modules of each type shall be provided in each of the control panels and I/O cabinets for future expansion of the system by mounting additional I/O modules. These I/O modules shall be wired up to the field end terminal blocks of the control panel and I/O cabinet or marshalling panel.

d) Fully wired 20%(or min. 01 no., whichever higher) spare accessories of each type and rating like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals (of each type), etc. shall be provided.

e) Usable spare space in cabinets to install 10% spare hardwired items like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals, etc. in future.

f) For all serial input / outputs to the system, 20% spare serial I/O ports of each type of serial input / output shall be provided.

g) 10% or minimum 1 no. Profinet module, MODBUS module, etc. shall be supplied as installed spares. These shall be complete with power supply module, conditioner unit, surge protector, etc. as applicable.

h) Each controller shall have 60% spare functional capacity to implement additional function blocks, over and above the implemented logics/loops. Further, each

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controller shall have spare capacity to handle minimum 20% additional I/Os of each type, over and above the installed (included the installed spares) capacity. The corresponding communication controller shall also have the same spare capacity as that of the controller. DDCMIS controller loading shall not exceed 40% after the commissioning of the entire system.

i) The data communication system including the main system bus and other system bus shall have 60% additional spare capacity over and above the capacity required to handle the installed spares and additions indicated the preceding clauses of this section.

j) Minimum 20% spare ports shall be available in each network switch after the commissioning of the entire system.

k) Minimum 60% spare memory shall available in the workstations, servers and all other PCs after commissioning of the system.

The spare capacity in the preceding clauses shall be uniformly distributed throughout all the cabinets. The system design shall ensure that above mentioned additions shall not require any additional controller / processor or peripheral drivers in the system delivered at site. Further, these additions shall not deteriorate the system response time/duty cycle, etc. from those stipulated under this specification.

6.10.3. Functional Requirement of Control System

Functionally the DDCMIS shall be broadly divided into the following major groups:

i. Steam Generator Control System (SG-C&I DDCMIS)
   a) Burner Management System (BMS) and Master Fuel Trip (MFT)
   b) Secondary Air Damper Control (SADC) System
   c) Flame Monitoring System
   d) Soot Blower Control (SBC) System
   e) Pressure Reducing and De-superheating (PRDS) Control System

ii. Steam Turbine Generator Control System (TG-C&I DDCMIS)
   a) Turbine Governing System
   b) Turbine Protection System
   c) Turbine Stress Evaluation cum Stress Control System
   d) Automatic Turbine Testing System
   e) Automatic Turbine Run-up System

iii. Steam Turbine driven Blower Control System (TB-C&I DDCMIS)
   a) Turbine Governing System
   b) Turbine Protection System
   c) Turbine Stress Evaluation cum Stress Control System
   d) Automatic Turbine Testing System
   e) Compressor Surge Detection
   f) Anti-surge Control
   g) Load Sharing Control
   h) Cold Blast Control
   i) Stove Changeover Control

iv. Common system Control System (Station-C&I DDCMIS) including ACW, CW and

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Compressed Air System

v. DM Plant

6.10.3.1. Steam Generator Control System (SG-C&I DDCMIS)

i. Burner Management System (BMS)

Microprocessor based Burner Management System with specially designed and proven hardware and software shall be provided to achieve the boiler start-up, operation, protection, shutdown and emergency shutdown functions i.e. Master Fuel Trip (MFT), fuel gas systems etc. The BMS shall be provided with automatic self-monitoring facility. All the modules to be used in this system shall be of failsafe design.

The BMS shall meet all applicable relevant safety requirements of NFPA 85, EN 50156, EN-62477

MFT functions shall be implemented in fault tolerant TRUE Triple Modular Redundant (TMR) configuration. Each of the three independent channels shall have their own processors, I/O modules, multifunction controllers, communication controllers, power supplies, interface modules etc. All the safety related process inputs shall be fed to each of the three channels. All the primary sensors for unit/boiler protection shall be triple redundant. The acquisition and conditioning of binary and analog protection criteria signals for MFT shall be carried out in each of the three triple redundant channels. Each channel shall compute the 2 out of 3 voting logic and issue a trip command. The trip signals of the three channels shall be fed to a fail safe 2 out of 3 relay tripping unit of each drive. The check back contact signals of each relay of the 2 out of 3 relay tripping unit shall be fed back to each of the triple redundant channels and continuously monitored for equivalence in each of them.

Signals and commands (including the ones from push button stations) which would initiate MFT must be hardwired.

The BMS shall incorporate the following conditions for boiler operations as a minimum:-

a) Prevent any fuel firing unless a satisfactory purge has been completed.
b) Prevent start-up of individual fuel firing equipment unless permissive interlocks have first been satisfied.
c) Monitor and control proper equipment sequencing during its start-up and shutdown.
d) Provide equipment status feedback and annunciator indication to the unit operator.
e) Provide flame monitoring when fuel-firing equipment is in service and effect a burner trip or master fuel trip upon warranted firing conditions.
f) Continually monitor boiler conditions and accurate a master fuel trip during adverse operating conditions which could be hazardous to equipment and personnel.
g) Reliably operates and minimize the number of false trips.
h) Provide a master fuel trip relay independent of processors and I/O modules to provide a completely independent trip path.
i) Provide all logic and safety interlocks in accordance with National Fire Protection Association (NFPA).
j) Include a first out feature in all controllers to identify the cause of ay burner trip or boiler trip.
k) Provide a complete BMS diagnostic system to immediately identify to the operator any system modules failure.

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l) Allow burners and igniters to be started, stopped and tripped on a burner basis.
m) Allow the automatic start and stop of burners based on boiler load. The sequence on which burner shall be started or stopped shall be selected by the operator from an OWS.

ii. Secondary Air Damper Control (SADC) System

SADC system shall be provided to achieve the following major functions:-

a) Control of fuel air and auxiliary air to fuel firing elevations
b) Control of wind box to furnace differential pressure
c) Limit NO_X content in the flue gas by modulating the over fire dampers, if provided.

Each secondary air damper shall be provided with SMART positioner.

SADC shall modulate fuel air dampers of each elevation based on the fuel gas firing rate. The auxiliary dampers shall be modulated to maintain the wind box to furnace differential pressure. All secondary air dampers and auxiliary air dampers shall be provided with dedicated SMART positioners.

iii. Flame Monitoring System

The purpose of the system is to detect the individual flame and to enhance the boiler/furnace safety, to avoid spurious and unwarranted trips and to increase operational reliability, availability and efficiency of the Steam Generator such that the consumption of fuel gas/oil shall be reduced to optimal minimum.

Fail Safe, easily maintainable Flame Monitoring System shall be provided which shall include furnace flame scanners of proven design for the type of fuel, environmental condition and other conditions, of established reliability at all loads of the Steam Generator. It shall be designed to work under all adverse conditions such as wide variation in fuel/air input ratio, wide variation in fuel characteristics, variation in operating temperature, maximum temperature under interruption of cooling air supply and shall be immune to Electro-Magnetic Interference (EMI). The system shall conform to NFPA recommendation and location of detectors as per NEC requirements. The Selection and location of the furnace flame scanners shall be decided by the Boiler manufacturer. The Bidder shall furnish the justification of selection of furnace flame scanners locations for Purchaser's review.

Flame scanners shall be working on the dynamic and static properties of primary combustion zone of each type of fuel and flicker frequency of flame. It shall pick up only the flame to which it is assigned and shall not respond to the adjacent and background flame or other radiation generated in the furnace. The design shall also take into account any type of deposition on the flame scanner head. The complete system shall be able to discriminate between flames produced by different types of fuel gases. Intensity indicators for main flame shall be provided in DDCMIS.

The system should be easily maintainable and include automatic self test facility at regular interval. Flame Monitoring System shall be provided with self diagnostic features, wide viewing angle, fast response time, and high detection range. The sensor fault, alarming, diagnostic and historical flame intensity value of flame monitoring system shall be hooked up to integral OWS with suitable software. Air cooling provision at local site for cooling of flame scanners (electronic part) shall be provided

The Bidder shall demonstrate the complete performance of flame scanners in cold start

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up test and load condition test. In cold start up test, capability of flame scanners to detect start-up gas flame under varying gas pressure shall be checked. In load test, the flame scanners shall be able to detect when BF+BOF, COG and CBM is present. It shall be ensured that the flame scanners are able to detect the proven flame at very low load with all types of fuel gases. The above tests shall be performed for every gas and at all elevation.

Provision of scanner air for cooling the flame scanners by 100% redundant Scanner Air Fans, one AC and other DC operated, shall be provided. The dampers associated with scanner air fans shall be pneumatically operated with DC solenoid valves. Pneumatically operated scanner emergency damper shall be erected to safeguard all the flame scanners even in case of failure of both FDs and both scanner air fans.

iv. Soot Blower Control (SBC) System

Intelligent soot blowing control system is envisaged for this furnace. Soot blowing shall be dynamically controlled 'ON DEMAND' basis. However, the automatic sequence control function shall also be offered. Soot blower Control (SBC) system complete with provision for individual operation of any soot blower and facility to bypass any soot blower shall be provided with following:

a) Automatic starting of each soot blower in the system
b) Cancelling the operation of any soot blower in the system when required.
c) Indication of the soot blower selected to operate.
d) Capability to monitor all the essential parameters of the soot blowing system.
e) Capability to prevent continued soot blower operation if the system is not functioning properly.
f) The ability to operate two soot blowers located in opposite walls simultaneously.
g) Manual Over riding of the automatic operations.
h) To prevent automatic blowing when the parameters of soot blowing system are beyond permissible limits.
i) Indications of soot blower which has malfunctioned.
j) Control circuit for retractable blower shall be so designed as to prevent insertion of the blowers into the combustion chamber unless the blowing medium is available.
k) Limit switches and torque switches are to be connected to DDCMIS and command termination shall be done in DDCMIS only for each of the blowers.

Soot blowing control system shall also included the following controls:-

a) Pressure and temperature control of the soot blowing steam
b) Warm up control of the complete piping system which shall include flow control, drain temperature control etc.

v. Pressure Reducing and De-superheating (PRDS) Control System

Each of the PRDS units shall be provided with automatic control loops for steam pressure control, steam temperature control and spray water pressure control. However, facility for remote manual control shall also be provided in case of failure of auto control**.**

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6.10.3.2. Steam Turbine Generator Control System (TG-C&I DDCMIS)

i. Turbine Governing System

Microprocessor based Digital Electro-hydraulic Turbine Governing (DEHG) System with specially designed and proven hardware and software shall be provided to achieve the turbine governing functions. The DEHG shall be provided with automatic self-monitoring facility. All the modules to be used in this system shall be of failsafe design.

DEHG system shall be offered in TRUE TMR or QMR configuration by the bidder. The system shall consist of two or three independent channels right from the sensors, transmitters, other field mounted devices, input modules, controller modules, output devices etc. of the electro-hydraulic converter. The independent channels shall also be fed from two independent power supplies.

The turbine governing system shall meet the following functional requirements:-

a) The controls covered in this system shall basically consist of speed controller, load controller, over speed protection controller, valve-lift controller, inlet steam pressure controller and output frequency droop characteristic controller. The speed controller shall ensure controlled acceleration of the turbine generator and shall prevent over speed without tripping of the unit under any operating condition or in the event of full load throw-off.

b) The speed controller shall limit the over speed of the turbine on loss of full load to a value less than over speed protection set point value. The governing system shall be equipped with speed/load changer 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 synchronisation of the generator with the bus. It shall be capable of varying the load on the machine from no load to full load.

The governing system shall be capable of being operated 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 predetermined limit, while the turbine is in operation.

ii. Turbine Protection System (TPS)

Microprocessor based Electronic Turbine Protection System with specially designed and proven hardware and software shall be provided to achieve the turbine protection functions. The TPS shall be provided with automatic self-monitoring facility. All the modules to be used in this system shall be of failsafe design.

The TPS shall meet all applicable relevant safety requirements of EN 50156, EN-62477

TPS functions shall be implemented in fault tolerant TRUE Triple Modular Redundant (TMR) configuration. Each of the three independent channels shall have their own processors, I/O modules, multifunction controllers, communication controllers, power supplies, interface modules etc. All the safety related process inputs shall be fed to each of the three channels. All the primary sensors for turbine protection shall be triple redundant. The acquisition and conditioning of binary and analog protection criteria signals for TPS shall be carried out in each of the three triple redundant channels. Each channel shall compute the 2 out of 3 voting logic and issue a trip command. The outputs of the three channels shall be used to implement 2 out of 3 voting logic in two relay units, the output of which shall be fed to the two turbine trip relays. The check back contact signals of each relay of the 2 out of 3 relay tripping unit shall be fed back to each of the

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triple redundant channels and continuously monitored for equivalence in each of them.

As an alternative, two independent trip channels may be processed, each having its dedicated and hot redundant processing modules, controllers, I/O modules etc. 2 out of 3 voting logic shall be implemented in each of the channels and the output of each channel shall be fed to each of the two turbine trip relays. Turbine shall be tripped when either of the two trip relay operates.

All the input required for the safety and protection of the turbine shall be configured in 2 out of 3 logics. The system shall include turbine lock-out relays, redundant turbine trip solenoids and necessary hardware required for testing.

The tripping devices shall be designed to operate on DC supply. The trip coils shall be monitored continuously for its healthiness and its failure shall be annunciated.

Electronic Overspeed Protection shall be provided in true TMR configuration with dedicated speed sensors.

iii. Turbine Stress Evaluation cum Stress Control System

A field proven microprocessor-based online Turbine Stress Evaluation cum Stress Control System shall be provided, which shall work in conjunction with turbine governing system and ATRS. The system shall be complete with measuring transducers for generator load, processing modules, I/O modules etc. for undertaking the stress calculations, turbine life calculations etc. The system shall offer the following functional requirements as minimum:-

a) Continuous on-line monitoring of thermal stress levels in all critical parts of the turbine such as main stop valves, control valves, casing, shaft etc.
b) Continuous on-line computation of stress margins available for the above-mentioned critical components of the turbine during various regimes of operation i.e. run-up, synchronization, loading, load manoeuvring, normal operation, run backs, unloading, shutdown etc.
c) Computation of the limits of speed and load changes allowable at any particular instant before synchronization and after synchronization respectively. The system shall be designed to inhibit further operation like speed/steam temperature raising or lowering wherever upper and lower temperature margins are not available (during periods prior to synchronization) and load/steam temperature raising or lowering whenever upper/lower load/temperature margins are not available (after synchronization) within allowable limits.
d) Carry out a fatigue analysis for all affected critical components of the turbine as per bidders standard and proven practice and also to compute the percentage service life consumption of the turbine.
e) Display the stress margins etc. on OWS for operator guidance and storage of necessary data such as percentage service life consumption etc.
f) Store long term data & carry out Residual Life Analysis.

The system shall be complete including measuring transducers for generator load and wall temperature, measured value processing modules, microprocessor based controllers for stress calculations and turbine life calculations etc.

iv. Automatic Turbine Testing (ATT) System

The bidder shall provide ATT system for the onload testing of the turbine protective equipment automatically in the sequential manner and keeping all the protective

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functions operative during the test. The ATT facility shall include but not limited to the following:-

a) Opening and closing of emergency stop and control valves
b) Overspeed trips
c) Low vacuum trip
d) Electrical remote trip

It shall be possible to carry out the ATT mentioned at sl. no. (b), (c) and (d) at 100% load.

v. Automatic Turbine Run-up System (ATRS)

ATRS shall run the turbine automatically from zero speed to synchronizing speed and then load the machine up to the block loading and continuously check the operation upto 100% MCR without impairing the life of turbine. The ATRS shall be designed in general to implement the following functions:-

a) Automatic start-up/shutdown sequence
b) Stress /temperature margin controlled acceleration as per the pre selected mode i.e. slow, normal and fast.
c) Stress/temperature margin controlled loading/unloading
d) Automatic synchronization and loading upto 100% MCR.
e) Unloading and shutdown of the machine.

All the above mentioned functions shall be read in conjunction with the other requirements indicated in the relevant technological volumes.

6.10.3.3. Steam Turbine driven Blower (TB-C&I DDCMIS)

a) Turbine Governing System

Microprocessor based Digital Electro-hydraulic Turbine Governing (DEHG) System with specially designed and proven hardware and software shall be provided to achieve the turbine governing functions. The DEHG shall be provided with automatic self-monitoring facility. All the modules to be used in this system shall be of failsafe design.

DEHG system shall be offered in TRUE TMR or QMR configuration by the bidder. The system shall consist of two/three independent channels right from the sensors, transmitters, other field mounted devices, input modules, controller modules, output devices etc. of the electro-hydraulic converter. The independent channels shall also be fed from two independent power supplies.

The controls covered in this system shall basically consist of speed controller, blower load controller, over speed protection controller, valve-lift controller, inlet steam pressure controller. The speed controller shall ensure controlled acceleration of the turbo-blower and shall prevent over speed without tripping of the unit under any operating condition.

The governing system shall be capable of being operated remotely from unit control room for the purpose of limiting the amount of opening of the governor controlled valves to set the blower load at a predetermined limit, while the turbine is in operation.

b) Turbine Protection System

Microprocessor based Electronic Turbine Protection System with specially designed and proven hardware and software shall be provided to achieve the turbine protection functions. The TPS shall be provided with automatic self-monitoring facility. All the

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modules to be used in this system shall be of failsafe design.

The TPS shall meet all applicable relevant safety requirements of EN 50156, EN-62477

TPS functions shall be implemented in fault tolerant TRUE Triple Modular Redundant (TMR) configuration. Each of the three independent channels shall have their own processors, I/O modules, multifunction controllers, communication controllers, power supplies, interface modules etc. All the safety related process inputs shall be fed to each of the three channels. All the primary sensors for turbine protection shall be triple redundant. The acquisition and conditioning of binary and analog protection criteria signals for TPS shall be carried out in each of the three triple redundant channels. Each channel shall compute the 2 out of 3 voting logic and issue a trip command. The outputs of the three channels shall be used to implement 2 out of 3 voting logic in two relay units, the output of which shall be fed to the two turbine trip relays. The check back contact signals of each relay of the 2 out of 3 relay tripping unit shall be fed back to each of the triple redundant channels and continuously monitored for equivalence in each of them.

As an alternative, two independent trip channels may be processed, each having its dedicated and hot redundant processing modules, controllers, I/O modules etc. 2 out of 3 voting logic shall be implemented in each of the channels and the output of each channel shall be fed to each of the two turbine trip relays. Turbine shall be tripped when either of the two trip relay operates.

All the input required for the safety and protection of the turbine shall be configured in 2 out of 3 logics. The system shall include turbine lock-out relays, redundant turbine trip solenoids and necessary hardware required for testing.

The tripping devices shall be designed to operate on DC supply. The trip coils shall be monitored continuously for its healthiness and its failure shall be annuciated.

Electronic Overspeed Protection shall be provided in true TMR configuration with dedicated speed sensors.

c) Turbine Stress Evaluation cum Stress Control System

A field proven microprocessor-based online Turbine Stress Evaluation cum Stress Control System shall be provided, which shall work in conjunction with turbine governing system and ATRS. The system shall be complete with required measuring transducer, processing modules, I/O modules etc. for undertaking the stress calculations, turbine life calculations etc. The system shall offer the following functional requirements as minimum:-

i. Continuous on-line monitoring of thermal stress levels in all critical parts of the turbine such as main stop valves, control valves, casing, shaft etc.
ii. Continuous on-line computation of stress margins available for the above- mentioned critical components of the turbine during various regimes of operation i.e. run-up, loading, load manoeuvring, normal operation, run backs, unloading, shutdown etc.
iii. Computation of the limits of speed and load changes allowable at any particular instant before increasing blower load and after attaining desired blower load respectively. The system shall be designed to inhibit further operation like speed/steam temperature raising or lowering wherever upper and lower temperature margins are not available (during periods prior to synchronisation) and load/steam temperature raising or lowering whenever upper/lower load/temperature margins are not available (after loading) within allowable limits.
iv. Carry out a fatigue analysis for all affected critical components of the turbine as per

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bidder's standard and proven practice and also to compute the percentage service life consumption of the turbine.

v. Display the stress margins etc. on OWS for operator guidance and storage of necessary data such as percentage service life consumption etc.

vi. Store long term data & carry out Residual Life Analysis.

The system shall be complete including necessary measuring transducers for wall temperature, measured value processing modules, microprocessor based controllers for stress calculations and turbine life calculations etc.

d) Automatic Turbine Testing System

The bidder shall provide ATT system for the onload testing of the turbine protective equipment automatically in the sequential manner and keeping all the protective functions operative during the test. The ATT facility shall include but not limited to the following:-

i. Opening and closing of emergency stop and control valves
ii. Overspeed trips
iii. Low vacuum trip

It shall be possible to carry out the ATT mentioned at sl. no. (2) and (3) at 100% load.

e) Blower Surge Detection

The bidder shall provide continuous real time blower surge detection facility. It shall be complete with all the necessary field sensors for surge detection. The field instruments required for the surge detection shall be offered in the triple redundant configuration.

f) Blower anti-surge Control

The bidder shall provide proven suite of blower anti-surge control for safeguarding the equipment and prevent the equipment/plant shutdown. It shall be complete with all the necessary field sensors for anti-surge control. The field instruments required for the anti-surge control shall be offered in the triple redundant configuration.

g) Load Sharing Control

The bidder shall provide load sharing control for the coordinated operation of the blowers based on cold blast demand. The load sharing control shall ensure stable operation of the blower during loading and unloading of the blower due change in load requirement.

6.10.3.4. Common Systems of CPP technological package (Station-C&I DDCMIS)

The Station-C&I DDCMIS shall perform all the balance function which are not covered in the SG-C&I DDCMIS, TG-C&I DDCMIS and TG-C&I DDCMIS. Broadly this system shall perform the following functions:-

i. Analog control functions, other than those covered in SG-C&I, TG-C&I & TB-C&I like master pressure control, furnace draft control, boiler drum level control, SH/RH steam temperature control, FW flow control, heaters/deaerator/condenser level control, pump recirculation control etc.

ii. Binary control functions pertaining to main plant auxiliaries like FD/ID/PA fans, APH, BFP, CEP, CTP, boiler fill pumps, ACW pumps, CW pumps, Compressed Air Station,

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dosing system etc.,

iii. Generator auxiliary systems and electrical breakers etc.

6.10.3.5. DM Plant

The DM Plant shall be controlled from the DDCMIS. The DDCMIS hardware for the DM Plant shall be placed in the DM Plant Control Room. The DM Plant DDCMIS shall be unified with the CPP DDCMIS through bidirectional redundant OFC interface.

Normal operation of the DM Plant shall be carried out from the DM Plant Control Room. The bidder shall provide the facility to operate the DM plant from the CPP Central Control Room under emergency or extraordinary conditions.

6.10.4. Measurement Functions of Control System

All the signal cables from the field shall be wired to field side terminal blocks of control panel or shall be routed through the marshalling panel as OEM standard practice. No field cable shall be directly wired to the I/O modules.

6.10.4.1. Analog Signal Conditioning and Processing

The DDCMIS shall be have the following signal conditioning and processing features for analog inputs for measurement and control purpose:

i. Galvanic isolation of input and output signals for which power supply source is other than the measurement system of the control system.
ii. Transmitter power supply with per point fuse protection or current limiting and power supply monitoring.
iii. Online maintenance, configuration and diagnostics of HART capable field devices.
iv. Implementation of multiple measurement schemes for signals for control purpose.
v. Pressure and temperature compensation
vi. Sensor/transmitter signal output limit check
vii. Square root extraction
viii. LVM generation
ix. Cold junction compensation for thermocouples.
x. On-line analog digital converter (ADC) gain and drift monitoring and correction at periodic intervals.
xi. Linearization of temperature signals (for thermocouple & RTD through temperature transmitters)
xii. Monitor sensor wire break/open circuit/short circuit and take suitable actions in logic/loop. (This shall include blocking of trip signals in case of RTD failure).
xiii. Fuse Protection and Fuse failure detection.
xiv. Galvanic/optical channel to channel Isolation shall be built in Module. The current limitation shall not be considered as channel isolation.
xv. Failure of individual channel shall not disturb the other channels for AI/TC/RTD card.
xvi. Detection of open circuit for thermocouples.

All analog signals for control purpose shall be acquired, validated, processed and their respective data base updated at a maximum interval of 250 milliseconds except for some fast-acting control loops for which the above referred time shall be as per process requirement. For signals required for information only, the above functions shall be

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performed at an interval of 1 –2 sec. The validated analog inputs shall be converted into engineering units on a per point basis. Analog input processing (scanning to alarm checking) shall be performed once every scan cycle. It shall be possible to delete any analog input from scan or to return it to scan on demand by the operator.

The analog 4-20 mA input cards shall have input loop resistance >= 250 ohm for interfacing transmitters/analysers/temp. signals (through temp transmitters) giving 4-20mA analog signal along with superimposed HART interface signals. 4-20 mA DC signal shall only be used for control purpose and superimposed HART signal shall be used for configuration, maintenance, diagnostic and record keeping facility for electronic transmitters and Analysers etc from the DDCMIS. ***Bidder shall note that standalone HART Management System (HMS) shall not be accepted and HMS shall be integral to the DDCMIS.***

6.10.4.2. Binary Signal Conditioning and Processing

The changeover type contacts (i.e. 'NC' + 'NO' together) shall be wired to the control system for all the binary inputs required for control purposes, except for inputs from MCC/switchgear, actuators and inputs related to hardwired signal exchange among various functional group for which non-changeover type contacts ('NC' or 'NO') shall be wired to the control system. The binary inputs required for information purposes only shall be wired to control system in the form of non-changeover type contacts.

The DDCMIS shall be have the following signal conditioning and processing features for binary inputs for information and control purpose:

i. 24 VDC power supply for contact interrogation for all potential free contacts with as per point fuse protection or suitable current limit feature/ isolation through opto- coupler.
ii. Contact bounce filtering. (The field contact which is changing state must remain in the new state for the filter delay time to be reported as one event). The filter delay time should be suitable for the field input & its scan rate.
iii. Facility for automatic pegging the binary signal to logic one/zero or last correct value in case of failure of binary input module.
iv. All binary signals shall be acquired validated, processed, alarm checked and their data base updated within one second.
v. It shall be possible to manually disable any binary input either through deleting from scan or substitution from HMI.
vi. The non-coincidence monitoring shall be provided for binary inputs for all changeover signals.
vii. Binary signal distribution to different users shall be in such a way so as to ensure that a short/ground fault on one user is not reflected to the other user.
viii. Implementation of multiple measurement schemes for signals for control purpose.
ix. Checking for excessive number of status changes for all binary/contact inputs.

6.10.5. Control System Functions

The Bidder shall provide all hardware/software, whether or not specifically indicated in this specification to fully meet operational/maintenance/ safety requirement as well as statutory/international standard and proven practices.

The application programs for the functional controllers shall be software based which shall be maintained even through power supply failure.

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Independent and dedicated controllers (main and its 100% hot standby) shall be provided for each of the functional group (FG) of Control system. All the 100% hot redundant backup controllers shall be identical in hardware and software implementation to their corresponding main controllers and shall be able to perform all its tasks. The backup controller shall track its corresponding main controller. There shall be an automatic and bumpless switchover from the main controller to its corresponding backup controller in case of main controller failure and vice versa without resulting in any change in control status. In case of switchover from main controller to the 100% hot backup controller, the back-up controller shall work as the main controller. Further, when only one controller is working and other controller is inserted on line (for example after repair/replacement), there should not be any degradation in the function of the working controller & control operation.

6.10.5.1. Closed Loop Control System (CLCS)

The CLCS shall continuously act on valves, dampers or other mechanical devices such as hydraulic couplings etc., which alter the plant operation conditions. The system shall be designed to give stable control action in steady state condition and for load changes in step/ramp over the load range of 50% to 100% MCR with variation or parameters within permissible limits.

The controller capability shall, as a minimum, include (i) P, PI, PD and PID control functions and their variations (ii) cascade control (iii) feed forward control (iv) On-Off control, (v) Ratio and bias control, (vi) Logical operation. Other advanced control strategy like adaptive & predictive control etc. can be considered for important loops like Furnace Draft, combustion control, FW flow control etc. in addition to SH temperature control. The bidder shall consider state variable control for superheater temperature control.

The control loop shall have enough flexibility and various features to perform feed forward, balancing of controller, increasing the response to achieve the desired process parameter within prescribed time frame. The loop reaction time of the closed loop control shall be as per clause no. 6.10.6 of the TS. All controllers shall be freely configurable with respect to requisite control algorithms.

The control system shall be bumplessly transferred to manual on the conditions of Control power supply failure, Failure of redundant controllers, Field input signal not available, Analog input and / or deviation exceeding preset value, etc. as a minimum and as finalised during detailed engineering.

Analog output of 4-20mADC shall be provided from CLCS to the respective SMART positioners / electrical actuators as applicable. The failure of one of the redundant, output module shall in no way affect the function of the other output module, wherever redundancy is provided. CLCS shall also provide all the necessary outputs for indicators and other devices with output loop resistance of 500 ohms for each channel of the output module.

Any switch over from auto to manual, manual to auto and switchover from TFT operation to auto manual station operation and vice versa shall be bumpless and without resulting in any change in the plant regulations and the same shall be reported to the operator.

The System being supplied shall be such that when permissible limits are exceeded, an automatic switchover from an operation governed by maximum efficiency, to an operation governed by safety and availability is affected.

For safety reasons, switchover logics associated with the modulating control loops shall be performed within the same controller. Modulating control loops shall be provided with standard features to interface overriding commands from OLCS/SG/TG Protection System

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like open, protection open etc.

Time supervision facility shall be provided to monitor the final control element. It shall be possible to block the controller output on a pre-programmed basis.

Whenever, alternate measurement is available for a control input the alternate measurement value shall be automatically substituted in the control loop in case of loss of control input. All necessary software for switching and reconfiguration shall be provided. In addition, such substitution shall be balanceless and bumpless and shall be reported to the operator.

6.10.5.2. Open Loop Control System (OLCS)

The OLCS shall include sequence control, interlock & protection for various plant auxiliaries, valves, dampers, drives etc. The sequence control shall provide safe and automatic start-up and shutdown of plant and of plant items associated with a plant group. The interlock and protection system shall ensure safe operation of plant/plant items at all times and shall automatically shut down plant/plant items when unsafe conditions arise.

The OLCS shall be arranged in the hierarchical control structure consisting ofunit level, group level, subgroup level & drive level (as applicable).

It shall be possible to perform automatic unit start-up & shutdown by issuing minimum number of command from the OWS. Thus, the unit level shall control all the control system blocks and issue appropriate start-up and shutdown commands to various blocks of control system.

The group level shall control a set of functional sub-groups of drives. Appropriate start-up and shut down commands shall be issued to the subgroup control and various checkbacks shall be received from sub-groups or drives. Each sub-group shall execute the sequential start-up and shut down programmes of a set of inter-related drives along with system interlocks and protections associated with that sub-group as well as basic interlocks and protections related to individual drive falling under that sub-group. The drive level shall accept commands from the sub-groups, push buttons (wherever provided), etc., and transmit them to the respective drive, after taking into account various interlocks and protections and the safety of that particular drive.

6.10.5.3. Sequence Control

A sequence shall be used to move a set of groups, sub-groups from an initial steady state (for instance 'OFF') to a final steady state (for instance 'ON'). The sequence initiating command for the unit & group level shall be issued from HMI.

A sequence shall be made of steps. The steps shall be executed in predetermined order according to logic criteria and monitoring time consisting of the interlock & protection requirements and check back of previous step which shall act as preconditions before the sequence control can execute the command for that step.

Each step shall have a "waiting time" implying that the subsequent step would not be executed unless the specified time elapses. A monitoring time shall also be defined as the maximum time required in executing the commands of any step and the time required for appearance of check back signals. In case, this is not completed within the specified time, a message shall be displayed and program shall not proceed further.

Manual intervention shall be possible at any stage of operation and the sequence control shall be able to continue at the correct point in the program on return to automatic control. Protection commands shall have priority over manual commands, and manual commands

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shall prevail over auto commands.

Open or close priority shall be selectable for each drive.

The sequence start-up mode shall be of the following types.

i. Automatic mode

In this mode of operation, the sequence shall progress without involving any action from the operator. The sequence start/stop command shall be issued from the HMI.

ii. Semi-automatic mode

In this mode of operation, once the sequence is initiated, the step progressing shall be displayed on the LED. But the step execution command shall be prevented and shall be sent by the operator via the keyboards. It shall be possible to bypass and/ or simulate one or more criteria to enable the program to proceed. This facility shall allow the program to be executed even if some criteria are not fulfilled because of defective switching device, etc., while the plant condition is satisfactory. All the criteria bypassed shall be logged and displayed. It shall be possible to put the system on the auto-mode after operating it on semi-automatic mode for some steps or vice-versa, without disturbance to the sequence operation.

iii. Operator guide mode/test mode

It shall be possible to use the sequential control in operator guide mode/ test mode i.e. the complete system runs and receives input from the plant and the individual push button stations (where provided)/ keyboards but its command output is blocked. The whole programme, in this case shall run in manual mode. This mode shall allow the operator to practice manual operation using step and criteria indications. The actual protection should remain valid during this mode of operation also.

For the drives, the command shall be provided through O/P module to the coupling relays in MCC/SWGR/Actuator/Relay Cabinets as applicable and inputs (status, SWGR & process) shall be acquired through input modules. The failure of one of the redundant, output module shall in no way affect the function of the other output module, wherever redundancy is provided.

The status for the 11 KV, 3.3 KV drives and some other important drives shall also be wired in parallel to redundant input modules so that on failure of the single input modules, the information regarding the status of the affected drive remains available in OLCS.

The output modules shall have the feature that ensures that in case of failure, all the outputs are driven to zero. The 24V DC command outputs to drives for ON/OPEN, OFF/CLOSE shall be separate and independent and inverted outputs shall not be employed. Live +24V DC outputs shall be provided to MCC/SWGR/ actuator as applicable when command is to be issued. Keeping +24V DC extended to the relays for these outputs continuously & extending ground/negative when command is to be issued, is not acceptable except some of the auxiliary plants as to be decided during detailed Engineering.

The drive function i.e. basic interlock & protection logic of the drive shall be implemented in redundant controllers. The drive function shall ensure that protection signals for the safety of the drive shall be effective under all conditions and under all modes of operation. The different commands shall be performed according to the priority of protection 'Off', Protection 'On', manual and automatic. The standard functions like running time monitoring, status signalling, alarm/drive annunciation, etc. shall be performed in drive function. The

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drive function shall prevent hunting of the actuator in the presence of both open & close commands for actuators of the valves & dampers. The drive function shall be implemented in dedicated standard software functional block (drive macros).

The OLCS shall also include the control of electrical systems in addition to the auxiliaries of boiler & turbine such as open/close or on/off etc. of various electrical systems such as generator, generator auxiliary systems, breakers of 11kV, 3.3 kV. 415 V switchgears, synchronisation of unit etc. as described in Section -5. All the features and specification requirements as specified above shall also be applicable for electrical system.

6.10.6. Performance requirement of DDCMIS

Loop execution time for protection and governing Controls	Maximum 20 ms
Loop execution time for CLCS	Maximum 100 ms (For all critical Loops)
Loop execution time for CLCS	Maximum 250 ms (For all Loops)
Loop execution time for OLCS	Maximum 100 ms (For all Loops)
Updating rate of Analog display	Max. 1 seconds (for measurement)
Updating rate of Analog display	Max. 1 second for OLCS/CLCS
Updating rate of Digital value display	Max. 1 seconds (for measurement)
Updating rate of Digital value	Max. 1 second for OLCS/CLCS
Updating rate of pulse signal	Max. 1 second
Change over to back up controller	less than 20ms (bump-less)
Time for display on screen	Max 1-2 seconds on demand

6.10.7. Human Machine Interface and Plant Interface System (HMIPIS)

The operator interface of the HMIPIS shall consist of workstations, colour printers, etc. The workstation based operation shall employ powerful menu-driven and window supported input facilities for operational ease and comfort. All workstations of the HMIPIS shall be fully interchangeable i.e. all operator functions including control, monitoring and operation of any plant area or drive shall be possible from any of the workstation at any point of time without the necessity of any action like downloading of additional files. Facility for operating multiple drives from a single display by calling faceplates or pop-ups windows shall be provided.

The system shall have integral access control features that shall restrict access of HMIPIS functions to authorised personnel based on their assigned access levels. This shall protect the system against inadvertent and unauthorised usage of the system. Assignment of allowable functions and entry fields shall be on the basis of user profile. The access control function shall contain various user levels with specific rights which shall be as finalized by the Purchaser during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).

No single failure in HMIPIS shall lead to non availability of more than one workstation and two printers. In such an event i.e., single failure leading to non availability of any workstation, it shall be possible to operate the entire plant under all regimes of operation including emergency conditions from each of the other available workstation.

The HMIPIS shall be designed such it shall process, display and store information to provide the operator, either automatically or on demand, the relevant information as indicated in subsequent clauses. The following minimum functions shall be performed by HMIPIS:

i. Calculations

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ii. Alarm monitoring and reporting
iii. Displays
iv. Logs and summaries
v. Log generation facility
vi. Historical Storage and Retrieval System (HSRS)
vii. Quality tag

6.10.7.1. Calculations

i. Basic Calculations

All the algebraic / logical calculations related to analog signals (i.e. sum, difference, difference, averaging, integration etc.), digital signals (i.e. COMPARE, AND, OR, etc.), transformations, flow calculations, time projection or rate of change calculations, frequency etc. shall be provided. All the calculated values of the plant shall be available in the database.

ii. Performance Calculations

The performance calculations shall use high level language calculations. These equations shall be changeable on-line at the job site. An extensive set of steam property subroutines based on 2021 ASME steam tables shall be included in the system. The results of these calculations shall be available through data base for appropriate logs and operator displays. The calculation shall be carried out at 30% unit load or higher. The calculation frequency shall be selectable at site from 10 minutes to 1 hour, with a step of 10 minutes.

The performance calculations shall be broadly subdivided into two classes:

a. Class 1 : Equipment performance calculations.

The Class 1 calculations are generally for the purpose of detecting & alarming unit malfunctions. These shall be executed at the scan cycle of the inputs, for the calculation.

These shall include super heater spray outlet approach to saturation temp., turbine steam-metal temp. differences, turbine metal temp. rates of change, feed water heater terminal temp. difference, feed water heater drain cooler approach, excess air deviation from standard, feed water heater temp. deviation from standard, any saturation temp. rate of change, metal temp. difference for SH ‘Y’ piece etc.

b. Class 2 : Plant/Equipment efficiency calculations.

The Class 2 performance calculations shall be performed to determine the performance of individual items of equipment and the overall unit. These shall include the following calculations:-

a) Boiler efficiency
b) Gross turbine generator heat rate
c) Gross unit heat rate
d) Net unit heat rate
e) Turbine enthalpy drop efficiency

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f) Feed water heater performance terminal temperature
g) Feed water heater performance drain cooler approach
h) Condenser performance
i) Deaerator performance
j) Economizer performance
k) BFP performance
l) Air pre-heater performance
m) Fan efficiency
n) Unit availability calculations
o) Deviations from expected values for each calculation

iii. Plant Optimisation Application

The Bidder shall provide PC based online plant performance optimization application for the plant. This application shall incorporate the complete thermal design model of the CPP and its auxiliaries. The system shall acquire the process data from the DDCMIS through appropriate redundant OPC interface to be provided by the Bidder. Performance Optimization Server shall be connected to OPC servers of DDCMIS for two-way communication i.e acquisition of process data and transmission of information to unit operators.

The Plant Optimization Application shall provide the functions specified herein in a modular and seamlessly integrated environment, using a common plant model and a dynamically shared data base. The database shall be open and accessible through well-defined interface for any third party application.

The Optimization Package should monitor the actual operation of the entire process and should compare it continuously to its current optimum. Specifically, the operation of the steam turbine, steam generator, turbo blower, the condenser and the feed water pre-heaters should be included in the Optimization Package evaluation. The impact of the relevant components on the economics of the current operation should be clearly identified. The operator should be informed whether any of the components is operating below its respective optimum value and how much this deviation costs in terms of additional fuel consumption.

a) Thermal Performance Monitoring and Analysis

Calculation of thermal performance of the plant comprising SG, TG, STB, condenser & other auxiliaries and efficiency of generation using measured data. Calculation of all the key system performance indicators at system level such as heat rate, plant and equipment efficiency generator output and controllable losses.

Analyse the impact of individual component performance on overall losses or gains in total megawatt generation using first principle/empirical models as applicable (not output correction curves). All possible components/heads of losses shall be considered including piping losses (e.g. between boiler & turbine, heat loss to environment through pipes and equipment), gland and other leakages, drains, LP turbine exhaust losses etc. The references values for above computing should consider the effect of aging and performance degradation of the equipment.

Perform detailed analysis of each component including calculation of key

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performance indicators such as efficiency, heat transfer co-efficient, effectiveness for heat exchangers, TTD, DCA and fouling factor, Air Heater X ratio, Logarithmic Mean Temperature Difference (LMTD) for condenser etc.

b) Emission Monitoring and Analysis

Monitor, track and analyse steam generator emissions such as SO_x, NO_x, Dust, CO and CO_2 or O_2 in real time and correlate with major operating conditions of the steam generator to identify the possible causes of deviation from the desired operating characteristics. Monitoring and analysis stack conditions such as flue gas temperature, humidity, flow, pressure and opacity.

Facilitate to achieve lowest emissions without compromising combustion efficiency.

c) Equipment Performance Analysis

Continuous online evaluation of process & system component performance degradation to detect inefficient and worn-out plant equipment. This shall cover degradation due to aging based on technical analysis of equipment performance data, material property etc. and pointers from measured/computed values.

Analysis of faults and abnormal operating conditions of all major equipment, auxiliaries and systems for identification of root cause of the fault and abnormal operating conditions.

Vibration measurement/analysis of major rotating machines & HT drives is performed separately under turbo supervisory instrumentation (TSI) system and vibration measurement system. The results from these systems shall be made available to Plant Optimization System through the DDCMIS network.

d) Boiler Performance Optimisation Package

The bidder shall provide online Boiler Performance Optimization System (BPOS) for steam generator. The BPOS shall incorporate the complete thermal design model of the steam generator capable of both forward and backward calculation of complete boiler thermal performance. The model shall be calibrated and made 'site specific' based on series of field trails of thermal performance of the boiler during start-up and prior to trial operation. The input for the BPOS shall be based on accurate and continuous online grid measurement of the following:-

- Flue gas temperature at economizer inlet and outlet
- Flue gas oxygen
- Fuel gas characteristics
- Unburnt hydrocarbon in flue gas
- Gas flow rate/Air fuel ratio at each elevation

The BPOS shall be capable for continuous on-line calculation of the thermal performance of the boiler for the operating conditions indicating performance prediction zonal absorption, metal temperature and shall have the following typical features.

- Fuel switching capability
- 'WHAT IF' capability

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- Selective soot blowing of Furnace/Super heater based on trends of zonal absorption.
- Expert system diagnostics for quick identification of the 'Root Cause' of deviations from the predicted parameters.

The bidder shall also offer boiler stress condition analyser as a part of BPOS.

The data acquisition, processing and transmission of performance optimization system results shall be done through redundant two way links between performance optimization system and main plant DDCMIS through OPC link. Performance optimization system results shall be made available in OPC servers and HMI data base of DDCMIS through appropriate interface to be provided by the bidder for display and recording. Advisory messages/data shall be displayed on operator screens and other user screens using this interface. Other authorised third parties shall be able to access the performance optimisation results/data through the OPC servers. However, to protect against unauthorized access to the application/network, sufficient security features in the form of firewall or any other suitable hardware / software keys etc., shall be provided by bidder.

Bidder shall provide all necessary software, hardware and any other suitable provision for remote diagnostic support for troubleshooting and optimization of the performance optimization system.

All the process instruments and sensors required for achieving the performance optimisation as indicated above shall be supplied by the bidder even if the same is not indicated in the clause no. 6.3 of this TS.

The bidder shall provide 02 nos. of performance optimisation servers with 01 no. colour laserjet printer(A3) for this application. The specification for the performance optimisation servers shall be as per clause no. 6.10.7.10(i) of the TS.

It shall be bidder’s responsibility to deliver a fully functional performance optimisation system at site. The bidder shall demonstrate the full functionality of this system. Prior to the acceptance, the purchaser shall test the system functionality inline with the TS requirement. Following minimum activities shall be performed by bidder during site acceptance test:-

i. Demonstration of online performance optimization system on running plant.
ii. Demonstration of data exchange between various modules.
iii. Demonstration and verification of data exchange between optimization modules and DDCMIS.
iv. Demonstration and verification of data exchange between optimization modules and OPC server and third party system.
v. Demonstration remote diagnostics facility

6.10.7.2. Alarm Monitoring, Reporting and Analysis

The system shall display history of alarms in chronological order on any of the workstation. The HMIPIS shall have the capability to store a minimum of 1000 alarms each with paging features allowing the operator to view any page. The system shall have all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. Other design features like set point/dead band adjustments, provision of alarm priority, manual inhibition & automatic inhibition based on predefined logic, alarm filtering etc., shall be provided and shall be as finalised during detailed engineering. The alarm display/report

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format shall be as approved by the Purchaser.

Facility of audio annunciation including voice audio shall be provided in OWS upon the occurrence of OWS alarms irrespective of whether alarms are displayed or not. Facility to disable the audio annunciation per OWS shall be provided under the security level of Maintenance or Administrator.

All digital point should be categorized with severity/priority 1-5 level and all analog signals must be colour coded in such a way that during normal range its value shall be green and after normal range up to certain level it should be yellow and in the dangerous zone it should change its colour to red to give alert signal to operator.

DDCMIS shall provide fault alarm analysis guiding the operator to the most likely cause of fault. The alarm system shall be designed in such a manner that main auxiliaries tripping can be traced to the originating cause.

6.10.7.3. Displays

Various displays on the workstation shall include P&ID displays or mimic, bar chart displays, X-Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start-up/shutdown message displays, generator capability curves, heat rate deviation displays, system status displays etc as a minimum. Number of displays and the exact functionality shall be on as required basis and as finalised during detailed engineering.

Other types of displays as applicable for convenience of operation shall be provided by Bidder. However, the minimum quantity of major types of displays shall be as follows:

i.	Control displays (group/sub-group/sequence/loop)	500
ii.	P&ID / Mimic display	100
iii.	Bar Chart	100
iv.	Trend display - X-Y Plot	100
v.	Trend display - X-T Plot	100
vi.	Sequence displays	On required basis
vii.	Drive level displays	On required basis
viii.	CLCS displays	On required basis
ix.	Alarm and fault analysis display	On required basis
x.	Operator guidance message	100
xi.	Plant starting / shutdown guidance message	100
xii.	Group displays	On required basis
xiii.	Bar graph display	200
xiv.	Point details display	200
xv.	System status & other diagnostic display	On required basis
xvi.	Display covering all 3D displays	On required basis
xvii.	Alarm facia displays on OWS/LVS	On required basis
xviii.	Other misc. display	25

6.10.7.4. Logs, summaries and reports

The system shall generate different types of logs, summaries and reports. The formats, design and parameters to be analyzed shall be decided during detailed engineering. The system shall have the facility for viewing of the logs/summaries on the OWS/LVS as well as for their copying in formats compatible to be used with MS-office or similar tools.

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The following type of logs, summaries and report generation facility shall be provided in the DDCMIS:-

i. Event activated logs
ii. Time activated logs
iii. Operator demand logs
iv. Boiler start-up log
v. Turbine run-up log
vi. Turbine, Generator and Blower diagnostics log
vii. Turbine recall log
viii. Turbine shutdown analysis log
ix. Performance log
x. Other special log
xi. Summaries
xii. Reports(in .csv and .pdf format also) that shall include total generation, running hours, steam parameter data, and totalised flow at TOP, consumables

6.10.7.5. Alarm Annunciation Facility

The alarm annunciation facility shall be integral to the DDCMIS. This annunciation shall include both the process alarms as well as system alarms. The top area of the OWS and LVS, shall be reserved for the alarm displays.

The annunciation points shall be displayed on uppermost part of mimic display. Facility of grouping of the alarm as per the operator requirement based on process area shall be provided. Speakers and hooters shall be configured for the reporting of the alarms, major/critical alarms shall be annuciated through hooters directly from the DO cards of the DDCMIS. The alarm acknowledge/reset facility shall be provided on the OWS. The annunciation window design, grouping, sequence etc. shall be as discussed and finalized during detailed engineering.

Bidder shall provide suitable “configuration utility” for viewing, creating and modifying list of all alarms (process and system) to be displayed on all annunciation area, band colour, text colour, flashing colour and frequency, font, etc.

6.10.7.6. Historical Data Storage and Retrieval System (Historian)

The historical data storage and retrieval system shall collect, organise and store process & system (DDCMIS) data for future analysis. The data shall be transferable to removable storage media for long term storage and retrieval. The binary data to be stored shall include status of SOE (1milli-second resolution), alarm and other binary inputs. All the important analog data shall be stored at the second interval. Selected logs viz. start-up log, trip analysis log shall also be stored. The data/information to be stored & frequency of storage and retrieval shall be as finalized during detailed engineering. However, it shall not be less than the following:

i. Sequence of event status and logs
ii. Critical analog points with 1 second resolution (500 nos.)
iii. Non critical analog points with 5 second resolution (500 nos.)
iv. Other analog points with 30 second resolution
v. All binary points on status change with suitable protection against false or excessive status changes
vi. All the logs, summaries and reports
vii. Maintenance logs

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viii. Alarm and event list
ix. Mode changes
x. Set point change data
xi. Messages
xii. Plant efficiency and performance history

02 nos. of dedicated Historian workstations shall be provided for this application. The Historian shall have adequate storage for atleast 180 days. The historian shall be able to retrieve data from portable storage device or NAS (automatic back-up facility) and present it in the form of X-T display, X-Y display, logs, reports, etc. Historian shall have the automatic data back-up facility to the NAS or to any other portable disk.

6.10.7.7. Sequence of Events (SOE) Recording

The bidder shall offer an integral SOE recording system, which shall belong to same family as that of the DDCMIS. The system shall monitor SOE inputs with a resolution of one (01) millisecond at all times for all inputs including spare inputs. That is, all SOE points' status change shall be reported and time tagged within one (01) millisecond of their occurrence. The SOE recording system shall be synchronized with master clock every one minute.

Input cards shall be equipped with digital filters with filter delay of minimum 4ms (identical for all points) to eliminate contact bounce such that field contact which is changing state must remain in the new state for successive 4 ms to be reported as one event. Facility shall be provided to identify bad inputs (like chattering) and make them off scan. Facility for adding a field adjustable software delay on a per point basis shall be provided. The start of data collection for SOE report shall be reported to OWS within 2 sec of SOE data collection initiation. Time stamping of SOE inputs/points shall be performed in the control system. Minimum 5000 SOE points shall be provided by bidder.

The SOE report collection shall begin on occurrence of change of status of any SOE point and shall be printed after an operator selectable time interval of 1 to 3 min. or 100 status changes have taken place after the first event. The system shall also include provision for historical storage and retrieval of SOE report for a period of 180 days. SOE reports shall be periodically transferred and stored in the Historian like other logs/reports.

The SOE reports shall also include a list of major equipment trip in chronological order and include the points that initiated (first-out) equipment trip / plant trip. The inputs for SOE shall include:-
(a) Hardwired inputs in input cards and
(b) calculated points/generated points of Control System.

In case the Bidder's system cannot use the internally calculated/generated points for SOE monitoring, all required I/O modules shall be provided within quoted price.

All the SOE inputs (Causes of Trip & Trip related inputs) shall also be available for interlock/protection functions.

Application software license as applicable shall be provided for SOE functionality as provided

6.10.7.8. Quality Tag

The system shall identify and tag the quality of all data (scanned and calculated points) in a way that makes all users (control, calculations, logs, displays, etc.) aware of its quality. Quality of data other than 'good' shall be clearly identified in all printouts and displays by appending quality character to the value/status of point. The quality tagging shall include

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good, bad, substitute, doubtful, suspect, etc.

6.10.7.9. Messaging System

It shall be possible to send pre-defined messages either periodically or on occurrence of certain events in the form of

i. Email to designated clients on station LAN
ii. Messages (SMS) to designated mobiles nos. (Min. 30 nos.)

In case the alarms are not acknowledged/rectified within a certain interval, then the same shall also be reported to designated users through messaging system. Adequate security in the system shall be built in the system to avoid any unauthorized access to DDCMIS system.

An application utility shall also be provided for configuring the events, grouping of events areas wise, priority of events within a group and configuring user groups for to which the event/event group can be assigned, escalated etc.

6.10.7.10. HMIPIS Hardware Specifications

i. Servers, OPC server, Gateway PC, Engineering Workstations, Performance Optimisation Server, Historian and Emergency Workstations

The server shall have following minimum specification. However, DDCMIS vendor shall be responsible for proper server sizing and ascertaining its quantity w.r.t functional requirement, capacity & scalability requirement.

a) Rack mounted servers with dedicated LVM switch, monitor, wired laser mouse and wired industrial grade keyboard.
b) Servers with hot redundant synchronized processors with dedicated cores, cache and memory
c) Min. Intel Xeon 6 64 bit 16 core or better with clock speed of 3.5 GHz or better
d) Windows Server 2022 or latest (64 bit OS)
e) Cache 112 MB L3 or better
f) RAM - 128 GB, DDR5, RDIMM 4800MT/s or more, RAM shall be upgradable to 1 TB. Server should have min. 8 DIMMs per core and 16 DIMMs per system. The memory shall have min. 60% reserve/spare capacity at full load.
g) Hot swappable 4x2TBhigh performance mixed use SAS SSD with RAID controller. One spare SSD of identical configuration shall also be provided. RAID configuration shall be RAID5 or RAID 10. For Historian and Servers Hot swappable 4x4TBhigh performance mixed use SAS SSD with RAID controller shall be provided.
h) In built 10/100/1000 MBPS 1GBase-T ports. Min. 06 nos. of Base-T ports shall be provided for each system.
i) Redundant Hot swappable power supply and Redundant Hot swappable cooling fan.
j) 27” full HD anti-glare colour LED backlit LCD monitor with IPS panel/178^{o} viewing angles, 75Hz refresh rate, TUV certified, HDMI and DP ports, USB (Gen. 3.2 or latest) ports (type-A and type-C), audio out ports, ethernet ports – same make as server OEM
k) 16x DVD read-write drive
l) PCIe 5.0 or higher generation graphics card (passively cooled) with min.16 GB memory (GPU). Graphics output shall be of HDMI or DP type

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m) Dual redundant interface modules for communication with system DCS controller bus and Data Highway; necessary serial ports, 6 nos. type-A and type-C USB(Gen. 3.2 or latest) ports for interfacing with peripheral devices.
n) Status monitoring of fan, power supply, memory, CPU, RAID, NIC etc. for impending failure.
o) Intelligent UPS with 1 hour back-up.

The servers shall have fault tolerant architecture with a minimum availability of 99.999%. The fault-tolerant configuration of server shall include synchronized redundant processors such that failure, if any, is transparent to the user and server applications, i.e. the data display on the graphic of any HMI shall not be lost for more than three (3) seconds in case of failure of the main server. In case of failure of working server, the maximum switchover time to redundant server shall be in the order of ten (10) seconds. During this switch over, real-time data shall be available in at least two HMI.

ii. Operator Workstations (OWS)

Each DDCMIS Operator workstation and LVS workstation shall comprise of following minimum configuration:-

a) Intel Core i9 (14 Gen. or higher) processor with min. 33MB cache, 20 cores, 28 threads, 2.1 GHz to 5.4 GHz turbo, 65W
b) Chipset W600 or W700 or advanced
c) Windows 11 LTSC or latest (64 bit OS)
d) RAM –2x16GB, DDR5, 6000MT/s or more, RAM shall be upgradable to 128GB. OWS should have min. 4 DIMM slots per system. The memory shall have min. 60% reserve/spare capacity at full load.
e) Hot swappable 2x2TBhigh performance mixed use SAS SSD with RAID controller. One spare SSD of identical configuration shall also be provided. RAID configuration shall support RAID 1.
f) In built 10/100/1000 MBPS 1GBase-T ports. Min. 04 nos. of Base-T ports shall be provided for each system.
g) Redundant Hot swappable power supply. Min. 1000W 80 plus platinum certified PSU with premium CPU air cooler with VR heat sink
h) Dual 27” full HD anti-glare colour LED backlit LCD monitor with IPS panel/178^{o} viewing angles, 75Hz refresh rate, TUV certified, HDMI and DP ports, USB (Gen. 3.2 or latest) ports (type-A and type-C), audio out ports, ethernet ports, built in speaker – same make as server OEM
i) 16x DVD read-write drive
j) PCIe 5.0 or higher generation graphics card (passively cooled) with min. 8 GB memory (GPU). Graphics output (min. 03 ports) shall be of HDMI or DP type
k) Industrial grade drip and dust proof keyboard
l) Wired laser mouse
m) Dual redundant interface modules for communication with system DCS controller bus and Data Highway; necessary serial ports, 6 nos. type-A and type-C USB (Gen. 3.2 or latest) ports for interfacing with peripheral devices.

iii. Laptop based Workstation

Laptop with following minimum configuration shall be provided:-
a) Intel Core i9 (14 Gen. or higher) processor with 4.0 GHz or higher
b) Windows 11 LTSC or latest (64 bit OS)

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c) Graphics card with atleast 8 GB GPU
d) 14-17" Anti Glare Full HD/HD+ LED backlit LCD Screen with wide angle viewing and 60Hz frame rate.
e) 2 TBSSD
f) Backlit keyboard
g) 64 GB DDR5 RAM expandable to 128GB, 6000MT/s or more
h) Slim type DVD-RW drive or an external USB type DVD-RW drive
i) Internal 10/100/1000Mbps Ethernet card
j) IEEE 802.11B connectivity port
k) IR port
l) Wireless optical mouse with dual mode (2.4 GHz / Bluetooth) connectivity
m) Wireless keyboard
n) 03 nos. USB 3.2 ports including 01 no. USB Type-C port, Wireless INTERNET and blue tooth interface
o) Minimum 8 hrs battery backup.
p) Recovery software tools.
q) Sound cards
r) Internal speakers
s) MS-Office Professional, Microsoft Visual Studio, Adobe Acrobat DC Pro, anti-virus, etc.
t) Application engineering & HMI software - to suit project specific requirement.
u) Leather carry bag.

iv. Large Video Screens

05 nos. of Large Display Unit (Giant Screen) shall be provided in the control room as per the requirement indicated in configuration diagram or in TS. Large Display Unit shall be used for:

- Demonstrations to visitors for ready impressive and effective plant overview and plant highlights.
- Display of any specific operator screen on the large screen, as required.
- Display of some operational situations like start-up or shut-down to enable mangers/ operators to discuss without disturbing the unit operator.
- Display of important operational data of the plant /unit for ready reference, eg. Production details, shutdown requirement/ request information, etc.
- The Large Display Unit shall be installed in specific wall or column in the control room.
- The Large Display Unit system shall have following minimum specifications:
- The screen design shall be based on large LCD.
- Optical system (screen/ monitor) shall have a minimum resolution of 1024x768 pixels (Colour). Size of screen shall be minimum 85" diagonally with 16.7 million colours.
- The optical system shall be provided with low power LED lamps with operational life of minimum 60,000 Hrs.
- They shall be able to provide uniform brightness of 95% with a contrast 1200:1, which shall be able to provide high contrast even in bright ambient light.

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- The display screen shall be seamless and flicker less. The blank screen shall be black or grey in colour. The brightness and contrast shall remain uniform.
- The control of screen displays and functionality shall be carried out from a dedicated workstation (PC) connected to Large Display Unit.
- The screen shall be lightweight and low thickness type, which can be supported from the control room wall.
- The system shall not be susceptible to environmental factors like heat, humidity, or vibration, which can cause an image to degrade over time The system shall be zero hassle and minimal maintenance. All components shall be carefully chosen to provide high mean time between failure and minimal mean time to repair.
- Provision of automatic switching off of Giant screen if temperature in the control room increases above the maximum permissible limit of large display unit.
- Ethernet card shall be provided in Large Display Unit so that it can be connected with Ethernet port of work station.
- The system shall be supplied complete with all hardware and software as necessary for the specified application including interface software.

v. Printers

a) A3 & A4 colour and B&W printing, heavy duty
b) Print, Scan & Copy
c) ADF
d) Duplex printing
e) Print(A4): Up to 40 ppm (B&W)
f) Print resolution: 600 x 600 dpi
g) Scan Speed (A4): Up to 25 ppm (B&W) and up to 20 ppm for colour
h) Scan resolution: 1200 x 1200 dpi
i) File Formats supported for scan: PDF; TIF; BMP; JPG
j) Memory: 512 MB (min.)
k) Display: Yes
l) Network printing capabilities. 1 Hi-Speed USB 2.0; 1 Fast Ethernet 10/100Base-TX; 1 Wireless 802.11b/g/n
m) power supply: 230 VAC, 50 Hz.

6.10.7.11. HMIPIS Bill of Material

S. No.	Equipment	Quantity	Location	Spec. Clause no.
1.	Operator Workstation (OWS)	10 nos.	Control Desk	6.10.7.10(ii)
2.	Engineering Workstations (EWS)	05 nos.	Programmer's Desk	6.10.7.10(i)
3.	Laptop based EWS	02 nos.	Programmer's Room	6.10.7.10(iii)
4.	Servers	04 nos.	Programmer's Room	6.10.7.10(i)
5.	Emergency Workstations	02 nos.	Programmer's Desk	6.10.7.10(i)
6.	Historian	02 nos.	Programmer's Desk	6.10.7.10(i)
7.	SOE Workstation	01 nos.	Control Desk	6.10.7.10(ii)
8.	Electrical Workstation	01 nos.	Control Desk	6.10.7.10(ii)
9.	Performance Calculation WS	01 no.	Control Desk	6.10.7.10(ii)
10.	Performance Optimisation Server	02 nos.	Programmer's Desk	6.10.7.10(i)
11.	85" LVS based Operator Workstation	05 nos.	Control Desk	6.10.7.10(i)

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				6.10.7.10(iv)
12.	Unit I/C Workstation	01 no.	Unit I/C room	6.10.7.10(ii)
13.	Shift I/C Workstation	01 no.	Unit I/C room	6.10.7.10(ii)
14.	Network PC	01 no.		6.10.7.10(ii)
15.	OPC Server	02 nos.	Programmer's Room	6.10.7.10(i)
16.	Operator cum Engineering Workstation for proprietary control system	02 nos. per system	Control Desk	6.10.7.10(ii)
17.	HART PC (Asset Management Station)	01 no.	C&I Maintenance Room	6.10.7.10(i)
18.	Remote Access Workstations	05 nos.	Plantwide Network	6.10.7.10(i)
19.	Network attached storage with auto back-up facility (each 16 TB min.)	02 nos.	Programmer's Room	
20	Colour Laserjet Printers(A3)	04 nos.		6.10.7.10(v)
21.	Colour Inktank Printers (A3)	02 nos.		

6.10.8. DDCMIS System Hardware Requirement

i. Central Processing Unit (Controller)

- Modular and plug-in type
- Minimum 32-bit microprocessor based.
- User memory: 48 MB or more.
- Redundant CPU shall be installed in independent rack/ backplane. Hot redundancy management.
- Processor rack/ chassis shall have hot redundant power supply modules, wherever separate power supply module is required.
- The system shall have different response time, i.e. from the time a change takes place at the input module, to the time it is displayed at the operator's station. System activation or log-on of a terminal shall be of 1 sec, Display update of simple pages like menu display shall be of 500 ms, Graphic page update shall be of 1 sec or less with max. 200 parameter/ screen, Command execution response time for display shall be of 4 sec, Data entry error reporting shall be of 1 sec, Response to mouse/keyboard commands shall be of 500 ms.
- Provision to latch desired outputs.
- Provided with redundant hot standby communication port from CPU.
- The CPU system shall have facility of bump-less transfer from working to standby unit in case of failure of one, without affecting the system and process. When the defective controller is put back into the system after rectification, it shall automatically & bumplessly get synchronized with the working controller without manual intervention. When both the controllers are in healthy conditions, either of the controller can be 'master' or 'slave'
- Hot standby processor shall regularly update the I/O information and shall also execute the program. However, the main/ master processor shall only provide the final output.
- CPU shall have crystal clock generator.
- Backup system communication (redundant communication bus) shall be provided.
- The processor shall have proper communication modules (for each CPU) for communicating with redundant processor, I/O racks and for communicating with

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other communication bus protocols like Ethernet bus/ Profinet/Modbus/Controlnet/ Field foundation bus etc. Communication module shall also be considered for all gas analyzers and for different special instruments for which RS 485/Profinet or other digital bus communication mentioned in data sheet of individual instruments.

- The processor shall have in-built provision for software timers, counters, examining input conditions, compare, compute, logical, conversion from/ to BCD, bit manipulation, block memory manipulation, diagnostic, shift, sequencing, conditional jumping, subroutine instructions etc.
- The controller shall have control algorithms to implement regulatory and advanced control strategies. These shall include PID adaptive, feed forward, cascade control, high-high, high, low, low-low signal selection, real-time computational capability, weighing and batching functions. The controller shall also have auto-tuning facility. Necessary software & functional blocks shall be provided accordingly.
- CPU modules shall have Conformal coating suitable for Air borne contaminants class G3, as per ISA-S71.04-198 for DM Plant DDCMIS. For other areas the CPU modules shall be G3 class compliant as per ISA-S71.04-198
- The system shall have built-in simulation features to check the I/O channels individually, from the engineering terminal, without activating technological elements
- The program memory shall be stored in EPROM/EEPROM or battery backed RAM. It shall have 40% free space for future use. It shall be expandable in blocks. In case of rechargeable batteries, necessary charging circuit shall be provided. The system shall have provision for battery replacement without loss of data.
- Control network shall be of star/ ring topology, Ethernet IEEE 802.3 (TCP/IP).
- Protection against over voltage & over current.
- Hot swappable I/O cards. Online replacement and auto detect for newly added I/O cards
- Operation of DCS shall be completely unaffected by a momentary loss of power for upto 20 ms
- LED indicator for Power ON, Error and flashing for active CPU, etc.
- Time synchronization with GPS based Master Clock System

ii. I/O Modules

a) <u>General requirement</u>

- High density, modular.
- ***DIN rail mounted I/O modules shall not be accepted***
- All the I/O modules shall have Conformal coating suitable for Air borne contaminants class G3, as per ISA-S71.04-198 for the DM Plant DDCMIS and all the DDCMIS RIOs under CPP package. For other areas the I/O modules shall be of class G3 as per ISA-S71.04-198.
- Insulation level of 500 / 1000 V AC/DC
- Input Field interrogation voltage 24 V DC.
- Individual DP MCB shall be provided in power supply for each backplane or each card (if separate power supply is required for each card).
- Cards shall have diagnostic features.
- Cards shall have Hot swapping features. On-line replacement of any module shall be possible in such a way that the removal and addition of any module shall be possible without de-energizing the system. Further there shall not be any interruption in the

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system while replacing a faulty module except for the inputs / outputs which are being handled by the module.

- Environmental condition: As indicated at sl. No. A.5 above
- LED indicator for Power ON (Green), Error (Red).
- For SIL certified cards (if required), the no. of channels shall be as per manufacturer's standard.
- The field cables shall not be brought directly to the I/O cards. The same shall be routed through the field termination / marshalling racks and shall be part of DCS.
- Both AO & DO modules shall have configurable fail-safe options such as, drive to zero or maintain last output value. These fail-safe actions, if configured, shall come into picture in case of processor halt or communication break between the controller and I/O module.

b) Analog Input Modules

- Shall be 8/16 channels, rack based & plug–in type.
- Suitable for 4-20 mA / 0-10V DC / 1-5 VDC/ pulse signals from flow meters or others/ weighing signal inputs.
- With necessary A/D converter having at least 14-bit resolution.
- Single or double ended type input channel
- Nominal signal range (span): 4-20 mA. Full signal range: 2-22 mA, with over range checking.
- Performance: Accuracy over temperature range: < 0.2% of span, Repeatability: < 0.05% of span.
- Each channel shall be galvanically or optically isolated from system and shall be factory tested at 500 VDC or more.
- Communication support: HART pass-through request/ response, HART variable reporting, Field device status reporting. HART scan time: 600-800 ms per channel
- Open circuit detection, Short circuit detection, Protection against reverse polarity, Fail safe option (configurable), Channel to channel isolation.
- Healthiness of every input shall be monitored & LED indication shall be provided.
- Analog module shall have the facility to be configured in voltage or current mode.
- Analog input modules shall be universal type which shall be suitable to accept signals from 2-wire, 3-wire and 4-wire transmitters.
- Each channel can be connected as sink or source mode depending on type of connected instruments. Wiring from module to TB shall be such that sink or source mode can be decided at site.
- For 4 – 20 mA analog inputs, fused T.B with blowing fuse indication shall be provided.

c) RTD Input Modules

- Shall be 4/8 channels, rack based & plug–in type.
- Suitable for all types of RTDs (i.e. Pt100, Pt200, Pt500, Pt1000, 3- wire / 4 wire, Ni120, Cu10) signal inputs.
- With necessary A/D converter having at least 14-bit resolution.
- Performance: Accuracy over temperature range: <+ 0.5 0C, Repeatability: < 0.05% of span, Resolution: 0.05 0C or better for Pt100. Common Mode Rejection: 120 dB @50 Hz. Common Mode impedance: > 10 MΩ
- Each channel shall be galvanically or optically isolated from system and shall be factory tested at 500 VDC or more.
- Calibration standard: DIN 43760/ / BS 1904 / IS 2848 / IEC 60751
- Temperature scale 0C or 0F selectable.

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- Open sensor detection.
- Healthiness of every input shall be monitored & LED indication shall be provided.

d) T/C Input Modules

- Shall be 4/8 channels, rack based & plug–in type.
- Suitable for all types of T/Cs (i.e. ISA type E, T, J, K, R, S, B, N) signal inputs.
- With necessary A/D converter having at least 14-bit resolution.
- Each channel shall be galvanically or optically isolated from system and shall be factory tested at 500 VDC or more.
- Performance: Accuracy over temperature range: <+ 0.1% of span, Repeatability: < 0.05% of span, Resolution: 0.2 0C or better. Common Mode Rejection: 120 dB @50 Hz. Common Mode impedance: > 10 MΩ
- Calibration standard: DIN 43710/ / BS 1904 / / ANSI MC96.1/ IEC 60584
- Temperature scale 0C or 0F selectable
- Linearization circuit
- Cold junction compensation: Integral or external. External temp. sensor shall be used.
- Open sensor detection.

e) Analog Output Modules

- Shall be 4/8 channels, rack based & plug–in type.
- Suitable for 4-20 mA DC signal outputs.
- With necessary A/D converter having at least 12-bit resolution.
- Nominal signal range (span): 4-20 mA. Full signal range: 2-22 mA.
- Output compliance: 20mA at 24VDC supply into 600 Ω load.
- Performance: Accuracy over temp. range: <0.25% of span.
- Calibration information shall be stored on card
- Each channel shall be galvanically or optically isolated from system and shall be factory tested at 500 VDC or more.
- Communication support: HART pass-through request/ response, HART variable reporting, Field device status reporting. HART scan time: 600-800 ms per channel
- Open circuit detection, Short circuit detection, Protection against reverse polarity, Fail safe option (configurable), Channel to channel isolation.

f) Digital Input Modules

- Shall be 16/32 channels, rack based & plug–in type.
- Suitable for 24 VDC dry contact type inputs, BCD input (suitable for 4 digit), Pulse inputs (Incremental encoder / digital tacho), Absolute / incremental encoder inputs.
- Time delay of about 10 millisecond to filter out noise and contact bounce.
- Each channel shall be galvanically or optically isolated from system and shall be factory tested at 500 VDC or more.
- Response time < 50 msec.
- Input impedance: 5 KΩ approx. or more.
- Return: Can use common return.
- Fail safe option (configurable), Channel to channel isolation.

g) Digital Output Modules

- Shall be 16/32 channels, rack based & plug–in type.
- Suitable for 24 VDC contact type outputs, BCD output units (suitable for four-digit output), Rated to drive seven segment LED displays
- Each channel shall be galvanically or optically isolated from system and shall be factory tested at 500 VDC or more.

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- Off state leakage current: 0.1 mA max.
- Return: Can use common return.
- Fail safe option (configurable), Channel to channel isolation.
- Duration of the single pulse output shall be configurable from the engineering workstation.
- The output module shall be through separate interposing relays (24V DC coil) with 2 NO+2NC, with contact rating of 5 A, 240 VAC, to drive solenoids, annunciation lamps, LEDs, Instrumentation control equipment, power devices like contactors etc. Separate relay boards with mounting base shall be used for the mounting of the relays. Relay powering shall be arranged through separate bulk power supply units.
- Any special requirement e.g position control to control field devices shall be met by using separate interface modules

iii. Intrinsic Safety Barriers

Intrinsic safety barriers shall be used to limit the total current, voltage and energy delivered to field mounted electrical or electronic installed in hazardous area or process with hazardous process fluid. All the instruments used in lube oil application and fuel gas application shall be provided with intrinsic safety barrier irrespective of the area classification. The bidder shall offer the intrinsic safety barrier as per the following specifications:-

a) Analog Input Safety Barrier

- Number of channels: 1 input (Tx. Installed in IEC Zone 1, Gr. IIA, IIB, T3) & 1 output
- Input & Output signal: 4 - 20 mA DC (HART) for both input & output
- Environmental condition: Up to 50 0C & up to 85% RH (non-condensing)
- Barrier power supply: 24-35 VDC
- Load driving capacity: 600 Ω load in safe area @ 24 VDC.
- Transmitter power supply: Yes, power supply to 2 wire transmitters from barrier
- Input/ Other circuit isolation: Galvanic isolation according to EN 60079-11
- Mounting: DIN rail or power rail
- Certification: Yes, ATEX cert.

b) Analog Output Safety Barrier

- Number of channels: 1 output (Positioner installed in IEC Zone 1, Gr. IIA, IIB, T3) & 1 input from DCS AO.
- Input & Output signal: 4 - 20 mA DC (HART) for both input & output
- Environmental condition: Up to 50 0C & up to 85% RH (non-condensing)
- Barrier power supply: 24-35 VDC
- Load driving capacity: 600 Ω load in hazardous area @ 24 VDC
- Line fault detection: Yes, line breakage & short circuit
- Positioner power supply: Yes, power supply to 2 wire positioner from barrier
- Input/Output & Output/PS isolation: Galvanic isolation according to EN 60079-11
- Mounting: DIN rail or power rail
- Certification: Yes, ATEX cert.

c) Digital Input Safety Barrier

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- Number of channels: 1 or 2 input (Dry contact or NAMUR input from item installed in IEC Zone 1, Gr. IIA, IIB, T3) & 1 or 2 passive transistor output
- Environmental condition: Up to 50 0C & up to 85% RH (non-condensing)
- Rated voltage: 20-30 VDC
- Configuration: Via DIP switches
- Indication: LEDs
- Input/Output & Output/PS isolation: Galvanic isolation according to EN 60079-11
- Mounting: DIN rail or power rail
- Certification: Yes, ATEX cert.

d) Digital Output Safety Barrier

- Number of channels: 1 or 2 output, for powering to solenoids, LEDs and audible alarms located in a hazardous area (IEC Zone 1, Gr. IIA, IIB, T3).
- Environmental condition: Up to 50 0C & up to 85% RH (non-condensing)
- Rated voltage: 20-30 VDC
- Configuration: Via DIP switches
- Line fault detection: Yes, open circuit & short circuit
- Line fault transparency: Yes
- Indication: LEDs
- Input/Output isolation: Galvanic isolation according to EN 60079-11
- Mounting: DIN rail or power rail
- Certification: Yes, ATEX cert.

iv. Power Supplies

a) General requirement

- Two sources of 240/110V AC single phase, 50 Hz from UPSDB for CPU cabinet, marshalling cabinet and I/O cabinet, i.e. 2 nos. of feeder for each main control/cabinet room and remote I/O cabinet room.
- Power supply unit for different types of cards **as described below shall have 100 % redundancy** & both power supply units shall have auto-changeover facility.
- Power supply unit shall be of regulated power supply to generate required AC or DC voltages
- DP MCBs shall be used for protection of power supply system. Separate DP MCBs shall be used at the incoming power to each power supply unit.
- Processor rack of Hot redundant Controller shall have separate hot redundant power supply modules or power supply unit.
- AI/AO/DI modules of each I/O cabinet shall have separate hot (dual) redundant power supply module/ unit. Common hot (dual) redundant PSU for different I/O cabinets shall not be acceptable.
- Separate DP MCB for input power supply to each I/O rack/ I/O backplane.
- Separate redundant power supply unit with suitable DP MCB shall be provided for power supply of solenoid valves (24 VDC), if directly fed from DCS I/O cabinet.
- Separate DP MCB for each 24 VDC/ 240 VAC/ 110 VAC 4 wire instrument shall be provided at marshalling/ power distribution cabinet. No marshalling or DBs shall be installed at field for these, unless otherwise specified in project specific TS.
- 20% spare DP MCB shall be provided in each panel.
- Power supply equipment and the distribution system shall have surge voltage protection, fuse protection in the input and output circuits, electronic over current protection, thermostat protection against over temperature, etc.

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b) Power supply module

- Input: 24 VDC, Output:24 VDC or 12 VDC or 5 VDC as required.
- Input protection: Through fuses
- Output protection: Output protected at 110% or more of rated voltage.
- LED indicator for Power ON (Green), Error (Red)

c) Power supply unit

- Input voltage range: 100 to 240 VAC
- Output: 24 VDC
- Use of MOSFET based Active redundancy module for redundant PSU system.
- Efficiency >90%
- Insulation voltage input, output / housing: 500 VAC or 700 VDC.
- Protection against surge protection & short circuit
- Over voltage protection (OVP) at the output
- DP MCB protection in the input and output circuit.
- PSU failure indication shall be available in HMI as alarm.
- Each of redundant bulk power supply unit (PSU) set shall be fed from two separate AC feeders. Each redundant PSU shall be sized with 35% load in normal condition and shall be able to take load upto 70% in case of failure of one of the units, i.e. each of the redundant PSU of a set shall function in load sharing basis.

v. Communication Modules

a) General requirement

- For communication between controller and data acquisition system, hot redundant I/O bus shall be provided from each CPU rack.
- For interfacing of redundant I/O bus, redundant communication interface modules shall be provided in each controller rack/ chassis controller subsystem and in each I/O rack. Interface module with redundant port or redundant I/O bus communication through backplane is also acceptable as per availability from the manufacturer.
- Each controller rack/ chassis shall communicate with operator workstations/ servers and other peripheral units through dual redundant Data Highway. The communication network shall be real time, switched Ethernet IEEE802.3 & IEEE802.3v compliant TCP/ IP type with bus speed of 100/ 1000 MBPS. Ethernet switches shall be industrial grade managed switches.
- If more than one DCS have been envisaged for a plant unit, then the above Data Highway shall be common for both the DCS for interfacing with the work stations and information exchange. However, in case DCS system of two plant units shall be connected through a common bus, complete facilities shall be provided for each unit DCS, eg. Engineering station shall be separate for each unit and shall be independent.
- Both the buses of redundant I/O bus and redundant Data Highway shall be active at all times. Periodic health diagnostic of each bus and communication interface modules shall be carried out automatically at regular intervals without affecting system operation. In case of any failure, it shall automatically transfer to the redundant device without interrupting the system operation and without any operator's intervention. It shall also be possible to change the communication from the main bus to the redundant bus manually without affecting the system operation. All these changes shall be reflected in the HMI and logged as events.
- Failure or planned shutdown of any one device connected to communication network shall not affect the ability of the system to communicate with any other device on the network.

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- The system shall also have proper interface modules for communication with Level-2 automation system, if envisaged for the plant. These interface modules shall be hot redundant type.
- For applications involving interfacing of DCS with Level-2 automation and other systems through OPC, details of hardware/software, as may be required for establishing communication and integrated performance shall be provided.
- Surge Protection Device (SPD) shall be provided on the system to limit the surge voltage to enter the system beyond safe limit under normal, abnormal or lightning strike condition. This SPD shall be provided in all the serial bus cables (UTP/ STP/ coaxial cables and not FO cable) which is coming to or going outside the control room building and at both control system end (wherever applicable). The SPD shall comply requirements indicated in IEC 61643-21.
- Various communication links including bus shall be suitably designed to take care of the total requirement of information exchange including future expansion requirements. The overall system performance including display update time shall be independent of the loading of the bus and the bus loading shall be decided accordingly.

b) Serial Interface module

- Port types: RS 232, RS 422/ 485 half duplex, RS 422/ 485 full duplex
- Each port shall be optically isolated from system and from each other and shall be factory tested at 1000 VDC or more. The ports shall be grounded.
- Baud rate: 300, 1200, 2400, 4800, 9600, 19200, 38400..
- Data bits: 7 or 8. Stop bits: 1 or 2.
- Parity: Even, Odd, None
- Message time out: 100-24000 msec. (100 msec. increments)

c) Profinet Modules

- Each port shall be isolated from system and from each other.
- Data transfer rate: 10-100 MBPS.
- No. of permissible connections per module : 28.
- Electrical connection: RJ45
- Protocol support: TCP/IP or any other standard protocol.
- The Profinet modules shall be considered in redundant configuration with features:
  - Switchover time for redundant master shall be <100 ms, and there shall be an output signal check and rescan of the bus to ensure that the process shall be undisturbed.
  - The slave card shall monitor the health of the active master, while the controller monitors the health of the redundant pair.
  - Whenever a fault shall be detected, the system shall automatically switch-over to the backup master. A hardware alert on the integrity error for the primary card shall be available in HMI. The backup card shall also monitor for integrity flags. Events that can cause a switchover include-
    - ⇨ Hardware component failure in the active card.
    - ⇨ Communications failure between the active card and the controller.
    - ⇨ Removal of the active card from the carrier.
    - ⇨ Detection of a fault in the field wiring.

  A switchover may also be manually initiated from the engineering station.

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6.10.9. Data Communication System (DCS)

The DCS shall include a redundant main system bus and local system buses for major subsystems with hot back-up and other applicable bus systems like cubicle bus, local bus, I/O bus etc except back plane which can be nonredundant. The redundant buses shall be physically separate and shall be routed separately.

Redundant communication controllers shall be provided to handle the communication between each functional group of controllers of control system and the system bus. The design shall be such as to minimise interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.

Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bumpless and the same shall be suitably alarmed and logged.

If the system bus requires a master bus controller philosophy, it shall employ redundant master bus controller with automatic switchover facility.

The Bidder shall furnish details regarding the communication system like communication protocol, bus utilisation calculations etc. Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 60% spare capacity shall be available for future expansion.

In case of any distance or other limitation in the DCS, bidder shall provide suitable repeaters, MODEMS, amplifiers, special type of cables like optical fibres as required to make the DCS fully operational.

Industrial grade managed switches shall be used in the data communication system. Bidder shall note that media converters are not envisaged for this package and the bidder shall provide network/ethernet switches with SFP ports.

6.10.10. Program Development, Maintenance and Documentation Facility

It shall be possible to configure the system with ease without any special knowledge of programming or high level languages. Control strategy shall be implemented using familiar and conventional automation function blocks (software implemented). Whenever any change in configuration is done, it shall be recorded and modified configurations shall be available for printing and documentation and shall be stored in non-volatile memory. All the system configuration, tuning/fixed parameters shall be documented and printed in form of function diagrams and lists respectively.

Structuring, configuring and tuning facilities shall be provided for structuring, modification, storing, loading, testing, tuning, monitoring, etc. of all the microprocessor based controllers of the control system. The configuration and tuning unit shall be hooked up with the system bus. In case different hardware is employed for different parts of control systems and it is not possible to provide structuring/ configuration and tuning of these from the same station, bidder shall provide necessary number of stations for the purpose.

On-line tuning of the control loops shall be possible without causing any disturbance in the execution of the control loops. Provision to store and retrieve on immediate and long term basis the system configuration, data base etc. on some device such as portable SSDs or to

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auto back-up facility (NAS) shall be included. Facility shall be provided to reload/down-load the system or controller module from the already stored data, on-line.

Online system shall be provided for program development/modification to achieve various functions including development, modification and testing of software of HMIPIS, generation and modification of graphics, logs, HSRS functions in an interactive manner, HMIPIS Database modification/creations, down loading the software with associated data base from the console and other features necessary for system maintenance. All operator functions shall also be available on HMIPIS programmer station. Also, facility shall be provided to print system fault as detected by the online self-diagnostic routine.

The programming tools shall have inbuilt safety features which shall protect the system against inadvertent and unauthorised use of these tools. Necessary hard key locks and software locks, etc. shall be provided for this. Any modification done in Control System and HMIPIS shall be suitably logged so that it can be traced to the user log-in ID and time of change.

The system shall have the facility to generate the associated documentation for both the Control System & HMIPIS with all required software and hardware tools for viewing and printing drawings and documents.

6.10.11. Power Supply and Grounding

6.10.11.1. Power Supply

Each control panel shall be fed from redundant UPS power supply feeders from ACDB/DCDB. All the control panels shall in general be provided with redundant 230V AC UPS power supply from the UPS ACDB. The power supply feeders shall be further regulated and converted in the control panel with redundant power supply modules followed by diode OR-ing before the distribution to the DDCMIS equipment.

Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/PLC annunciation & suitably grouped.

Bidder shall provide 230V AC utility power supply for panel lighting, cooling fans, power sockets, space heater etc.

6.10.11.2. Grounding System

The bidder shall provide dedicated electronic earthing for the DDCMIS equipment apart from the power earthing exclusively for the DDCMIS equipment. The earth pits for the electronic and power earthing shall be separate. The earthing resistance for the electronic earthing shall be less than 0.5 ohms.

All panels, desks, cabinets shall be provided with a continuous bare copper ground bus, bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels. Each ground bus shall have provision at each end for connection of ground leaks (6mm x 50mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder.

6.10.12. Control Panels and System Cabinets

All control panels, system cabinets, control desks, LVS panel etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti- vibration pads, internal ducting& accessories as required for completeness of the system.

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The cabinet mounted equipment shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Purchaser approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site. The Bidder shall ensure that the cabinets are complete and ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets should only involve connections through multi pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/UCP.

The DDCMIS cabinets shall be grouped into physically separate cabinets as follows:

i. Control System cabinets
ii. Marshalling cabinets
iii. Relay cabinets
iv. HMIPIS cabinets

However, in case Bidder's system design requires the termination cabinet independent from system cabinet, the marshalling cabinets can be combined with the termination cabinet. In case, the termination arrangement is part of the system cabinet, independent marshalling cabinets shall be provided. The HMIPIS cabinets can be clubbed with Control System Cabinets for small areas where only 24V DC power supply is used. Bidder may make a special note that termination of field cables directly to control system cabinet is not acceptable.

The control panels/cabinets and desks installed in the control room shall be designed in such a way that the temperature rise in the panel doesn't increase beyond 10 ^{o}C (or within the safe operating limits of the system components, *whichever lower*) from the ambient temperature under the worst-case scenario or during the air conditioning failure. The bidder shall ensure optimum packaging density of the components installed inside the panel for ease of maintenance and to restrict excessive temperature rise. Each control panel shall be provided with temperature sensor to measure the panel internal temperature. The temperature sensor shall be provided with digital display and alarm facility to the DDCMIS.

All panels, shelters, cabinets, consoles & enclosures installed under the open/outdoor environment shall be provided with lightening/surge protection system as per system requirements.

6.10.12.1. Control Panels and System Cabinets and Desks

All type of panels, control panels, cubicles, consoles, SOV panels, GIU panels, Fire alarm panels and enclosures shall be fabricated from CRCA steel sheets. Panels shall be of modular construction and shall be based on multi-folded frame-based structure (Minimum 9-folded Profile) made from a single sheet. Panels with multi folded profiles shall be mandatory for all types of DDCMIS, DCS and PLC panels. The minimum sheet thickness of panels shall be as follows:

i. Side and top – not less than 1.5 mm
ii. Door – not less than 2.0 mm
iii. Mounting plate –3mm
iv. Base frame metal plate - 2.5 mm
v. Gland plate – 3 mm

The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cut-outs, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall

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have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Doors shall be reversible type, left hinged as a default, with 130-degree swing. Door latches shall be of the four -point type to ensure tight closing. Door locks shall be furnished which shall allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling. Doors should come with double bit cam locks to ensure rigid and in position locking which provides consistent IP protection and avoids entry of external substances/dust/water.

Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of four -point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 600 mm, double doors shall be provided. Doors shall be provided with polyurethane gasket only (Durometer hardness as per ASTM D2240-97/e1) with sustainable IP throughout product life. The front and rear doors shall be of full height.

The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg. C above the ambient under the worst conditions.

All panels shall be mounted on vibration dampers (min. 15mm thick), which are secured to base frame (min. ISMC 100) mounted on the floor. All panels shall have auto door operated on/off switch for internal lighting. Exhaust Fans with louvers & filters shall be provided. All the power supply circuit for control panels shall be provided with auto changeover circuitry. Properly installed grounding and potential equalization of various electrically conductive parts in order to compensate for voltage differences between conductive parts shall be preliminary design requirement for all the panels/enclosures to be met by the Bidder.

All panels, desks, cabinets shall be free standing type & have bottom / top entry for cables to be finalized application wise during detailed engineering stage. The bottom of desk & cabinets shall be sealed with bottom plate, compression cable glands (double for field and single for inside rooms) and fire proof sealing material to prevent ingress of dust and propagation of fire. Sufficient number of power receptacles with disconnect switches shall be installed within all panels/desk.

Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 2 mm or higher and 50 microns for sheet thickness equal to or less than 2mm. Minimum 2 coats of inhibitive epoxy primer and two sprays of final finish colour shall be applied to all surfaces. The exact color shall be finalised during detailed engineering.

All panels, desks, shelters, cabinets, consoles & enclosures installed under the open/outdoor environment shall be provided with lightening protection system as per system requirements.

6.10.12.2. Control Desk, PC Console and Modular Chairs

Bidder shall offer ergonomically designed control desk as per the guidelines and recommendations of ISO 11064:2013 for all the control rooms under this package. Control desk shall be Modular, non-welded construction free standing table top type with front & back cover constructed of 2 mm thick Aluminium/SS steel plates. The tabletop of the control desk shall be arc-shaped for mounting monitors & mice for SG, TG, Blower, BOP and

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synchroscope. Monitors and synchroscope shall be provided with adjustable mounting arrangement. Control desk shall be provided with dual monitor stand. The work surface of control desk shall be 30mm thick with the top 12mm of Acrylic Solid Surface (ASS) and the remaining 18mm of laminated medium density fiber board. Work surface shall be made of two different colors at same level and seamlessly joined in each section. The structure frame shall consist of extruded aluminum/SS top and bottom horizontal beams and vertical support tensioned together to form an integrated, finished curvilinear shaped frame. Vertical & Horizontal supports, minimum 2.5mm and 2mm thick respectively, have to be provided for the structure frame. Extreme side legs shall be illuminated type and should complete the overall form and aesthetics of the desk. It shall have concealed cable & wire way management system. PA system handsets, telephone sets, very few PB stations and lamps shall be mounted on the control desk on mosaic grid structure. Sliding keyboard trays shall be provided on the CD. The exact profile of the desk, dimension and the radius of curvature shall be finalised during detailed engineering stage.

All the control desk shall be equipped with Anti vibration pad of min. 15 mm thickness. Cable gland plate thickness shall be 3 mm. Base support frame height shall be min. 100 mm. Doors shall be provided with neoprene/polyurethene gasket only.

CPU cabinets shall be integral to the control desk and shall be seamlessly integrated to the control desk structure. CPU cabinets shall be fabricated from 2mm thick Aluminium/SS steel plates. CPU cabinets shall be provided with draw out type CPU tray, automatic door operated LED lights, cooling fans (on the back side), louvers with filter, universal sockets with spike guard/surge protector etc.

The CCR control desk shall have additional space for mounting one OWS of the TRT automation system.

The specification for the PC console shall be similar to the Control desk, except for the table which shall be 25mm thick with similar construction feature.

Modular chairs shall be high backrest with head rest, height adjustable, adjustable arm rest with SS frame. Each PC shall be provided with one no. modular chair. One additional modular chair also shall be provided for the TRT workstation.

6.10.12.3. Hardwired Control Desk (HCD)

One hardwired control desk shall be provided by the bidder for the emergency operation major plant equipment. The profile of the HCD shall be similar to the Control Desk to be provided by the Purchaser for the CPP control room. HCD shall be provided with hardwired devices which shall be mounted on a mosaic grid mosaic portion for mounting backup. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat and flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

HCD shall be Modular, non-welded construction free standing table top type with front & back doors constructed of 1.6 mm thick CRCA/SS steel plates. The structure frame shall consist of extruded aluminum top and bottom horizontal beams and vertical support tensioned together to form an integrated, finished curvilinear/linear shaped frame. Vertical & Horizontal supports, minimum 2.5mm and 2mm thick respectively, have to be provided for the structure frame. Extreme side legs shall be illuminated type and should complete the overall form and aesthetics of the desk. It shall have concealed cable & wire way management system. The exact profile of the desk, dimension and the radius of curvature shall be finalised during detailed engineering stage. HCD shall be equipped with Anti vibration pad of min. 15 mm thickness. Cable gland plate thickness shall be 3 mm. Base

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support frame height shall be min. 100 mm. Doors shall be provided with neoprene/polyurethene gasket only.

HCD shall be provided with automatic door operated LED lights, cooling fans (on the back side), louvers with filter, universal sockets with spike guard/surge protector etc.

All conventional back up devices/instruments shall be provided on control desk. For mounting items like PB stations, miniaturised control switches, indicators, recorders annunciation windows, on mosaic grid, the size of all these devices/instruments shall be compatible to mosaic grid on control desk.

6.10.13. System Software Requirement

The Bidder shall provide all licensed software packages required by the system for meeting the intent, functional and parametric and performance requirements of the specification.

All software licenses shall be offered with lifetime/perpetual(irrevocable) validity/license. The software licenses shall be provided for the project and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Purchaser to seek a new license/renew license due to up gradation/change of hardware/machine in DDCMIS at site.

i. Operating system for all OWS, EWS, PC & Servers
ii. System related software's real time operating system for meeting the functionality of DCS and HMIPIS
iii. System related software's real time operating system for meeting the functionality HMIPIS
iv. Software for determination of optimum Controller parameters
v. SOE recording application
vi. Disk cloning software tool
vii. Backup (manual and auto back-up), History management, NAS and File management software for HSRS/Historian
viii. Replay Software for Trip and disturbance analysis
ix. Programming and engineering software for HMIPIS functionality
x. On line diagnostics/debug software for control system
xi. On line diagnostics/debug software for HMIPIS
xii. Universal software utility(HART based) for configuration, diagnostics, maintenance and commissioning intelligent field instruments and devices.
xiii. Network Management Software
xiv. Latest versions of MS-office.
xv. High level programming support software's like Microsoft visual studio
xvi. Teamviewer software
xvii. Software package for documentation system
xviii. Software drivers and other system interfacing
xix. Anti virus software's for all the Machines
xx. Intrusion Protection System software utility
xxi. Client server suite for OPC connectivity. Min. 10 nos. of additional licenses shall be provided over and over the requirement as per this TS.
xxii. Datalogger software for OPC server (licence with unlimited tags)
xxiii. Application software for Remote Service Centre

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The bidder shall provide the back-up of all the software with application program in a portable SSD and in the Server or Programmer's PC as decided during the detailed engineering.

6.10.13.1. Software for determination of optimum Controller parameters

The programming station shall be equipped with a system/software to calculate the tuning constants i.e. P, I and D values of control loops automatically. Facility shall be provided to conduct open loop test (i.e. controller in manual mode) and closed loop (i.e. controller in auto mode) tests on control loops through GUI based user interface. It shall be possible for the user to adjust the step size of disturbance, sample time, duration of test. Facility shall be provided to choose the type of process being tuned i.e. PI, PID etc., controller type i.e. regulating or tracking, and the type of process being controlled i.e. integrating, non integrating. Further it shall also be possible to calculate the tuning constants by capturing process changes during normal process disturbance (without conducting any test). The calculation of tuning constants shall follow internationally accepted tuning procedures. The system shall be provided with facility to monitor the performance of control loops during normal operation of the plant and display important statistics and performance indices about the loops e.g. average absolute error, peak overshoot, no. of set point crossings, controller output saturation etc. and recommend retuning of the loop based on these parameters.

6.10.13.2. Replay Software for Trip and disturbance analysis

A software-based trip/disturbance analysis utility shall be provided. The utility shall have the capability to acquire point information of last 48 hrs. from the Station LAN server or Unit historians on a continuous basis (FIFO) and using the acquired data, replay the actual plant mimics with auto updation every second. It shall be possible to select the time interval for which the data is to be replayed. Process alarms, commands from OWS/LVS, UCD commands, GIU commands etc. during the selected time interval shall also be suitably displayed for ease of analysis. Actual no. of points which is to be configured shall be decided during detailed engineering.

6.10.14. System Documentation

The bidder shall furnish detailed system and equipment documentation. It shall include detailed system and components description covering the installation, operation, care and maintenance of all system components. All final system documentation for DDCMIS hardware and related software shall be furnished. The same shall be complete, accurate and fully representative of the supplied system and its elements. All documentation/catalogues etc., shall be furnished in English language. In addition to the hard copies, bidder shall submit all the documents portable SSD and shall also be stored in the programmer's PC or Server as decided during detailed engineering. The same should be compatible to the on-line document generation facility indicated in Clause no. 6.10.13 of this specification.

6.10.14.1. Hardware Documentation

Detailed technical literature, reference manuals, O&M manuals, user's guide/manuals for the complete hardware like control system hardware, HMIPIS hardware, I/O hardware, bulk memory units, peripherals and their controllers, communication hardware including controllers, man- machine interfaces programmer's unit, power supply modules etc., shall be furnished by the Bidder.

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6.10.14.2. Software Documentation

All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the DDCMIS shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalisation for Purchaser's review and approval. The software listings shall be submitted by the Bidder for source code of project specific application software and all special-to-project data files

6.10.15. HART Management System

The bidder shall provide HART Management System integral to the DDCMIS. ***Standalone HART Management System shall not be accepted.*** The centralised configuration, maintenance, diagnostics & record-keeping for all electronic transmitters, temperature transmitters, control valves position transmitters and analysers (as applicable) with HART protocol shall be carried out from the DDCMIS workstation. For implementing this functionality all the analog input modules provided shall HART pass through type.

The Bidder shall provide following functionalities as a minimum through software:

i. Constant scanning to monitor faults or changes to instrument configuration.
ii. Purchaser-defined and standard calibration and configuration procedures for all transmitters.
iii. Constant signal data collection facilities to maintain continuously updated records.
iv. Automatic tracking of configuration changes made in the field, such as may be introduced by hand-held communicator. All configuration function associated with hand-held communicators shall be available in the system.
v. Event and log reports on screen as well as on printer.
vi. Any addition/deletion of transmitter shall be reported on printer and logged in hard disk.
vii. Automatic or manual downloading and update of HART DD and DTM files.

Licensed software application required for implementing the above functionality shall be provided by the bidder. The licence provided by the bidder for this application shall come with perpetual validity. The application shall have 30% spare tags for adding more transmitters/devices in future.

6.10.16. Interfacing with RIOs and Third Party systems

6.10.16.1. Interfacing with RIOs, Master Clock System and CBMS

In case of RIO, OFC based redundant bidirectional communication shall be provided by the Bidder. Single Mode Fiber Optic cable shall be provided for communication between DDCMIS and its RIO. 100% spare fibers shall be provided in the OFC. RIO panels shall be located in the air conditioned room. All necessary hardware and software required for fiber optic communication shall be provided by the bidder. The RIO panels shall be powered from plant UPS.

The DDCMIS shall be interfaced to the BF automation system RIO for the hardwired signal exchange between the two control systems. The BF automation system RIO shall be placed in the CPP control room. The cable required for establishing this hardwired interface shall be in the scope of the bidder. The no. of I/Os in BF RIO panel are as follows:-

Analog Inputs : 18

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Analog Outputs	:	12
Digital Inputs	:	64
Digital Outputs	:	64

Accordingly the bidder shall reserve the I/Os in DDCMIS for hardwired signal exchange with BF RIO.

The DDCMIS shall be time synchronized to redundant master clock system to be supplied by the bidder.

The DDCMIS shall be interfaced to the CBMS system on redundant bidirectional OPC(UA) link. The DDCMIS shall also be interfaced with the Compressor Control System, UPS and DG Set Controller on OPC/UA compliant protocol or on MODBUS protocol.

6.10.16.2. Interfacing with Blast Furnace Automation System and TRT Automation System

Redundant bi-directional OPC(UA) compliant interface shall be provided to transfer information from the DDCMIS to the BF automation system, TRT automation system and SAIL-ISP's Plantwide Network in an efficient manner. Bidder shall ensure sufficient spare provision to establish redundant bidirectional OPC(UA) interface with atleast 10 nos. of third party systems in future.

The purpose for transferring information to the BF automation system, TRT automation system and Plantwide Network are as follows:

a. Permit the transfer of control graphics of the CPP in BF automation system, TRT automation system and Plantwide Network.
b. Provide consolidated alarm sequencing and handling capability for the CPP and auxiliary equipment in Plantwide Network.
c. Permit historical data storage and retrieval for the CPP and auxiliary equipment in Plantwide Network.

Interface hardware and software shall be suitable to match the foreign device communication requirement, like hardware interface, communication protocol etc. While writing software or mapping the input / output in the interface device it must be ensured that integrity of the data to be transferred like resolution, correctness etc. shall be maintained.

Provision shall be provided to interface with plantwide network of the Client for the implementation MIS/ERP. All the interfaces with third party control system and Plantwide Network shall be routed through the Firewall.

All hardware and software required for establishing the OPC(UA) interface with BF automation system and TRT automation system shall be in the scope of the bidder.

All hardware and software required for establishing the OPC interface with BF automation system shall be in the scope of the bidder both at CPP DDCMIS end and BF automation system end, only spare ports shall be provided at BF automation system for the termination of the communication/network cables. Additionally, all hardware and software required for establishing the interface with the Plantwide Network shall be provided by the bidder at the CPP DDCMIS end.

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6.10.16.3. Master Clock System

The bidder shall provide GPS based date insensitive redundant Master Clock System to ensure uniform time synchronization between various automation, electrical and security (CCTV) systems across the plant. The master clock system shall be 19" rack based type mounted in a dedicated panel. The master clock panel specifications shall be inline with the control panel specification mentioned elsewhere in this specification with glass front.

The master clock system shall be complete with redundant antennas, receivers, master clocks, comparators, power supplies, lightning arrestors etc. Master Clock system shall receive the synchronizing pulses from the Global Positioning Satellite (GPS) system, process it and then transmit and synchronize this time with other system (PLC and microprocessor based) clocks for recording of any event, logs and reports, which may take place in any part of the network distributed throughout the plant. A provision shall be available in the master clock system for synchronization with other GPS/Radio signal as primary and Switchyard Disturbance recorder as secondary. The exact format/type of external synchronization of master clock with other sources shall be finalised during detailed Engg. Stage.

Master clock system shall have atleast two signal conditioners for transmitting clock pulses of different formats, (such as IRIG-B, pulse, NTP/SNTP, PPS, NTP (LAN), serial etc.) for time synchronizing with other automation and electrical systems of the plant. Redundant time synchronisation signals shall be provided for major or critical plant packages, for such systems redundant time signals shall be provided from separate signal conditioners. Following tentative outputs shall be provided by the bidder as minimum:-

i.	Ethernet (NTP & SNTP)	: 02 nos. RJ-45 + 02 nos. RJ-45 (redundant)
ii.	IRIG-B(AM & PWM/TTL)	: 02 nos. BNC + 02 nos BNC (redundant)
iii.	RS-232	: 02 nos. DB9
iv.	Pulse	: 02 nos
v.	RS-485-TCP/IP	: 02 nos.
vi.	Slave Clocks	: 10 nos. (Active) + 05 nos. (Spare)

The final configuration time outputs shall be decided during the detailed engineering based on the inputs received from suppliers of various packages.

The clock system shall include a redundant master clock and slave display units. The Clock system shall be dual redundant microprocessor controlled and fully automatic. The master clock shall employ highly stable crystal oscillator to ensure accurate time indication. The stability shall be better than 0.1 sec per day. Facility for manual setting of time i.e. hours/minutes/seconds shall be provided in the master clock. Master clock system should display date, month, year and time.

The master clock system shall be provided with self-diagnostics feature. Any fault shall be indicated on the master clock system and annunciation shall be provided in the automation system using potential free contacts.

Since the timing synchronization of many plant facilities shall be done through station LAN, the slave clocks may be alternatively driven by respective systems/sub-systems. The supplier shall provide stable regulated power supply housed in master cock panel. Input power supply of 230V AC 50Hz ±10% UPS shall be provided for master clock system. Necessary Diode-Oring & AC/DC Converters shall be provided inside panel for control purposes. The master clock system shall be powered from the plant UPS. Incase, if UPS power supply is not available for the slave units mounted in offsite facility, the same shall be powered from

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230V AC utility power supply. All MCBs, erection hardware etc. required for arranging the power supply shall be arranged by the bidder.

The complete interconnecting cables along with necessary accessories shall be provided for master clock system package by the bidder. Considering the transmission distance line amplifier /line drivers, signal boosters etc. shall be provided on "AS REQUIRED" basis.

All the application software packages required for implementing the above mentioned facilities shall be provided by the bidder.

6.10.16.4. Slave Clock

The master clock shall drive the slave display units. Bidder shall provide 10 nos. of slave displays to be installed across the plant and its various offsite facilities. It shall be ensured that loss of any slave display unit does not affect the display of any other unit. The slave clock display shall have following minimum features:-

i. No. of Digits : 6 (2-hours, 2-Minutes, 2-Seconds)
ii. Display element : 7 segment Red LEDs.
iii. Digit Size : 100 mm (minimum)
iv. Viewing Distance : 20 meters
v. Glass Cover : Non – Glare type.
vi. Mounting : Wall / Panel mounting
vii. Protection : Weatherproof
viii. Operating Temperature : 0 – 50°C
ix. Relative Humidity : 95 % maximum

Note:

In between the digits for hours/minutes and minutes/seconds, flashing LED'S should be provided to segregate hours, minutes, seconds digits.

6.10.17. Firewall

Industrial grade Artificial Intelligence powered Firewall device should facilitate multi-vendor, multi-application environment and should support third-party products on open alliance. It should support Active-Active configuration. The firewall shall monitor and filter the incoming and outgoing network traffic based on the established security policy of the plant.

6.10.17.1. Hardware specification of the firewall shall be as follows:

i. Along with Threat defence software
ii. Throughput: Threat defence software- 2 GBPS or more
iii. IPS Throughput- 2.5 GBPS or more
iv. Interfaces- 8 RJ45, 4 SFP
v. Security Intelligence- Standard, with IP, URL and DNS threat intelligence
vi. Centralized configuration, logging, monitoring, and reporting shall be performed by the Threat Defence Manager (FMC) or, alternatively, from the cloud. Malware Defence for Networks- Shall enable detection, blocking, tracking, analysis, and addressing the attack.

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6.10.17.2. The firewall should contain following features:

i. Stateful inspection of packets.
ii. Network Address Translation (NAT) functionality, including dynamic and static NAT translations
iii. Latest version of SNMP
iv. The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.
v. Remote network access to the firewall should only be possible through the administration interface.
vi. The firewall administration station must be capable of pushing firewall security policies and configurations to individual or multiple firewalls through a secure, encrypted connection to the firewall administration interfaces.
vii. Graphical User Interface (GUI) and a Command Line Interface (CLI) for making changes to the firewall rules set should be provided. (Access to the firewalls via the GUI or the CLI must be through a secure encrypted channel).
viii. Any changes or commands issued by an authenticated user should be logged to a database configured on any of the machines in the LAN. The administration station must allow for a hierarchical architecture for rules set administration and viewing of firewall configurations Management.
ix. Periodic security audits and vulnerability assessment
x. The firewall must not support any unencrypted means of access to the firewall.
xi. It should Monitors ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.
xii. Detects unknown threats via anomaly scanning.
xiii. Detect unknown threats via behaviour pattern to protect from zero day attacks.
xiv. Keeps up-to-date on new threats and vulnerabilities.
xv. Integrated Intrusion Protection System(IPS)

6.10.17.3. Intrusion Protection System (IPS)

The bidder shall provide IPS for real-time monitoring of inbound and outbound network traffic for safeguarding the system from cyber security threats. The IPS shall identify and report events related to system breach or intrusion by the unauthorized parties. The IPS shall offer 24x7 real-time protection against efforts of unauthorized and unethical access attempts. IPS shall offer complete suite of Intruder Detection cum Protection System for safeguarding the plants assets. The IPS shall offer the following features:-

i. Able to analyze, detect and report on security related events.
ii. Defence against phishing and social engineering
iii. Able to inspect traffic and to drop malicious traffic based on the configuration of security policy.
iv. Able to inspect the content of network packets for unique sequences/signatures.
v. Able to detect and prevent known types of attacks such as worm or Trojan infections and hacks.
vi. Able to prevent denial of service (DOS) and Distributed Denial of Service attacks.
vii. Able to prevent abnormal behaviours by monitoring and learning normal network behaviours.
viii. Keeps up-to-date on new threats and vulnerabilities.

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ix. Should provide user friendly interface to queries and reports on threats and event data so that security administrators can gain a better understanding of their ability to protect their network.
x. Should provide detailed activity logs for auditing.
xi. Able to detect known threats via deep-packet inspection.
xii. Able to detect unknown threats via anomaly scanning.
xiii. Able to detect unknown threats via behaviour pattern to protect from zero day attacks.

6.10.18. Remote Service Centre

Bidder shall provide the necessary hardware & software required for connecting the DDCMIS system to Bidder's remote service centre, through which the diagnostics & fault analysis of the DDCMIS system can be carried out. This shall include the automation system and unit HMI, however the diagnostic of bought out items like LAN switches, etc. are excluded. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the plant's DDCMIS system.

In Plant, complete hardware, telephone exchange, cables, UPS with battery, industrial grade Modem, industrial grade Ethernet switches, complete industrial grade networking components, Firewall, power sockets, Broadband connection, and software etc to make system complete in every aspect, shall be provided by bidder.

At other end, Bidder shall also provide the complete hardware & software to establish the link/connection with project DDCMIS. Purchaser shall facilitate the bidder in obtaining the required clearance/license (if any) for establishing connectivity. However, bidder shall be responsible for obtaining all such clearances & permits at his own cost. The fixed charges & running cost till warranty period shall be included in the Quoted Price.

Connection for Remote access to the DDCMIS for diagnostics shall be through the firewall. Virtual Private Networks (VPN) technology shall be used for data integrity and confidentiality. The type of VPN and encryption etc. shall be decided during detailed engineering. Further, this access shall be strictly under request control & record of such access shall be made available to the Purchaser's designated personnel. Also, it should be ensured that the hardware at the other end of the Remote access connection (i.e. at the bidder's works) shall be standalone/ isolated (i.e. not connected to any network).

6.10.19. Programmable Logic Controller Or Proprietary Control System

Although it is preferred that the entire CPP and associated BOP packages shall be operated from a common DDCMIS of a single model and make, the bidder may offer proprietary control system for certain technological equipment or small package units, as per OEM standard. All such PLCs shall communicate with the DDCMIS so that complete operation & monitoring of the system can be done from the HMI of DDCMIS.

6.10.20. Compressor Control System

Each compressor and drier shall be provided with an integral PLC based control system or microprocessor-based control system as per the OEM practice for operation, control and monitoring. The skid mounted compressor/drier control panel/unit shall be complete with indicating lights, push buttons, selector switches, hooter etc. for operation and monitoring of the compressor. Each compressor/drier shall be provided with alphanumeric colour display based operator interface unit with function keys for operation, control, monitoring and configuration of the compressor.

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The Bidder shall provide facility for both LOCAL MODE and REMOTE MODE of operation. Under normal regimes of operation, compressor shall generally be operated from CPP DDCMIS. The LOCAL / REMOTE selector switch shall be provided on the compressor HMI facia. In REMOTE mode of operation, the compressor START-STOP, Emergency STOP and LOAD-UNLOAD operations are envisaged from the CPP DDCMIS. These commands along with their feedbacks shall be hardwired to CPP DDCMIS.

The CAS shall be designed and configured to operate in MANUAL and AUTO mode. The standby compressor shall automatically come into operation incase of low header pressure or tripping of working compressor in AUTO mode.

Hardwired and dual redundant bidirectional ethernet (or MODBUS) connectivity shall be provided between the integral compressor control system and CPP DDCMIS. The complete responsibility of establishing a hardwired signal transfer and ethernet (or MODBUS) connectivity with CPP DDCMIS is in the scope of Bidder. All types hardware i.e. signal cable, control cable, communication cable, OFC, media converter, LIU, signal multipliers, JBs etc. required for establishing this ethernet/hardwired signal transfer shall be in the scope of the bidder both at compressor end as well as CPP DDCMIS end. Required application software to establish this connectivity shall be in the scope of bidder.

For realizing the LOCAL-REMOTE, LOAD-UNLOAD, REMOTE START-UP, STANDBY START-UP, group control of compressors etc., the bidder shall provide all necessary logics in compressor control system and CPP DDCMIS along with the control philosophy.

Hardwired signal transfer between air drier LCP and CPP DDCMIS shall be provided for the following signals:-

a) Drier RUNNING feedback

b) REMOTE mode selection

c) START-STOP command

d) Common alarm

6.10.21. DG Set Controller

The DG Set Controller shall be interfaced to the DDCMIS on OPC/UA compliant protocol or on MODBUS protocol. Monitoring signals, fault/alarm parameters for engine, generator and generator breaker panel shall be communicated to DDCMIS.

6.11. Maintenance and Calibration Equipment for C&I Laboratory

6.11.1. Electronic Test Bench with Computer aided Calibration System

Fully functional and self-contained test bench fabricated from anodised aluminum/CRCA steel sheet for testing, repair and calibration of electronic instruments and devices shall be provided. The test bench shall be aesthetically designed and modular in construction, enabling replacement or rearrangement of the devices used for the calibration of the instruments and devices.

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The test bench shall be fabricated from atleast 2mm thick anodized aluminium or CRCA sheet. The actual sheet thickness shall be decided by the bidder considering the loading of the test bench. The test bench shall be provided with laminated top of atleast 25mm. The top of the test bench shall be provided with rubber mat, the bidder shall provide one spare mat also. The test bench shall be adequately sized to accommodate all the equipment required for the calibration, Calibration PC and the instrument to be calibrated. The test shall provide adequate storage facility for storing the connectors, cables, test jacks and other loose devices.

The test bench shall include necessary isolating switches, power supply switches, holding brackets, test leads, calibration certificates, user manuals, sensor connectors etc. The test bench shall contain the following power packs with sockets for following power supply rating:-

Power Supply Module	Technical Requirement	No. of Sockets
UPS Power Supply	UPS Power supply from redundant feeders shall be provided from UPS ACDB. Sockets shall be 3-pin type with 230V AC, 6A rating with individual switches and circuit breaker	02
Utility Power Supply	Utility Power supply from redundant feeders shall be provided. Sockets shall be 3-pin type with 230V AC, 16A rating with individual switches and circuit breaker	02
Isolated Supply Module	3-pin socket with switch, ELCB, circuit breaker,240V AC+/-0.5%,1Phase 50 Hz,	04
Isolated Supply Module	240V AC ±0.5%, 1 phase, 50 Hz, 3 kVA supply socket with switch, circuit breaker, as an Isolated supply module	01
Isolated Supply Module	Voltage stabilizer 230(+/-0.5%) VAC, 1phase, 50Hz, 3 kVA	04
Isolated Supply Module	110V AC ,2 AMPS(Step Down Transformer),50hz supply socket	02
Variable Supply Module	0-260V AC, 1ph, 50Hz (Variac), 10amps with Digital meter for current (resolution 0.01 A) and voltage (Resolution 0.1 V)	02
Variable Supply Module	0-220V DC (variable) stabilized output 2 Amp No load to full load regulation shall be +/-0.2% or better with Digital meter for current and voltage	02
Fixed supply module	+/-48V DC, 5A floating type with Digital meter for current and voltage with external adjustment and reverse polarity protection	02
Fixed supply module	+/-24V DC, 5A floating type with Digital meter for current and voltage with external adjustment and reverse polarity protection	02
Fixed supply module	+/-12V DC, 5A floating type with Digital meter for current and voltage with external adjustment and reverse polarity protection	02
Fixed supply module	+/-5V DC, 5A floating type with Digital meter for current and voltage with external adjustment and reverse polarity protection	02
NOTE:- i. The actual rating of the power supplies shall be finalised during detailed engineering		

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inline with bidder supplied equipment.

ii. Apart from the power supply modules/power packs mentioned above, following instruments shall also be provided with the test bench.
   a) Current source – Accuracy +/- 0.01 mA, range 0-60 mA, load 500 ohms with digital current indicator, one no. with RS-232 Interface
   b) mV source – Accuracy +/-0.01mV,Range 0-100mV with digital millivolt indicator, one no. with RS-232 Interface
   c) One 5 ½ (Five and half Digit) digital multimeter for display of voltage, current, resistance, with +/- 0.1% accuracy with RS-232 Connection/interface
   d) 01 set digital AC and DC ammeter and voltmeter.

The test bench shall include socket holders where the electronic gadgets under test may be plugged. The front equipment shall include multipoint connectors and test jacks for interconnection. There shall be connection between the connector and holder in which device under test shall be plugged in. All power points must be labelled. Electronic test bench should have instrument earth tapping points. 2 nos. Air guns shall be provided for cleaning the instrument in test bench tools.

The standard high accuracy resistors (06 nos. in different combinations) shall be included to load and measure the current output of devices. Necessary control devices for voltage and current adjustments/ control switches for power supplies to feeders, isolation etc., shall be included. All electric circuits shall be protected against overload by fuses, whose holders are located on front of the panel. All electrical circuits and metal structures shall be properly grounded. Anti-Static Band & other necessary accessories should be provided along with the equipment.

The bidder shall provide redundant UPS feeders to the C&I laboratory. All the cables required for the C&I laboratory shall be in the scope of bidder. 3phase, 415V AC power supply with proper distribution board for electric actuator motor testing should be available in the lab by bidder.

The bidder shall provide 01 no. calibration PC and 01 no. Calibration Laptop with Calibration Management Software for the automated calibration and record maintenance of the calibration activities carried out in the C&I Laboratory and directly in the field. One no. A3 colour laserjet printer shall be provided alongwith the calibration PC. The specifications of the Calibration PC, Calibration Laptop and Laserjet Printer shall be as per clause no. 6.10.7.10. Calibration Management Software with following facilities shall be provided:-

i. The Calibration Management Software shall have facility to for testing and calibrating all types of pressure instruments, temperature instruments, electro-pneumatic positioners, converters etc.
ii. Interfacing with instruments with or without serial interface.
iii. Simultaneous calibration of multiple instruments of same or different types
iv. Calibration due date reminders
v. Documentation and record keeping of calibration activity
vi. Calibration certificate generation as per relevant ISO standards
vii. Printing facility of reports and database
viii. Database management of instruments of the CPP
ix. Interfacing with ERP/MES of the Purchaser

The calibration of the instruments can be done in automatic, semi-automatic and manual

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mode as per the operator requirement. Calibration Management Software shall be based on open system architecture, it shall be able to interface with calibrators from different OEMs to download the calibration data from the handheld calibrators. The Calibration Management Software system shall be modular and scalable to upgrade the calibration database by upgrading or adding new calibration drivers/configurations. All the hardware or any additional software required for implementing the computer aided automatic calibration shall be provided by the bidder.

6.11.2. Pneumatic Test Bench

Type	Desktop
Instruments to be checked	Electronic and Pneumatic pressure, differential pressure and vacuum transmitters. Signal converters, including Valve positioners. Indicators, Recorders, Controllers either pneumatic or electro-pneumatic type. Pressure/ Diff. pressure switches. Pressure gauges, Diff. pressure gauges and others
Accessories	Flexible tubings, connectors, fuses, flying leads and plugs. Installation, operational and maintenance manual with reference standard certificates, Test & guarantee certificates.
Other features	Rollers below bench stands

Construction details of Test Bench:

Work & laboratory table

The basic frame shall be made of heavy grade high quality steel constructions with properly fabricated, welded & powder coated structure. High quality laminated chipboard of suitable thickness (minimum 25 mm thick) on tabletop shall be provided to ensure the aesthetic, appearance of the total system while maintaining rigidity. Colour of the test bench shall be silver grey.

Bench-top unit

Built-in modules with suitable cutout to equip / mount various instruments. The main power pre-wired to cater all the instruments mounted with frontal controls in this bench-top unit.

Under bench cabinet

Storage space with lockable drawers (3 Nos.) on one side of test bench
The test benches shall be designed & supplied as per the requirement of space to accommodate the facilities. Dimensions shall be considered by the bidder in such a way that the test bench can be easily installed in the laboratory building rooms. In case, the bidder needs any erection opening to be kept during construction of the building, the same shall be informed by the Bidder prior to the construction of the building. The construction of the building and the air conditioning systems etc. are being arranged separately by the Purchaser.

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Facility: 1

Mains power supply

Specifications:

240V± 10% AC, 50± 6% Hz single phase main power supply
For protection of built-in modules/cassettes etc.
Residual current circuit breaker & earth leakage circuit breaker with main switch
Rated fault current : 30mA
Rated current : 25A
Number of poles :2
Emergency off
Line indicating lamp
Surge protection device

Facility: 2

Fixed DC Power Supply

Specifications:

Input Voltage : 240V± 10% AC, 50± 6% Hz
Output Voltage & Current : +12VDC/ 10 A
No. of Sockets : 1 sets of O/P sockets.
MCB : 1 No. of MCB for protection against
Overload for each fixed DC power supply panel

Facility: 3

Regulated DC Power Supply (0-32VDC/0-5A)

Specifications

Range	0 to 32 VDC / 0 to 5 Amps
Metering	3 Digit DPM
Meter accuracy	± 3 counts
Regulation :	
Line	± 0.01% ± 2mv for ± 10% change in line voltage
Load	± 0.01% ± 2mv for load change from zero to full load
Ripple & noise	1 mV rms max. 20 Hz – 20 MHz.
Regulation :	
Line	± 0.1% ± 250 mA for ± 10% line change
Load	± 0.1% ± 250 mA for load change inoutput voltage from 0 volts to max. output voltage.
Ripple & noise	0.04% rms
Output polarity	floating w.r.t ground
Overload protection	Automatic overload and short circuit protection.
Operating temperature	0 – 50 °C

Facility: 4

Variable AC Power Supply – Auto Transformer (Variac)

Specifications

Input Volts : 240V± 10% AC, 50± 6% Hz, 1 Phase
Current rating : 10 A

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Power Socket : 1 No. of 230VAC /10A socket (Std. Indian Make)
MCB : 1 No. of MCB shall be provided for protection against overload

Facility: 5

Power Socket
2 Nos. of 230V AC / 5A /15A Power sockets with On-Off Lamp indication switch
2 Nos. of 110V AC / 2A Power sockets with On-Off Lamp indication switch

6.11.3. Hand-held HART configurator with lifetime license

Function	Hand-held unit designed to configure, display process variable, diagnostics and troubleshoot all HART based (press, DP, flow, level & temp.) transmitters, flow meters, etc. either remotely or at the unit. No interruption in output while comm. With transmitter.
Type	Universal Type Capable of configuration of all transmitters (from different make) with up to HART 7 Protocol.
Display	Min. 4.3" (diagonal) anti-glare, touch screen, colour VGA/ SVGA
Keyboard	Qwerty or other type keypad
Connection to Host Instrument	Using 1.5 m lead wire set with insulated mini-grabbers and alligator-clips (To be supplied with the instrument)
Hazardous area approval	ATEX certification to IEC Zone 1, Gr. IIA, IIB
Power Supply	Rechargeable Ni-Cd/ Li-ion battery/power pack
Battery Recharger	Plug Type with 240 VAC, 50 Hz input
Temp. & RH limits	0 – 50 ºC & up to 95% (non-condensing)
Storage temp. limits	- 20 to 60 °C
Memory	Min. 256 MB RAM and Min. 512 MB internal flash memory
Device description	DD shall be for all the HART based instruments used
Device update	DD and DTM files update shall be provided for lifetime.
Accessories	• 10 nos. of precision 250 ohm resistances. • Battery charger - 1 set, if rechargeable battery used • Carrying Case (incl. hand & shoulder-strap, as available)

OR

Laptop based configurator

Hardware specification:

- Intel i9 Processor/ equivalent with clock speed of 4.5 GHz or higher, Business laptop
- 13" high resolution colour LCD monitor
- Minimum 32 GB memory, 1TB SSD
- Intel Integrated Graphic Accelerator Card
- Interface modules for communication with equipment for which configuration to be done.
- Power supply, 230 VAC, 50 Hz
- Necessary serial ports, 3 nos. USB ports for interfacing with peripheral devices
- Dust & drip proof flat keyboard

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- Built-in speaker with different type sound levels
- Wireless mouse (dual mode), power adapter, communication cable for connecting with device, etc.
- Windows, Office, Anti-virus software – with perpetual license.
- DD and DTM files update shall be provided for lifetime.

The hardware & software shall be provided as per the latest proven & available models at the time of engineering. This is the minimum requirement, however specification shall be as finalised during detailed engineering.

6.11.4. Portable multi-function calibrator (HART based)

Function	Hand-held unit designed to configure, calibrate and troubleshoot the HART based (pressure, differential-pressure, level & temperature) transmitters, flow meters, etc. either remotely or at the unit.
Type	Universal Type Capable of configuration & calibrate all transmitters (from different make) with up to HART 7 Protocol.
Application requirement	• Pressure meas. & feed for the min. & max. range used. Required module & integrated electric pump or hand pump, etc. shall be considered. • Voltage measurement (±1 VDC & up to 60 VDC) & generation ((±1 VDC & up to 24 VDC). Built-in 24 VDC power supply to 2-wire transmitter. • Current meas.(0 to ±100 mA) and generation (0 to 50 mA). • Frequency meas. & generation (0 to 50 Hz) • Pulse counting & generation (0 to 10 Mpulse) • Resistance meas. & simulation (0 to 4 kΩ) • RTD (all types) meas. & simulation • T/C (all types) meas. & simulation along with connector
Performance	• Current meas.: Accuracy- 0.75 µA±0.0075% of read.; Resolution: 0.001 mA • Current generation: Accuracy- 1.5 µA±0.0075% of read.; Resolution: 0.001 mA • Voltage meas.: Accuracy- 0.13 mV±0.003% of read.; Resolution: 0.01 mV for 0 to 60 V range • Voltage generation: Accuracy- 0.05 mV±0.003% of read.; Resolution: 0.01 mV for 0 to 24 V range • mV meas. & generation: Accuracy- 3 µV±0.004% of read.; Resolution: 0.001 mV for -1 to +1 V range
Wireless connectivity	Required
Display	Min. 5.5” (diagonal), touch screen, 640x480 TFT LCD display
Keyboard	Membrane type keyboard
Hazardous area approval	ATEX certification to IEC Zone 1, Gr. IIA, IIB
Power Supply	Rechargeable Ni-Cd/ Li-ion battery/power pack
Battery Recharger	Plug Type with 240 VAC, 50 Hz input
Temp. & RH limits	0 – 45 ºC & up to 80% (non-condensing)

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Storage temp. limits	- 20 to 60 °C
Enclosure class	IP 65 or better
Accessories	• NABL/ FINAS accredited traceable calibration certificate • Software for loading in to computer • USB cable for computer interface • Test leads & test clips • Integrated electric pump or Pressure hand pump, pressure T hose, pressure modules. • 10 nos. of precision 250 ohm resistances. • Battery charger - 1 set • Carrying Case (incl. detachable shoulder-strap)

6.11.5. Portable Pressure Calibrator (-1 to 2 kg/cm^{2}g) with Pump

Type	Portable
Display	Alpha numeric
Other features	Intrinsically safe
Accuracy	± 0.05 % of full range
Accessories	Hand pump, 1 set of spare battery, probes, test kit with fitting and tubing etc.

6.11.6. Portable Pressure Calibrator (2 to 40 kg/cm^{2}g) with Pump

Type	Portable
Display	Alpha numeric
Other features	Intrinsically safe
Accuracy	± 0.05 % of full range
Accessories	Hand pump, 1 set of spare battery, probes, test kit with fitting and tubing etc.

6.11.7. Digital manometer

Type	Portable
Range	0-13000 mmWC
Display	Digital, 4 digit
Other features	Pressure measurement (absolute and gauge), differential pressure measurement
Accuracy	0.1 % of span
Accessories	Spare battery

6.11.8. Portable Ultrasonic Clamp-on Meter (DN50 to DN1000)

Type of ultrasonic	Transit time design for clean fluid.
Measuring fluids	Liquid, Air & Gas
Velocity range	0.1 to 35 m/sec.
Accuracy	<+2% of reading +0.02 ft/s
Repeatability	<+0.2% of reading +0.02 ft/s
Data logger	For physical quantities, totalized values and diagnostic values
Enclosure Class	Suitable for FM Class 1/ Div.2

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Calibration	Calibration certificate traceable to NIST
Power supply	Battery operated
Indication	Yes, Digital, flow rate & totalized flow in engg. Unit
Mounting Brackets	Required for sensor mounting on pipe size from DN 50 to DN 1000
Accessories	• Mounting kit • RS 232C bus cable for data download to PC • Software • Battery charger - 1 set • Carrying Case

6.11.9. Thermocouple test furnace

Range	140 Deg C to 1200 Deg C
Facility	Calibration of RTD and thermocouple
Accessories	Probe kit, clamp, rod

6.11.10. Handheld Pyrometer

Type	Portable
Temperature range	0-300 °C
Measuring accuracy	±0.5% of reading + 1 ºC
Repeatability	±0.3 % of reading ±1 ºC
Response time	Max. 50 msec.
Emissivity	0.10 - 1.00
Laser target sighting	Required
Accessories	• Probe adaptors, necessary cables • Battery charger - 1 set • Carrying Case

6.11.11. Handheld Thermal Imaging Camera with software

Type	Portable
Infrared resolution	640 x 480
Laser Sharp Auto Focus	Yes, for consistently in-focus images.
Laser distance meter	Yes, should calculate distance to the target for precisely focused image and display distance on screen
Advanced manual focus	Yes
Wireless connectivity	Yes
Accuracy	±2 °C or 2 %
On-screen emissivity correction	Yes
On-screen reflected background temperature compensation	Yes
On-screen transmission correction	Yes
Accessories	• Battery charger - 1 set • Carrying Case
Data storage & image captured	Min. 2 GB storage
Software	Full analysis and reporting software

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Analyze and store data on a PC	Yes

6.11.12. True RMS Multimeter

Type	Digital, Portable
Display	3 ¾ digit- LCD (Back-lit)/ LED
Measuring Range	Voltage:- AC:- 0-750 V (should be able to measure mV) DC:- 0-1000 V (Should be able to measure in mV range) Current:- AC:-0-10 A (Should be able to measure mA range) DC:-0-10 A (Should be able to measure mA range) Resistance:- 0-400 Ohm 0-400 K Ohm 0-40 MOhm Frequency:-0-90 KHz Capacitance:-0-10 µF
Features	Continuity test, diode test, data hold, auto power off, minimum 100 hours battery life
Accessories	Test leads, alligator clips, Holster, Temperature probe, loose spare battery

6.11.13. Soldering and de-soldering station

Size of SMD to be handled	Up to 30 mm square minimum
Type of ICs to be soldered and de-soldered	PGA, QFP, SOP, PLCC, BGA
Other features	Precise spot soldering and de-soldering without changing, Re-flow capacity Lead free soldering
Accessories	Soldering and de-soldering tips-1 kg

6.11.14. Industrial grade vacuum cleaner and blower

Vacuum capacity	2000 mmwc minimum
Dust capacity	1.5 litre minimum
Feature	Auto coil facility of power cord
Accessories	All purpose nozzle Floor brush Dust collection bag

6.11.15. Portable Digital Multimeter

Portable digital multimeters, with high voltage grade leads/probes and suitable casing including carrying strap are shall be provided. Digital multimeter shall have 4 1/2 digits read out indicator with automatic decimal point and polarity indicator. Indication shall be in seven segment LCD display. Meters shall be complete with accessories for high voltage, DC current, temperature, capacitance and frequency measurements.

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Instruments offered, shall have built in overload protection feature. These shall have high resolution and low response time. For AC signals (True RMS) digital multimeter shall have good fidelity over a large range of frequencies.

The digital multimeter shall be provided with the following features:-

i.	Display	:	Backlit LCD
ii.	Continuity buzzer	:	Yes
iii.	Diode/transistor test	:	Yes
iv.	Temperature probe	:	Yes
v.	Overload alarm	:	Yes
vi.	Shock test	:	1 mtr. drop test as per IEC 61010-1:2001
vii.	Accessories	:	test leads, battery charger, rechargeable batteries, magnetic strap/hanger, temperature probe
viii.	Carry case	:	to be provided

The range of the signals to be measured by the multimeter shall be as indicated in the table:-

Parameter	Range	Accuracy
DC voltage	0 to 100mV 0 to 1V 0 to 10V 0 to 100V 0 to 1000V	+/- 0.05% + 2 digits or better
AC voltage	0 to 100mV 0 to 1V 0 to 10V 0 to 100V 0 to 1000V	+/- 0.7% + 2 digits or better
Current DC	0 to 20mA 0 to 1mA 0 to 10mA 0 to 100mA 0 to 1A 0 to 10A	+/- 0.2% + 2 digits or better
Current AC	0 to 20mA 0 to 1mA 0 to 10mA 0 to 100mA 0 to 1A 0 to 10A	+/- 1.0% + 2 digits or better
Resistance	0 to 100 ohm 0 to 1 kohm 0 to 100 kohm 0 to 1 Mohm 0 to 10 Mohm 0 to 50 Mohm	+/- 0.3% + 2 digits or better

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6.11.16. Dead Weight Tester

Applicable Standard	:	ASME PTC 19. 2-1964 except as modified in this specification.
Type	:	Dual range (High Range & Low Range) allowing an automatic change of scale of 10:1 ratio. Dual piston type
Piston Material	:	Tungsten carbide with nickel binder
Cylinder Material	:	Tungsten carbide
Weight Material	:	Non magnetic stainless steel
Ranges	:	0-60 & 0-600 Kg/cm2
Accuracy	:	+/- 0.02 percent of actual reading
Calibration	:	+/- 0.01% traceable to NBS
Connection	:	Suitablefor1/8,1/4,3/8 and 1/2 inch NPT
Accessories	:	i. Following weights of each type shall be provided: a. 10 & 100Kg/sq.cm 5nos. b. 9 & 90kg/sq.cm 1no. c. 5 & 50kg/sq.cm 1no. d. 2 & 20 kg/sq.cm 2nos. e. 1 &r 10kg/sq.cm 1no. f. 0.5 & 5 kg/sq.cm 1no. g. 0.2 & 2 kg/sq.cm 2nos. h. 0.1 & 1 kg/sq.cm 1no. i. 0.05 & 0.5 kg/sq.cm 1no. j. 0.02 & 0.2 kg/sq.cm 2nos. k. 0.01 & 0.1 kg/sq.cm 1no. ii. Tools like wrenches, spanners etc. iii. Hard storage Carrying case iv. Oil filters to prevent contamination and wear v. Spirit level, spare seals, keys, spare oil vi. Instruction manual vii. Software shall be provided to correct for effect of environment factors such as gravity & temp. to determine the pressure generated by dead weight tester. Software & hardware for interfacing. viii. Master pressure gauge required with digital indicator and with range to match above. ix. Instrument shall be fitted with priming lever pump, hand wheel pressure adjustment, levelling screw and built-in spirit indicator. x. Adaptors for gauges of 1/8, 1/4, 1/2"NPT and BSP type, 8 bonded seals, bottle of technical grade oil and dust cover.

6.11.17. Standard Pressure Gauges

Applicable standard	:	ASME PTC 19.2-1964 in general
Type	:	Bourdon tube
Accuracy	:	+/-0.1% of span
Bourdon material	:	SS 316
Movement material	:	SS 316
Case material	:	SS or die cast aluminium
Dial size	:	300mm

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Scale	:	Aluminium, black letters on white dial
Connection	:	½" NPT or ¼" NPT, to be decided during detailed engineering
Range	:	(-)1 to 0 Kg/cm^2 (-)1 to 1 Kg/cm^2 0 to 1.6 Kg/cm^2 0 to 4 Kg/cm^2 0 to 6 Kg/cm^2 0 to 10 Kg/cm^2 0 to 25 Kg/cm^2 0 to 60 Kg/cm^2 0 to 100 Kg/cm^2 0 to 250 Kg/cm^2

6.11.18. Aneroid Barometer

Range	:	660 to 800mmHg
Accuracy	:	+/- 0.5mmHg
Sensitivity	:	+/- 0.2% of full scale
Temperature compensation	:	Required
Dial diameter	:	4" to 7"
Dial calibration	:	Calibration in mmHg or inHg
Min. graduation	:	0.5mm or 0.02"
Case for barometer	:	Wooden box

6.11.19. Proximity Probe testing kit (Wobulator)

Purpose	:	Testing the transducer and monitors of CBMS system
Probe mount	:	Universal type
Wobulator range	:	2 to 10 mils
Spindle micrometer range	:	0 to 25mm
Probe diameter	:	5mm to 19mm
Power supply	:	230V AC

6.11.20. Mercury Thermometer

Type	:	Mercury in glass
Bulb material	:	SS 316
Scale material	:	Hardened borosilicate glass
Graduation	:	Black
Range	:	(-)30 to 20 ºC 0 to 50 ºC 50 to 100 ºC 100 to 150 ºC 150 to 200 ºC 200 to 250 ºC 250 to 300 ºC 300 to 350 ºC 350 to 400 ºC

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400 to 600 ºC

6.11.21. Fluidized Temperature Bath

Type	:	Microprocessor based
Control	:	Automatic PID
Fluidizing medium	:	Aluminium oxide
Reference thermocouple	:	To be provided
Equalizing block	:	Required
Tank and lid material	:	SS 316
Display	:	Digital LCD
Range	:	50 to 600 ºC
Accuracy	:	+/- 0.1ºC
Stability	:	+/- 2 ºC
Communication	:	RS 232 or RS 485
Software	:	Yes
Power supply	:	230V AC
Accessories	:	Insertion cables, insertion tubes, all required cables, metallic probe holders, multi probe holders, alumina powder (10 kg), instruction manual

6.11.22. Portable Dry Block Temperature Calibrator (Low, Medium and High temperature)

Portable Dry Block type temperature calibrator with microprocessor based controller heater shall be supplied for field calibration of temperature instruments i.e. T/C, RTD, switches, gauges, indicator, recorder, surface sensors, IR thermometers etc. Calibrator shall be supplied in three ranges as follows (One no. for each range):-

i. Low temperature portable dry block calibrator

Type	:	Removable insert type
Range	:	(-)55 to 140 ºC
Stability	:	+/- 0.03ºC
Uniformity	:	+/- 0.02ºC
Measuring holes	:	Bore size ranging from 5mm to 30mm
Measuring volume	:	Suitable for elements with TW to avoid stem conduction error
Serial Interface	:	RS 232 or RS 485 with software and cable
RTD	:	Standard RTD traceable to national or international standards

ii. Medium temperature portable dry block calibrator

Type	:	Removable insert type
Range	:	35 to 650 ºC
Stability	:	+/- 0.03ºC
Uniformity	:	+/- 0.081ºC
Measuring holes	:	Bore size ranging from 5mm to 30mm
Measuring volume	:	Suitable for elements with TW to avoid stem conduction error
Serial Interface	:	RS 232 or RS 485 with software and cable
Thermocouple	:	Standard T/C traceable to national or international standards

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iii. High temperature portable dry block calibrator

Type	:	Removable insert type
Range	:	150 to 1200 ^{o}C
Stability	:	+/- 0.2^{o}C
Uniformity	:	+/- 0.2^{o}C
Measuring holes	:	Bore size ranging from 5mm to 30mm
Measuring volume	:	Suitable for elements with TW to avoid stem conduction error
Serial Interface	:	RS 232 or RS 485 with software and cable
Thermocouple	:	Standard T/C traceable to national or international standards

6.11.23. Digital Thermograph/Hygrometer

A microprocessor based thermograph/hygrometer with inbuilt sensor for temperature and humidity measurement shall be provided. The Digital Thermograph/hygrometer shall meet as a minimum the following requirements:

Display	:	Digital LCD
Range	:	Temperature –0 to 50 ^{o}C Humidity – 10 to 90% RH
Sensor	:	Temperature – Thermistor Humidity – Resistive or capacitive
Accuracy	:	Temperature –1 ^{o}C Humidity – 5%
Resolution	:	Temperature – 0.1^{o}C Humidity – 1%
External temperature	:	Required, probe to be provided
Calibration	:	Traceable to NIST
Accessories	:	Rechargeable batteries, battery charger

6.11.24. Function Generator

Channels	:	Dual channels
Display	:	3.5” colour LCD
Frequency range	:	upto 80 MHz
Sampling rate	:	1.2 GSa/s
Mode	:	Burst, sweep, continuous
Waveforms	:	Sine, square, pulse, triangle, ramp, DC
Frequency counter	:	Yes
USB interface	:	Yes, cable with software required
Power supply	:	230V ac
Accessories	:	Power cord, USB cable

6.11.25. Digital Oscilloscope

Type	:	Dual beam storage
Display	:	Colour LCD
Frequency range	:	Upto 200 MHz
Resolution	:	12 bit
Sampling rate	:	1.2 GSa/s

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Channels	:	4 analog channels and 16 digital channels
USB interface	:	Yes, cable with software required
Power supply	:	230V AC
Accessories	:	Probes, power supply cord, USB cable

6.11.26. Digital Tachometer

Modes	:	Contact & non-contact
Range	:	Contact – 0 to 19999 rpm Non contact – 0 to 99999 rpm
Accuracy	:	Non contact – +/- 0.2% of reading + 1 digit
Display	:	Backlit LCD
Accessories	:	Extension rod, conical tips (2 nos.), Wheels (2 nos.), batteries, reflective tapes, carry case

6.11.27. QR code reader

Communication	Wireless
Camera quantity	2 nos.
Sensor	CMOS
Light Source	White LED
Aimer light source	Laser/ LED
Supported symbols	2D codes:- QR, Micro QR, Data Matrix, PDF, Dot Code, etc. Barcodes
Minimum resolution	2D codes:- 0.127 mm minimum Bar codes:- 0.070 mm minimum
Reading distance	10 to 600 mm
Communication	Bluetooth 5.0 and wireless LAN
Enclosure rating	IP 65
Continuous usage duration	Minimum 15 hours
Charging	Wireless and USB

6.12. INSTALLATION, CALIBRATION, TESTING AND COMMISSIONING

6.12.1. Installation Guidelines

i. Equipment manufacturer's recommendation, where available, shall prevail over the guidelines furnished in this section and incase, of any contradiction between the stipulations.
ii. All thermowells shall be thoroughly cleaned with air jet and wire brush before insertion of temperature gauges / element.
iii. Welded thermowells shall be welded on pipes / vessels / equipment by certified welders only and all post-weld tests shall be performed as per main pipeline specification.
iv. Both the elements of duplex type temperature elements shall be terminated at the junction box.
v. The place where the instrument is to be installed must be easily accessible from nearest floor / platform level and there must have enough clear space to allow maintenance work and lay-down.

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vi. The installed position must be such as not to cause any inconvenience to repair, removal, observation, inspection and maintenance of the installed equipment and other items nearby.

vii. In general, no instrument shall be erected in areas prone to vibration.

viii. The nearby high temperature equipment or process piping shall not give rise to any injurious effect to instruments.

ix. All clamps, supports, stands etc. required for installation and erection of instruments and their accessories, shall be painted.

x. Bidder's scope of work shall include fabrication and installation of mounting frames, pedestals, canopies, protective enclosures and local gauge boards for mounting local instruments, analyzer and junction boxes. Bidder's scope shall also include mounting of the instruments in these local stanchions / pedestals / gauge / boards with all necessary mounting fixtures, piping, painting cabling up to local junction box and any other associated civil work like chipping, grouting etc.

xi. All steel items shall be de-scaled and degreased by suitable solvent cleaning. All structures shall be welded throughout. All welds should be grounded to smoothness, corners should be rounded and weld splatters should be cleaned.

xii. All floor / platform mounted structures shall be self-supporting and free standing type. These should not depend on supports derived from nearby columns / structures / pipelines etc. for their rigidity and mounting.

xiii. After welding, the structure surfaces shall be smoothed with emery paper and painted with two coats of red oxide primer. After erection, all site fabricated structures shall be painted with two coats of finishing paints of 2.0 mil/coat DFT.

xiv. Necessary grouting pockets are to be chipped and anchor bolts / studs shall be fixed on floor, column or wall. All structures, mounting frame on cement / concrete floor shall be formed with a raised cement platform / base.

xv. No field mounted instruments shall be installed without simultaneously taking up impulse line work connected with the instrument.

xvi. Wherever practicable the height of the instrument from its working floor / platform shall be between 1000-1400 mm.

xvii. The illumination at the locations where instruments are located shall be adequate so that the scales can be read unassisted.

xviii. Cabling work shall normally imply pulling, laying, marking, splicing, glanding, dressing, ferruling, crimping and termination of cables at both ends with associated conduit and sub-tray work, followed by testing of cables. Instrumentation cable shall be laid on trays or in conduits. Sub-trays, where required, shall be erected for proper routing of the cables and tubes and no cable shall be laid unsupported.

xix. Cabling and interconnection activity shall include cabling work between local switches, resistance temperature detectors, transmitters, converters, limit switches, position transmitters, torque switches, solenoid valves etc. up to local junction boxes, thermocouples up to local thermostatic junction boxes, temperature transmitters or Control Room panels from local junction boxes / local panels / transmitter racks / instruments to termination cabinets / panels / electronic cabinets in Control Room / control equipment room, command and feedback signals from MCC / Switch Gear room to termination cabinets / panels / electronic cabinets in Control Room / control equipment room, inter-cabling between various cabinets in Control Room / control equipment room, earthing of all panels / racks / cabinets / junction boxes etc. up to ground lug / riser with appropriate cable, special cabling between sensing devices to converter cabinets and cabling work of prefabricated and highway cables.

xx. Cable shall enter in the enclosures through double compression cable glands.

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xxi. All the cable runs shall be properly identified by easily readable printed permanent tag plate fastened to the cable with steel wires, provided at both field ends and panel ends and at a maximum of 20 meter intervals in straight length. Tags shall be provided in all bends and both sides of the barrier walls as well as at both terminal ends.

xxii. Cable glands and other openings in the junction boxes shall be properly sealed by means of sealing compound to make them thoroughly dust and moisture proof. Unused opening shall be plugged with dummies.

xxiii. All cable shields shall be individually terminated and jumpered together at the terminal blocks. Earthing of the shields shall, however, be performed at the control panel end.

xxiv. Cable conducting AC and DC signals shall be segregated. Compensating cables shall not be mixed with cables carrying milli ampere signals. The signal cables and power cables shall not be in the same conduit, tray or junction box.

xxv. All spare conductors of a multicore cable shall be left at their maximum lengths for possible future replacements of any other conductors in the cable. Each spare conductor shall be identified and neatly coiled separately and then taped to the conductors being used.

6.12.2. Calibration Guidelines

i. All instruments, jigs, tools and tackle for the purpose of performing the tests shall be provided by Bidder. All the instruments or devices used for the site calibration of the instruments shall have valid calibration certificate from an NABL certified laboratory.

ii. Before erection, all instruments shall be subjected to calibration and other functional checks at Bidder's site laboratory. Instruments shall be calibrated throughout the instrument range at five check points viz. 0%, 25%, 50%, 75% & 100% of span, both upscale run and downscale run. The error between theoretical and calibration figures thus obtained at each check point shall not exceed the instrument manufacturer's stated figures. If the error exceeds the limits specified by the manufacturer, the instruments shall be adjusted to achieve calibration accuracy within the specified limits. Minor repairs and adjustments of the instruments shall be performed by Bidder. Once the defective instrument has been successfully repaired, it shall again be subjected to calibration and functional checks, as indicated above. A record of such repairs and adjustments shall be systematically maintained by Bidder. For instruments found acceptable and conforming to the declared performance parameters of the manufacturer, the test report shall be prepared.

iii. Process actuated switches shall be tested for adjustability and repeatability of set point by means of suitable testing instruments of certified accuracy. Test results shall be presented to indicate linearity and differential.

iv. Temperature gauges shall be calibrated in controlled temperature oven with the help of standard laboratory thermometer of certified accuracy in addition to check ambient temperature reading. Zeroing of the gauges shall be done separately by means of ice bath. Test results shall be presented to indicate accuracy, hysteresis and linearity.

v. Temperature elements shall be tested for continuity from their terminals at element head. Thermocouple and RTD shall be tested in temperature controlled bath at several temperature (depending on the type of T/C or RTD) points with digital milli-voltmeter / Thermocouple or RTD calibrator. The results thus obtained must be compared with standard table as per ASME / DIN.

vi. Valves shall be lubricated (if required), stroked and checked for hysteresis. Alignment of valve positioners shall be checked. Connection and operation of

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solenoid valves and air lock relays (if provided) shall also be checked. Action of actuator shall be checked by applying spring range pressure through air filter regulator / multifunction calibrator and observing the stem travel against a scale. The position transmitter output scale shall be read with a 4-20 mA calibrator capable of powering the transmitter with 24 V DC supply. Necessary adjustment of zero and span shall be Bidder 's responsibility. Bidder shall also check the function and adjustability of limit switches.

6.12.3. Testing Guidelines

i. Hydrostatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1. All instrument piping/tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum operating pressure.
ii. All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 Kg/sq.cm through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.
iii. Hydrotest and leak test on the instruments shall be performed along with the manifold /valve assembly.
iv. All insulated conductors shall be tested for continuity and conductor identification.
v. All insulated conductors of multi-conductor cable shall be tested for short circuit. Short circuit tests shall include all tests necessary to confirm that no conductor of a multi-conductor cable is short circuited to another conductor in that cable.
vi. All cables shall be tested for continuity and insulation before and after installation. All insulated conductors shall be tested with a 500 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptance resistance values shall be 50,000,000 ohms.
vii. Loop test shall be carried out for all the instruments with the DDCMIS online.

6.13. QUESTIONNAIRE

The following questionnaire for Instrumentation & control, duly filled-in by the bidder shall be submitted along with the offer.

Sl. No.	Description	Bidder's reply
I.	Bidder shall confirm compliance to the following sub-clauses included under Instrumentation, Control& Automation	
1.	'General' clause	
2.	'Scope of supply & work' clause	
3.	'List of measurement & controls' clause	
4.	'Spares' clause	
5.	'Training' clause	
6.	'Digitalization and Industry 4.0' clause	
7.	'List of drawings & documents' clause	
8.	'List of testing equipment and tools & tackles to be supplied' clause	
9.	'Installation, Calibration, Testing & Commissioning' clause	
II.	Bidder shall confirm compliance to the Automation system	

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	configuration diagram attached	
III.	Bidder shall confirm compliance to the 'Technical Specification for Instrumentation Equipment' clauses. Bidder shall also confirm that the instrumentation, control system equipment shall be selected in compliance to the specification included in above clause.	
IV.	Bidder shall confirm compliance to the 'Technical Specification for Digital Distributed Control, Monitoring And Information System' clauses. Bidder shall also confirm that the automation system equipment shall be selected in compliance to the specification included in above clause.	
V.	Bidder shall confirm that the makes of instrumentation, control equipment & accessories shall be selected from the list of acceptable makes included in bid document.	
VI.	Bidder shall confirm that the drawings & documents as indicated under clause no. 6.7 have been submitted along with their offer w.r.t instrumentation & control.	

**** End of Clauses ****

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7. INSPECTION AND QUALITY ASSURANCE

7.1. General

Inspection & testing of plant & equipment under witness category as per approved QAP shall be witnessed by CLIENT/ CONSULTANT at the works of successful Tenderer during manufacturing and/or on final product to ensure conformity of the same with the acceptance criteria of technical specifications, approved drawings, stamped manufacturing drawings and applicable national / international standards.

Items which are under review category as per approved QAP, test reports submitted by the successful Tenderer shall be scrutinized to ensure conformity of the same with the acceptance criteria of technical specifications, approved drawings, stamped manufacturing drawings and applicable national / international standards.

7.2. Quality System Requirements

The successful Tenderer must recognize the importance of quality and follow defined quality control program in all stages of manufacturing and ensure the product achieves its intended quality. The same needs to be ensured by the Tenderer in case the product is sub-contracted either partly or fully and/or the product is assembled from the procured components. All bought-out equipment or component shall be procured from preferred vendor list of concerned project.

CLIENT/CONSULTANT reserves the right to verify the quality program of Tenderer & its vendors/sub- vendors to assure the effectiveness of the program to meet the intended and specified quality of the product.

7.3. Quality Assurance Plan (QAP)

7.3.1. The successful Tenderer shall furnish QAP for all equipments in respective packages after finalization of billing schedule/ equipment identification number for CLIENT/CONSULTANT's approval at least one month prior to start of manufacturing in accordance with the following clauses 3.2 and 3.3.

7.3.2. QAP shall be prepared & furnished separately by Successful Tenderer in Form Nos. 11.20(DQM)F-09,10,11 Ed.3 Rev 1 (specimen blank enclosed) for structural & mechanical, electrical & instrumentation, and refractory items respectively, including major bought-out items. QAPs must be submitted in as defined in contract, for approval and shall be duly stamped and signed by the successful Tenderer. Also, column no. 4, 5 & 7 of QAP formats are tentative and for reference purpose only.

7.3.3. The successful Tenderer shall submit copies of P.O., Sub-P.O., T.S., approved GA drawings/ data sheets & detailed manufacturing drawings(if asked for) as backup reference materials for scrutiny & final approval of QAP by CLIENT/CONSULTANT.

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7.3.4. Inspection and test requirements shall be decided with due consideration of factors like safety, duty cycle, operating conditions, equipment life, environmental conditions, place of installation and statutory regulations, as applicable, for a particular equipment. Any, additional type or special tests or routine tests if found necessary to establish the intended quality after detailed engineering, then same have to be incorporated in the QAP without any commercial implication.

7.3.5. Detailed QAP shall be prepared by the successful Tenderer in consultation with their Manufacturers to avoid any complicacy later.

7. 3.6. Successful Tenderer shall follow respective original QAP for commissioning spares which are complete equipment such as valves, pumps etc.

7.3.7. Approval of QAP indicating the name of manufacturer does not give *approval of make*. List of approved makes along with detail address/location shall be as per List of Preferred make (Chapter 14.00).

7.3.8. QAP shall be valid for three years from the date of issue.

7.4. Calibration of Measuring Instruments

7.4.1. All the measuring equipment used for inspection & testing shall be of appropriate accuracy class and shall have valid calibration certificate with traceability to national standards of NPL / NABL accredited laboratories with unbroken chain of comparison. These valid calibration certificates shall be submitted to CLIENT/CONSULTANT for review prior to inspection.

Calibration certificate shall also indicate reference no. of calibration standards calibrated by NPL/NABL accredited laboratories and copies of such calibration certificates of calibration standards shall be furnished in the compiled dossiers of inspection/test results if asked for.

7.4.2. In case, valid calibration certificates are not available, inspection shall not be carried out using uncalibrated instruments. Successful tenderer/successful Tenderer shall be responsible for any delay due to re-inspection / re-visit.

7.5. Test Certificates and Documents

7.5.1. For each of the item/equipment offered for inspection, following test certificates and documents in 2 sets or as defined in contract, as per approved QAP, duly endorsed by the Manufacturer and successful Tenderer with appropriate linkage to project, purchase order and acceptance criteria etc. shall be submitted to CLIENT/CONSULTANT, as applicable.

i) Raw materials identification & physical and chemical test certificates for all materials used in manufacture of the plant and equipment.

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ii) WPS, PQR & WPQ documents as per applicable code.

iii) Details of stage-wise inspection & rectification records for fabricated items, castings, forgings and machined articles if asked for by CLIENT/CONSULTANT.

iv) Control dimension chart with records of alignment, squareness etc.

v) Manufacturer's material and performance/relevant test certificates for all bought out items.

vi) Details of heat treatment and stress relieving charts as per specification.

vii) Non Destructive Test reports as per respective code carried out by competent person.

viii) Static/dynamic balancing certificate for rotating components/machines.

ix) Hardness test certificate.

x) Pressure/Leakage Test Certificates.

xi) Performance Test Certificates with characteristics graph.

xii) Routine / Type / Calibration /Acceptance / Special tests certificates for electrical/ power electronics/ automation/ instrumentation items as identified in QAP. Furnishing valid type test certificate for similar design of above items is mandatory until unless exemption is granted specifically in technical specification for any item. In case, type test certificate of similar design is not available, successful Tenderer shall organize to carry out such tests at his own cost without affecting the project schedule.

xiii) Surface preparation and painting certificates.

xiv) Certificates from competent authority for the items coming under statutory regulations (PESO, IBR, FM, UL, CMRI, LPCB, NFPA, TAC, Weights & Measures etc.)

xv) Environmental test reports for electronics/ automation items.

7.5.2. Manufacturer/successful Tenderer shall provide mill test certificates for raw material of steel structures as per make specified in GTS/CTS.

7.5.3. Where mill test certificates for equipments or its components are not available or where additional tests are required, the successful Tenderer shall arrange to get the samples tested in an NABL accredited laboratory/govt. laboratory at his cost and submit the copies of test results in requisite numbers to CLIENT/CONSULTANT for review. Number of test samples against each heat/cast/lot or batch of materials, as applicable shall be as per relevant Indian or International Standards.

7.5.4. Where test facility of finished product is not available, the manufacturer/ successful

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Tenderer shall arrange to get test samples of the offered material tested in an NABL accredited laboratory/govt. laboratories (eg. CSIR labs-NML, CGCRI etc./labs or institutes recognized by govt. of India eg. IIT, NIT, DISIR) at his own cost and submit the copies of test results in requisite numbers to CLIENT/CONSULTANT for review. Number of test samples shall be as per relevant Indian or International Standards.

7.5.5. CLIENT/CONSULTANT shall have the right to be present and witness all tests being carried out by the successful Tenderer at the accredited laboratory. Also, CLIENT/CONSULTANT reserves the right to call for confirmatory test on samples, at his discretion at the cost of the manufacturer/successful Tenderer.

7.6. Internal Inspection by Successful Tenderer

7.6.1. Inspection and tests shall be carried out by successful Tenderer and Manufacturer in accordance with approved drawings/datasheet/material specification/Package T.S/P.O., relevant standards (BIS/ASME/IEC/DIN/API etc.) and approved QAP. Records shall be maintained for each inspection and test carried out and signed documents shall be submitted to CLIENT/CONSULTANT for verification.

7.6.2. The successful Tenderer/manufacturer shall carry out their internal inspection and obtain clearance from statutory bodies e.g. IBR, PESO, UL, FM, LPCB, NFPA, TAC, Weights & Measures, IE rules, CMRI etc. prior to offering any equipment for CLIENT/CONSULTANT's inspection in accordance with approved QAP.

7.6.3. The successful Tenderer/ manufacturer shall identify all the inspected equipment/component/raw materials & shall maintain the record of status of inspection viz. inspected & found acceptable, require rectification/rework, rejected etc.

7.6.4. The successful Tenderer shall establish and maintain procedures to ensure that the product that does not conform to specified requirements, is prevented from inadvertent use or supply/ installation. The description of non-conformity that has been accepted subsequently by CLIENT/CONSULTANT by concession and/or of repairs, shall be recorded.

7.6.5. Repaired and reworked product shall be offered for re-inspection to CLIENT/CONSULTANT along-with records of corrective action taken. Clause 9.1 shall also be referred in this regard.

7.7. Manufacturing and Inspection Schedule

Successful Tenderer shall submit the schedule for manufacturing and inspection indicating equipment / components, sub- assembly/ assembly, date of approval of drawings / data sheets, address of manufacturer with contact person and scheduled date of inspection. Such reports shall be submitted to respective CLIENT/CONSULTANT's inspecting offices. These monthly reports shall state the planning for next three months. Submission of first reports must commence one month prior to commencement of manufacturing activities of

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the product.

7.8. Method of Undertaking Inspection & Testing by Client/Consultant

7.8.1. Inspection call shall be given only on readiness of the equipment/ assembly/ sub-assembly and after approval of all relevant drawings and QAP. CLIENT/CONSULTANT shall be given 14 working days notice period to organize inspection for indigenous items and 30 working days notice period for imported items after submission of inspection call to CLIENT/CONSULTANT)by the successful tenderer. In case, equipment/ assembly/ sub-assembly offered for inspection *are found not ready* on or after proposed date, Inspection Memo shall be issued then and there and the call shall be cancelled. In the case of re-inspection, all the cost of visit of CLIENT/CONSULTANT's engineer have to be borne by the successful tenderer. Photographic evidence and internal test report to support readiness of material shall be furnished along with fresh inspection call.

If the equipment/assembly/sub-assembly after inspection is found not acceptable, or requires rework or involve CLIENT/CONSULTANT's re- inspection, then the successful tenderer/successful Tenderer shall be responsible for any delay due to re-inspection / revisit.

7.8.2. Inspection call shall be raised to CLIENT/CONSULTANT through their prescribed Inspection Management System. Soft copy of all documents like test Certificates, Internal Inspection Reports, P.O., Sub-P.O., T.S., Approved QAP, approved GA drawings/ data sheets/manufacturing drawings and all other relevant certificates as per approved QAP shall be attached with inspection call in IMS. Before raising of inspection call, the successful Tenderer shall ensure stamping & signature from approval authority in every page of approved drawing/datasheet/QAP. All TC's shall be signed and endorsed by successful tenderer. Also, the hard copy comprising of all documents along with signed and stamped inspection call shall be submitted to CLIENT/CONSULTANT for further processing. Scrutinizing of call documents shall start after receipt of hard copies of inspection call and shall be processed within 14 working days.

7.8.3. Inspection calls raised without the documents specified in clause 9.3 shall be treated as invalid and subject to rejection.

7.8.4. The successful Tenderer shall offer substantial quantity of items for inspection considering economical aspect of inspection with respect to size of order. In case, quantity is defined in lot or set, then approved lot or set clarification is to be submitted along with inspection call.

7.8.5. For items where inspection has been kept under review category as per approved QAP, calls shall be processed on the basis of document review within 14 working days from the date of submission of complete documents by the successful Tenderer.

7.8.6. In case of any discrepancy or shortfall in the submitted documents, same shall be commented / sent for clarification through Inspection Management System. Compliance

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submitted shall be reviewed within 14 working days by CLIENT/ CONSULTANT.

7.8.7. Observation/ Comments if any, forwarded by CLIENT/ CONSULTANT to successful Tenderer to be complied within 14 days from the date of such comments. In case the compliance is not submitted within 14 days by successful tenderer, inspection call shall be liable to be cancelled. New inspection call for those items shall be raised as per regular inspection calls in accordance with approved QAP.

7.9. Obligations of Successful Tenderer

7.9.1. The successful Tenderer shall provide all facilities and ensure full & free access of the manufacturer's premises at any time to Inspecting Engineer of CLIENT/ CONSULTANT to facilitate the inspector to carry out inspection & testing of the product during and/or after manufacturing of the same.

7.9.2. The successful Tenderer shall nominate a Coordinator to liaison with CLIENT/ CONSULTANT on all inspection matters. Representative of successful Tenderer shall be present during all inspection at manufacturer's works.

7.9.3. The successful Tenderer shall comply with instructions of CLIENT/ CONSULTANT fully with promptitude.

7.9.4. The successful Tenderer shall provide all calibrated instruments, tools, necessary testing and other inspection facilities to CLIENT/CONSULTANT at free of cost for carrying out inspection.

7.9.5. The cost of testing welds by method of ultrasonic, radiographic and dye penetration tests etc. in the fabrication workshop shall be borne by the successful tenderer. These tests shall be witnessed and approved by ASNT/ISNT Level-II qualified NDT personal.

7.9.6. The successful Tenderer shall ensure that the equipment/assembly/ component of the plant and equipment required to be inspected, are not dismantled or dispatched before inspection.

7.9.7. The successful Tenderer shall not offer plant and equipment for inspection in painted condition unless otherwise agreed in writing by CLIENT/ CONSULTANT.

7.9.8. For billable items which are approved in set or lot, successful Tenderer shall submit ordered lot/set details and obtain certification from CLIENT/ CONSULTANT's concerned design department. In case lot/set details are not submitted by the successful Tenderer, Inspection Certificate shall be issued as part lot.

7.9.9. The successful Tenderer shall submit test certificates from OEM for workshop equipments even if they are procured through dealer/sub-contractor.

7.9.10. The successful Tenderer shall ensure that equipment and materials once rejected by the CLIENT/ CONSULTANT, are not re-used in the manufacture of the plant and equipment.

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Where parts rejected during inspection have been rectified as per agreed procedures laid down in advance, such parts shall be segregated for separate inspection and approval, before being used in the work.

7.10. Stamping and Issue of Inspection Documents

7.10.1. Inspection Memo (IM)

For items, which do not conform to Technical Specification in one or more quality characteristics requiring rectification / rework, Inspection Memo shall be issued indicating there in the details of observation & remarks. All the non-conformities with respect to specification of the product shall be indicated in the Inspection Memo for further quality control by successful Tenderer.

7.10.2. Inspection Certificate (IC)

On satisfactory completion of final inspection and testing or verification of documents(for review category items), all accepted plant & equipment shall be stamped as applicable and Inspection Certificate shall be issued by CLIENT/CONSULTANT for the accepted items. Inspection Certificate shall be valid for one year from the date of certificate.

7.11. Amendment

Amendment in IC may be issued only for the following purposes provided there is no change in the accepted item/equipment and quantity:

i) Wrong entry in billing schedule number.
ii) Wrong entry in description of billing schedule.
iii) Other typo error.

However, amendment shall not be issued in case billing schedule is revised after issue of Inspection Certificate.

7.12. General Clauses

7.12.1. Inspection & tests carried out by CLIENT/ CONSULTANT shall not absolve the responsibility of the successful Tenderer/ Manufacturer to provide acceptable product as per the terms of contract nor shall it preclude subsequent rejection.

7.12.2. CLIENT/CONSULTANT reserves the right to inspect any product at any stage of manufacturing beyond pre-identified stages and hold points of approved QAP.

7.13. Abbreviations

IBR	:	Indian Boiler Regulations
ASNT	:	American Society of Non Destructive Testing

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CMRI	:	Construction Methods and Materials Research Institute
FM	:	Factory Mutual
ISNT	:	Indian Society of Non Destructive Testing
LPCB	:	Loss Prevention Certification Board
NABL	:	National Accreditation Board of Laboratories
NDT	:	Non Destructive Testing
NFPA	:	National Fire Protection Association
NPL	:	National Physical Laboratory
PESO	:	Petroleum & Explosives Safety Organization
PQR	:	Procedure Qualification Record
QAP	:	Quality Assurance Plan
TAC	:	Type Approval Certificate
UL	:	Underwriter Laboratories
WPS	:	Welding Procedure Specification
WQT	:	Welder's Qualification Test

**** End of Clauses ****

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	CONTRACTOR	*	QUALITY ASSURANCE PLAN	WORK ITEM NO.	*
	ORDER NO. & DATE	*	FOR	PROJECT	*
	SUB - CONTRACTOR		STRUCTURAL & MECHANICAL EQUIPMENTS	PACKAGE NO.	*
	ORDER NO. & DATE			PACKAGE NAME	*

INSTRUCTIONS FOR FILLING UP :

1 QAP shall be submitted for each of the equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.

2 Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

3 Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4 Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

RS: RANDOM SAMPLING
CONTR : CONTRACTOR
MFG : MANUFACTURER
P : PERFORM
W : WITNESS
R: REVIEW
RS1: One/type/Size/Lot
RS2: 10%/type/Size/Lot

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	Description	Code	Description	Code	Description	Code	Description
1.	Visual(Welding etc.)	19.	Sponge test	34.	Internal Inspection report by Contractor	D1.	Approved GA drawings
2.	Dimensional	20.	Dust/Water Ingress test	35.	Hardness test	D2.	Information and other reference drg / stamped drgs released for mfg.
3.	Fitment & Alignment	21.	Friction Factor Test	36.	Spark test for Lining	D3.	Relevant catalogues
4.	Physical Test(Sample)	22.	Adhesion Test	37.	Calibration	D4.	Bill of Matl./ item no./ identification.
5.	Chemical Test (Sample)	23.	Performance Test/ Characteristic curve	38.	Safety device test	D5	Matchmark details
6.	Ultrasonic Test	24.	No. Load/Free running Test	39.	Ease of Maintenance	D6	Line/Layout diagram
7.	Magnetic Particle Test(MPT)	25.	Load/Overload Test			D7	Approved erection procedures
8.	Radiography test	26.	Measurement of speeds			D8	Unpriced sub P.O.with specification and amendments, if any
9.	Dye Penetration Test	27.	Accoustical test			D9.	Calibration Certificate of all measuring instrument and gauges.
10.	Metallographic Exam.	28.	Geometrical Accuracy				
11.	Welder's Qualification & Weld Procedure Test	29.	Repeatability and Positioning Accuracy			D10	Guarantee certificate
12.	Approval of Test and Repair Procedure	30.	Proving Test				
13.	Heat Treatment	31.	Surface Preparation				
		32.	Manufacturer's Test Certificate for bought out items				
14.	Pressure Test						
15.	Leakage test						
16.	Balancing	33.	IBR/Other statutory agencies compliance certificate				
17.	Vibration Test						
18.	Amplitude test						

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON/CLIENT	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
*	*		*	*						*	*	*	*	*	

*** : Mandatory Field**

for MECON (Stamp & Signature)

For Contractor and manufacturer (Stamp & Signature)

(QAP No. to be allotted by MECON)

MECON QAP NO. | **REV. :-**

SHEET : of

This QAP is valid for a period of three years from the date of issue.

CONTINUATION SHEET

FORM NO. 11.20 (DQM) F-09, Ed.-3 REV-1

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)		Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON/CLIENT	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16

NOTES to Contractor and / or Manufacturer:

(1) Ultrasonic test of plates (lamination check) will be done as per ASTM A-435 (or equivalent) for equal to and above 20mm thick plate.
(2). Ultrasonic test of forged & Rolled rounds will be done as per ASTM A - 388 (or equivalent) for equal to and above 50 mm dia round and acceptance standard to be mutually agreed upon.
(3). All the relevant test reports/certificates shall be submitted during inspection.
(4) Dye penetration test shall be as per Art - 24, Sub section B, code SE 165, ASME Section - V.
(5) All NDT - DPT / UT / RT / MPT/ Leak test / pressure test of weld joints are to be carried out wherever drawing / TS calls for as per applicable standards.
(6) Mill TC for major raw materials to be submitted. In absence of which physical & chemical testing reports will be submitted from NABL accredited laboratory.
(7).WPS/PQR/WPQ to be submitted for review wherever required. All welding shall be done by qualified welders. Duly endorsed documents will be submitted to MECON.
(8) Electrical & refractory items / equipments coming under this QAP should be followed as per relevant electrical & refractory QAP.
(9) Column '14' will be inclusive for all the inspection check points under column 'Inspection & Tests' (Column No. 8-13) and all documents of (Column 15) Acceptance Criteria.
(10). All statutory items including CCOE / IBR items etc. shall be generally under waiver category of MECON. Inspection documents for such items will be submitted for review in accordance with the reference codes.
(11). D9 to be submitted for measuring instruments.
(12). Painting shall be done as per approved Specification.
(13). List of equipments with quantity to be furnished under the unit 'set' or 'lot' as annexure along with inspection call.
(14). Manufacturer's 'Quality Control Procedure' shall be submitted along with inspection call, wherever in existence.
(15) Only type test certificate of same design and same Material of Construction of equipment to be sumbmitted, wherever required.
(16) All the manufacturers shall be from prefered make list of General Technical Specification (GTS) / Contract Technical Specification (CTS) / Approved drawing/datasheet.
(17) Relevant Tests, required as per Approved- drawing / technical datasheets / relevant standards /codes/procudure; to be carried out by Manufacturer and/or Contractor (as applicable) and reports shall be submitted.
(18) Contractor/Manufacturer's scope is not limited to test codes indicated herewith and contractor to ensure compliance to all requirments stipulated in approved drawing/datasheet/TS and CTS.
(19) Correct & proper entry of Billing Schedule / Identification No. and quantity is the sole responsibility of the contractor.
(20) Inspection Call to be raised only after the respective approved drawing / datasheet is submitted by contractor and processed (A / AAN) by MECON.
(21) QAP approval does not give approval of Manufacturer/Vendor.

for MECON (Stamp & Signature)

For Contractor and manufacturer (Stamp & Signature)

(QAP No. to be allotted by MECON).	**REV. :-**
MECON QAP NO.:	
SHEET : OF	

This QAP is valid for a period of three years from the date of issue.

CONTRACTOR	*	QUALITY ASSURANCE PLAN	WORK ITEM NO.	*
ORDER NO. & DATE	*	FOR	PROJECT	*
SUB - CONTRACTOR		ELECTRICAL & INSTRUMENTATION EQUIPMENT	PACKAGE NO.	*
ORDER NO. & DATE			PACKAGE NAME	*

INSTRUCTIONS FOR FILLING UP :

1 QAP shall be submitted for each of the equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.

2 Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

3 Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4 Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

CONTR : CONTRACTOR — P:PERFORM, R: REVIEW

MFR : MANUFACTURER — W : WITNESS

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	Description
1.	Visual
2.	Dimensional
3.	Fitment & Alignment
4.	Physical Test(Sample)
5.	Chemical Test (Sample)
6.	Ultrasonic Test
7.	Magnetic Particle Test(MPT)
8.	Radiography test
9.	Dye Penetration Test
10.	Measurement of IR Value : a) Before HV Test
	b) After HV Test
11.	High voltage test/Dielectric test.
12.	Routine test as per relevant IS/other standard.
13.	Type tests as per relevant IS/ other standard.
14.	Impulse Test.
15.	Partial Discharge Test.
16.	Heat run test/Temp. rise test.
17.	Enclosure protection Test.
18.	Calibration.
19.	Noise & Vibration.
20.	Test Certificates for bought out components.
21.	Tank pressure test / Over pressure test
22.	Paint shade & thickness verification.
23.	Short time rating.
24.	Operation & functional check.
25.	Overspeed Test.
26.	Flame proof test
27.	Clearance and creepage distance.
28.	Acceptance Test
29.	Verification of BOM
30.	PI Value check
31.	Earthing provision & Ferruling Check
32.	HV &IR test of BTD, RTD & Space heater
33.	Galvanization test
34.	Continuity test
35.	FRLS test
36.	Dynamic balancing test
37.	Shaft voltage measurement
38.	SFRA test
39.	Functional test for RTCP
40.	Load/overload test
41	Specific fuel consumption rate check
42.	Tan delta test
43.	Harmonic test

DOCUMENTS :

D1. Approved GA drawings
D2. Approved single line / schematic diagram.
D3. Approved Catalogues / Approved data sheet.
D4. Approved bill of materials.
D5. Unpriced P.O.copy and approved BS copy
D6. Calibration Certificate of all measuring instruments and gauges.
D7 . Approved FAT procedure
D8 . Manufacturer TC /Certificate of compliance
D9 . Inspection report for contractor
D10. Conformity certificate
D11. Gurrantee/Warranty certificate
D12. Compatibility certificate
D13. Screenshot of FAT
D14. Approved P & ID
D15. Approved Graphics

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by			Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No./ Billing Schedule No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR.	MECON	MFR	CONTR.	MECON/CLIENT			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
*	*		*	*						*	*	*	*	*	

* Mandatory field

for MECON (Stamp & Signature)

For Contractor and manufacturer (Stamp & Signature)

(QAP No. to be alloted by MECON)

MECON QAP NO.

SHEET : OF

REV. :

This QAP is valid for a period of three years from the date of issue.

CONTINUATION SHEET

FORM NO.11.20(DQM) F-10, Ed.-3 REV-1

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by			Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Sche-dule of Final Inspn	MFR	CONTR.	MECON/NMDC	MFR	CONTR.	MECON/CLIENT			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

NOTES to Contractor and / or Manufacturer:

1. Manufacturer shall be from approved make list of General Technical Specification (GTS)/Contract Technical Specification (CTS). Relevant documents of approval of make in support of manufacturer shall be furnished along with every inspection call.
2. Column '14' will be inclusive of all the inspection check points under column 'Inspection & Tests' (Column No. 8-13) and all documents of Acceptance Criteria (Column 15).
3. List of items with quantity (in quantifiable unit), duly certified by technical section, to be furnished under the unit 'set' or 'lot' as annexure along with inspection call.
4. Relevant Tests, required as per drawing / technical datasheets / relevant standards /codes; to be carried out by Manufacturer and/or Contractor (as applicable).
5. In case of waiver of any item, Witness Inspection (Witness at Manufacturer's works) & Acceptance Report of Contractor is mandatory along with Guarantee Certificate.
6. Correct & proper entry of Billing Schedule / Identification No. and quantity is the sole responsibility of the contractor.
7. QAP approval does not give approval of Manufacturer/Vendor. Manufacturer shall be as per GTS/CTS.
8. Information furnished under Column no. 4, 5, 7 are notional and indicative only.
9. Mechanical & refractory items / equipments coming under this QAP should be followed as per relevant mechanical & refractory QAP.
10. All statutory items including CCOE / IBR items etc. shall be generally under waiver category of MECON. Inspection documents for such items will be submitted. for review
11. Manufacturer's 'Quality Control Procedure' shall be submitted along with this QAP, wherever in existence.
12. Type test certificate of same design and same rating of equipment to be sumbmitted, wherever applicable.
13. Contractor/Manufacturer's scope is not limited to test codes indicated herewith and contractor to ensure compliance to all requirments stipulated in approved drawing/datasheet/TS and CTS.
14. Inspection Call to be raised only after the respective approved drawing / datasheet is submitted by contractor and processed (A / AAN) by MECON.

(QAP No. to be alloted by MECON)	REV. :
MECON QAP NO.	
SHEET : OF	

for MECON (Stamp & Signature)

For Contractor and manufacturer (Stamp & Signature)

This QAP is valid for a period of three years from the date of issue.

CONTRACTOR	*	**QUALITY ASSURANCE PLAN FOR REFRACTORY MATERIALS**	WORK ITEM NO.	*
ORDER NO. & DATE	*		PROJECT	*
SUB - CONTRACTOR			PACKAGE NO.	*
ORDER NO. & DATE			PACKAGE NAME	*

INSTRUCTIONS FOR FILLING UP :

1. QAP shall be submitted for each of the equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.
4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

CONTR : CONTRACTOR
MFR : MANUFACTURER
P : PERFORM
R : REVIEW
W : WITNESS

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	Description	Code	Description	Code	Description
1.	Visual	18.	Drying & firing shrinkage	38.	Special test
2.	Dimensions and geometry	19.	Sieve analysis	39.	Fibre diameter
3.	Chemical composition	20.	Warpage	40.	Heat Resistance
4.	Apparent porosity	21.	Drip slag test	41.	Recovery after compression
5.	True specific gravity	22.	Permeability test	42.	Shot Content
6.	Bulk density/true density	23.	Hydration resistance test	43.	Moisture Content & Absorption
7.	Cold crushing / compressive strength	24.	Lap joint strength	44.	Incombustibility
8.	Pyrometric cone equivalent	25.	Abrasion resistance	45.	Alkalinity
9.	Refractoriness under load	26.	Cold bonding strength	46.	Resistance to Vibration & Jolting
10.	Spalling resistance	27.	Oxidation resistance	47.	Chloride and / or Sulphur content
11.	Permanent linear change after heating	28.	Workability	48.	Dimensional stability
		29.	Surface area	49.	Water vapour transmission
12.	Modulus of Rupture/ Flexural strength	30.	Corrosion resistance	50.	Closed cell content
		31.	Consistency	51.	Horizontal burning
13.	Reversible thermal expansion	32.	Tensile strength		
14.	Resistance to dis-integration effect of carbon monoxide gas.	33.	Max. Service temp.		
		34.	Set / Part assembly		
15.	Water absorption	35.	Control assembly.		
16.	Acid resistance	36.	Creep Test		
17.	Thermal conductivity	37.	Flow Test		

DOCUMENTS :

- D1. Approved / Reference Drawing / Datasheet with Technical Specification
- D2. Dimensional drgs. showing plan, elevation, side view & cross sectional view duly approved.
- D3. Approved Acceptance Criteria for Physical attributes & Dimensional Check with tolerances
- D4. Approved Test Methodology & Acceptance Criteria for MOR & WORKABILITY of MORTAR
- D5. Laboratory Test Report
- D6. Dimension Check & Physical Attributes Check Report
- D7. Calibration Certificate of all measuring instruments and gauges with indexed list indicating tests.
- D8. Copies of sub P.O. with Technical Specification.
- D9. Guarantee Certificate
- D10. Internal Inspection & Acceptance Report

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity		Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON/CLIENT	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
			No / M	T											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
*	*		*	*						*	*	*	*	*	

* Mandatory field

for MECON(Stamp & Signature)

For Contractor and manufacturer (Stamp & Signature)

(QAP No. to be allotted by MECON)

MECON QAP NO. REV.:

SHEET : OF

This QAP is valid for a period of three years from the date of issue.

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity		Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON/CLIENT	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
			No / M	T											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**

NOTES to **Contractor** and / or **Manufacturer**:

1. Bricks (except. insulation) shall be stacked in two rows with access from both sides for lot verification and sampling. 100% bricks (except. insulation) shall be marked with quality code, Lot No., Shape / Item No.
2. For castables, mortars, ramming mixes etc.: Batch No., Date of manufacturing and shelf life shall be mentioned in Test Certificate (TC) and packing bags. Water required for casting / mixing shall be mentioned in TC. In absence of aforementioned information, TC shall be treated as invalid.
3. Manufacturer shall be from approved make list of General Technical Specification (GTS)/Contract Technical Specification (CTS). Relevant documents of approval of make in support of manufacturer shall be furnished along with every inspection call.
4. For conformance of thermal conductivity test of LRB Mattress as per IS:3144, recent Type Test Certificate [of appropriate specimens corresponding to product and density of the material, supplied by a plant] from Govt. Approved Lab (CBRI Roorke / IIT Madras / PIBCO R&D) may be furnished.
5. Column '14' will be inclusive of all the inspection check points under column 'Inspection & Tests' (Column No. 8-13) and all documents of Acceptance Criteria (Column 15).
6. List of items with quantity (in quantifiable unit), duly certified by technical section, to be furnished under the unit 'set' or 'lot' as annexure along with inspection call.
7. Relevant Tests, required as per drawing / technical datasheets / relevant standards /codes; to be carried out by Manufacturer and/or Contractor (as applicable).
8. In case of waiver of any item, Field Inspection (Witness at Manufacturer's works) & Acceptance Report of Contractor is mandatory along with Guarantee Certificate.

REMARKS:

1. Correct & proper entry of Billing Schedule / Identification No. and quantity is the sole responsibility of the contractor.
2. QAP approval does not give approval of Manufacturer/Vendor. Manufacturer shall be as per GTS/CTS.
3. Information furnished under Column no. 4, 5, 7 are notional and indicative only.

for MECON(Stamp & Signature)

For Contractor and manufacturer (Stamp & Signature)

(QAP No. to be allotted by MECON)	**REV.:**
MECON QAP NO.	
SHEET : OF	

This QAP is valid for a period of three years from the date of issue.

8. SURFACE PREPARATION AND PAINTING

8.1. General

8.1.1. This specification covers the materials, tools, facilities and quality requirement for surface preparation and painting of steel structures, mechanical & electrical equipment, technological structures, piping, ducts, etc. for Captive Power Plant (Technological Package – 1) as elaborated in the further text.

This specification will be read in conjunction with other parts/ volumes of the Tender specification where other related project requirements have been indicated.

The term "Painting" referred herein covers rust preventive, preventive and decorative coating along with surface preparation of the following areas.

i) All Mechanical equipment, Technological structures, chutes, piping, ducts etc. unless otherwise specifically indicated in the relevant section
ii) Various types of static and rotary equipment inclusive of electric motors etc.+
iii) Steel tanks and vessels
iv) Pipe work including trestles, supports, hangers, etc.
v) Metallic duct work such as ventilation ducts, gas ducts including supports, hangers, etc.

This is a general guideline to the paining scheme to be followed. However, in case if a specific painting procedure is stipulated in any tendering specification, then this general guideline will be superseded. Any special case which may arise from time to time will be dealt with individually on the merits of each case.

8.1.2. Surfaces made of aluminium, brass, bronze, stainless steel, and other corrosion resistant alloys are not required to be painted unless specified except for identification bands or for aesthetic purposes.

8.1.3. All machined mating surfaces (e.g. flanges) will be properly cleaned, and will be provided with protective coating before dispatch.

8.1.4. The complete painting scheme for any item includes the following basic activities:

i) Proper surface preparation
ii) Application of primer coats
iii) Application of intermediate coats and
iv) Application of finish coats

All the above coats will be of quality paint products and of approved make as stipulated in this specification. The scope of work will also include supply of all paint materials as per specification described herein and of approved quality/ specifications.

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8.2. Painting for Mechanical, Electrical and Other Equipment, Mechanical Structures, Piping, Ducts, etc.

8.2.1. This section covers the painting requirements for the power plant equipment, structures, piping etc. and any other surface required to be painted.

8.2.2. Codes and Standards

Painting of equipment will be carried out as per the specifications indicated below and will conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:6278	:	Code of practice for white washing and colour washing
IS:3140	:	Code of practice for painting asbestos cement building products
IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting
IS : 2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS : 104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS : 2932	:	Enamel , synthetic, exterior (a) undercoating (b) finishing specification.

8.2.3. Preparation of Surfaces

i) Surface preparation being a pre requisite for any paint application, will be such as to clean the surface thoroughly of any materials which will be conducive to premature failure of the paint substrates.

ii) All surfaces to be painted will be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust and any other foreign matter. Mechanical cleaning by power tool and scrapping with steel wire brushes will be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, sand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents will be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents will be adopted only after written approval of

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the Owner/ consultant.

iii) The workmanship will, in general, be in accordance with IS: 1477-1971. Surface of all the steel works to be painted will be thoroughly cleaned and degreased in accordance with IS:1477(Part-I) by means of mechanical and power tool cleaning or shot blasting. The cleaning quality will conform to second quality blast cleaning as per BS-4332 or to SA 2.5 of Swedish Standards Institution SIS 055900. Cleaning of surface will ensure primer coat is rigidly anchored to the virgin metal surface. Primer paint will be applied not later than 2-3 hours after preparation of surface, unless otherwise specified.

8.2.4 The acceptable surface preparation quality/grade are described under each painting scheme. The procedures covered are solvent cleaning, hand tool cleaning, power tool cleaning and blast cleaning

i) Solvent Cleaning (SP 1) (If applicable)

The surface will be cleaned by wiping, immersion, spraying or vapour contacting of a suitable solvent or washing with an emulsion or alkaline solution to remove oil, grease, dirt, old paint, etc. Solvent cleaning will not remove rust, scales, mill scales or weld flux. Therefore, before application of paint, solvent cleaning will be followed by other cleaning procedures as stated below.

ii) Hand Tool Cleaning (SP 2)

The surface will be cleaned by vigorous wire brushing done manually to St-2 quality. This method effectively removes loosely adherent materials, but would not affect residues of rust or mill scales that are intact and firmly adherent.

iii) Power Tool Cleaning (SP 3)

The surface will be cleaned by electric or pneumatic tools to St-3 quality. The tools will be used carefully to prevent excessive roughing of surface and formation of ridges and burns. This method will remove loosely adherent materials but would not affect residues of rust or mill scales that are firmly adherent.

iv) Blast Cleaning (SP 4)

The surface will be cleaned by impingement of abrasive materials, such as graded sand at high velocity created by clean and dry compressed air blast. This method will remove loosely adherent materials as well as adherent scales and mill scales. Prior to application of blast, heavy deposit of oil and grease are removed by solvent cleaning and excessive surface scales are removed by hand tools or power tool cleaning. The surface will be cleaned to Sa-2 1/2 quality which means that to 95% of surface area is free from all rust, mill scales and visible residues, foreign materials, etc. The blast cleaning is not recommended for sheet metal work.

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8.2.5. Primer Paints (P)

After the surface is prepared in a manner acceptable to Owner/ consultant, two (2) coats of Primer paints will be applied only on dry and clean surfaces. Second coat of red oxide primer will be applied only after first coat has dried up completely. Coating of primer will in general conform to IS:2074-92 and will be applied by brushing to ensure a continuous film without "holidays".

i) Primer paint P1: (Epoxy based)

A two pack air drying epoxy polyamide resin based red oxide –zinc phosphate (primer):

Epoxy content (% wt)	15 to 18
Air drying time	About 30 minutes (touch dry) Over night (hard dry)
Dry film thickness (DFT/coat)	30 microns (min)
Temperature resistance	Upto 120 deg.C dry heat

ii) Primer paint P2 (Epoxy based)

A two pack air drying epoxy polyamide with zinc dust of at least 92% zinc dust on the dry film.

Epoxy content (% wt)	8 to 10
Air drying time	About 10 minutes (touch dry) 2 hours (hard dry)
Dry film thickness (DFT/coat)	40 microns (min)
Temperature resistance	Upto 300 deg.C dry heat

iii) Primer paint P3 (Ethyl zinc silicate, EZS, based)

A two pack heavy duty zinc dust rich silicate primer:

Total solids (% wt)	84 + 2
Air drying time	16 hours
Density	3.07 + 0.005
Dry film thickness (DFT/coat)	60 microns (min)
Temperature resistance	Upto 450 deg.C dry heat

iv) Primer paint P4 : Double boiled linseed oil as per IS – 77 : specification for linseed oil, boiled for paints

v) Primer paint P5 : In organic Zinc silicate with suitable air drying time. 40 microns per coat

vi) Primer paint P6 : Red oxide Zinc phosphate as per IS 12744 with DFT 30 microns per coat

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vii) Primer paint P7 : Red oxide Zinc chrome primer(alkyd based) as per IS 2074 with DFT 40 microns per coat

8.2.6. Intermediate paints (N)

These paints will be applied over primer coats as an intermediate layer to provide weatherproof seal of primer coats.

i) Intermediate paint N1

A two pack air drying high build epoxy resin based paint with MIO.

Air drying time	6 to 8 hours (touch dry) 7 days (full cure)
Dry film thickness (DFT/coat)	80 microns
Temperature resistance	Upto 180 deg.C dry heat
Compatible with	Primer P1

ii) Intermediate Paint N2: Synthetic Enamel (long oil alkyd) to IS 2932, 1 coat = 20 Microns per coat.

8.2.7. Finish Paint (F)

Finish paint coats will be applied over primer coats and intermediate coats after proper cleaning and touch up of primed coats. Synthetic enamel paint comprising of IS:2932-95 will be used for finish coats.

i) Finish paint (F1)

A two pack air drying epoxy polyamide enamel suitably pigmented.

Air drying time	2 to 3 hours (touch dry) 7 days (full cure)
Dry film thickness (DFT/coat)	30 microns
Temperature resistance	Upto 130 deg.C dry heat
Compatible with	Primers P1 and P2 Intermediate N1
Colour	Generally all shades

ii) Finish paint (F2)

A single pack synthetic rubber based enamel paint.

Air drying time	2 hours (touch dry) 24 hours (hand dry)
Dry film thickness (DFT/coat)	25 microns
Temperature resistance	Upto 200 deg.C dry heat

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Compatible with	No primers
Colour	Generally all shades

iii) Finish Paint F3

A single pack heat resistant silicon Aluminum paint.

Air drying time	3 to 4 hours (touch dry) 24 hours (hard dry)
Dry film thickness (DFT/coat)	25 microns (min)
Temperature resistance	upto 400 deg.C dry heat
Compatible with	Primer paint P3
Colour	smooth aluminium

Heat resistant Silicone Aluminium Paint with suitable air drying time as per IS 13183 Gr I , 25 microns per coat.

iv) Finish Paint F4: Heat resistant Alumina Paint IS 13183 Gr II, DFT 20 microns per coat.

v) Finish Paint F5 :Heat resistant Silicone Aluminium Paint with suitable air drying time as per IS 13183 Gr I, 25 microns per coat.

vi) Finish Paint F6:Aliphatic acrylic polyurethane paint , DFT= 30 microns per coat.

vii) After cleaning the dust on the dried up primer/ intermediate paint, , first coat of synthetic enamel will be applied. After this first coat dries up hard, the surface is wet scrubbed cutting down to a smooth finish and ensuring that at no place the first coat is completely removed. After allowing the water to get evaporated completely, the second finish coat of synthetic enamel paint will be applied only after gently removing the gloss of first coat from entire surface and it is dusted off the surface. The requirement of workmanship will be as per IS:1477-71.

viii) Equipment No. and the name of the equipment will be painted on the surface of the equipment on visible locations in English. Service of the Pipe/Line designation with arrow identification for the direction of flow will be painted on all pipes at visible locations at an interval of 20 metres. Wherever pipelines are insulated, the service of the piping and arrow mark will be painted over the clad surface.

ix) For painting of equipment, tanks & vessels etc. colour code shall be as per manufacturer standard or approved by Purchaser.

x) For insulated pipeline the finish paint will be applied at that place where colour band is to be painted on the aluminium sheeting. The finished paint (colour band) will be of 1m length at that place.

xi) Colour band for piping will be applied at these following locations-

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a) At start and end point.
b) At every 10m intervals.
c) At every T joints and cross connection of piping.
d) At every battery limit of pipeline
e) Near valves before connection with the consumer.

xii) Width of band

Size of pipe including insulated Pipe line outside diameter	Width of band
80 mm and below	25 mm
Above 80 mm upto 150 mm	50 mm
Above 200 mm upto 300 mm	75mm
Above 350 mm	100 mm

xiii) Direction of flow will be indicated by black or white arrow in contrast to the base colour on the pipeline. Length of the arrow will be minimum 125 mm and width will be minimum 65 mm. These will be put at an interval of 10 m.

**** End of Clauses ****

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9. PROJECT SCHEDULE & PROGRESS MONITORING

9.1. The project envisages installation of Captive power plant at IISCO Steel Plant (ISP), Burnpur. Overall schedule for completion of captive power plant would be of 39 months from zero date (effective date of contract) which includes engineering, erection of equipment, testing and commissioning in addition to civil and structural work. Zero Date & Commissioning mentioned above and as shown in the schedule shall be same as defined in the technical and commercial part of the specification.

The project shall be executed on discreet turnkey basis, excluding civil and structural work which shall be carried out by the Purchaser, based on the load data and other relevant details to be furnished by the successful Tenderer.

An indicative Implementation Schedule, in line with the total time period and indicating the major activities, is shown in drg. no. MEC/11/PY/M-0033/TS/CPP-1/5112 for reference.

9.2. Project Schedule

9.2.1. The Tenderer shall submit the following along with the offer.

a) Overall bar-chart schedule

The overall bar-chart schedule shall cover the major activities of the project. The major milestones for the project are also to be highlighted in the schedule.

b) Off-site/On-site organization chart for execution of the project.

c) Deployment schedule of manpower during site execution.

d) Deployment schedule of construction equipment during site execution.

9.2.2. The Tenderer shall note the following:

a) Area within Battery limit shall be utilized for storage area. However, if additional area outside the battery limit (may be outside plant) is available, the client may permit the bidder to utilize the same.

b) Provision of construction water –Refer SBD clause no.20.4.2

c) Provision of construction power- Refer SBD clause no.20.4.3

9.2.3. The successful Tenderer shall have to submit the following –

a) Load Data for civil / structural work within 2 months from effective date of contract to enable the Purchaser to take up the detailed design and engineering for civil and

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structural work.

c) The Level-II PERT network schedule both in hard and editable soft copy (in MS Project / Primavera) as mentioned in GCC Clause No. -18 of SBD (Updated in December 2022).

9.3. Progress Monitoring

Refer General Conditions of Contract (GCC) Clause No. -18 of SBD (Updated in December, 2022).

9.4. Relevant IS code

Following IS codes may also be referred by the Contactor as guideline for preparation of project network schedule, organization chart, progress reports, etc.

IS 14580 (Part 1) : 2020 & IS 14580 (Part 2) : 2006(Reaffirmed year: 2020)
IS 15883 (Part 1) : 2009(Reaffirmed year: 2019) & IS 15883 (Part 2) : 2013(Reaffirmed year: 2018)

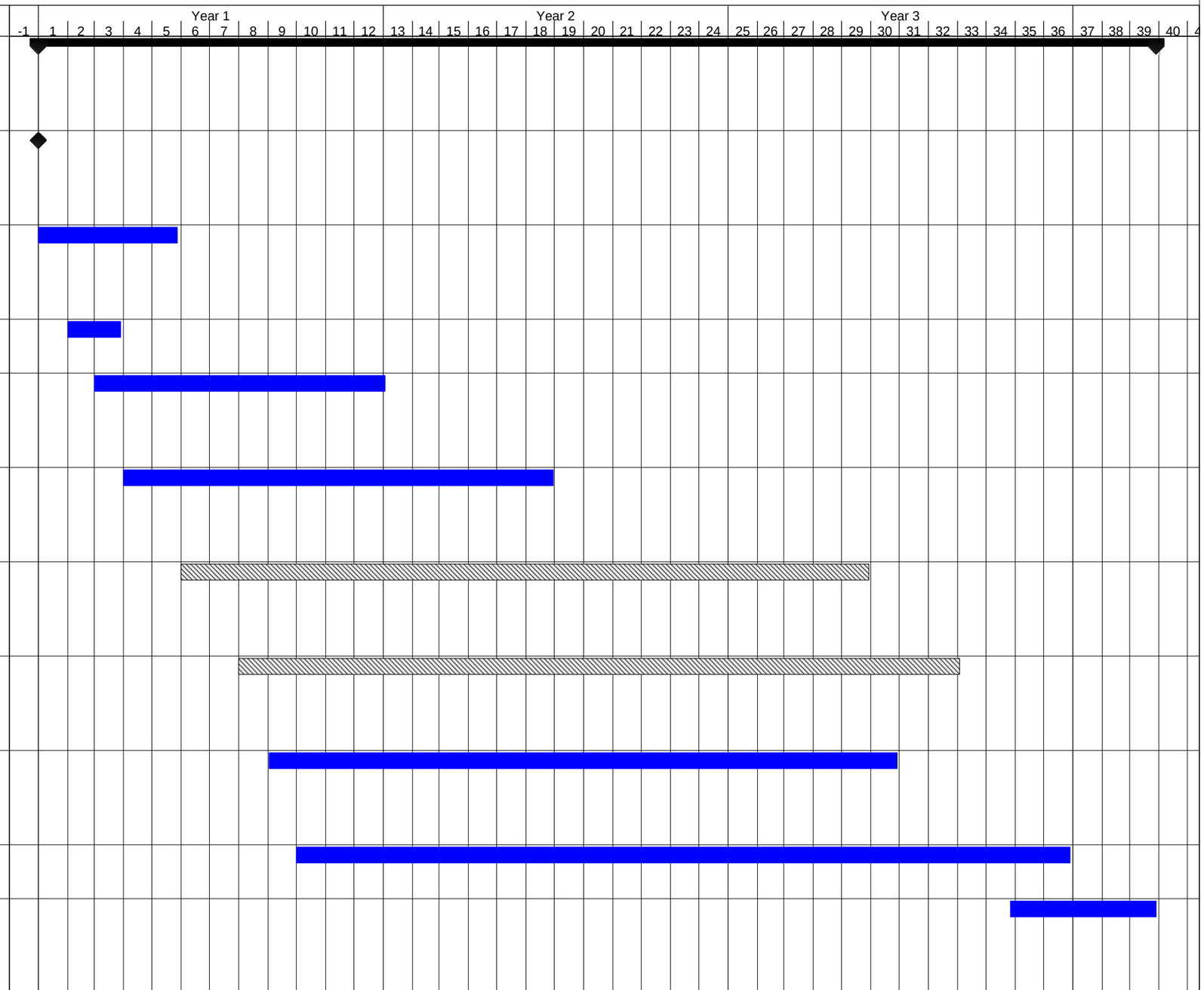
**** End of Clauses ****

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STEEL AUTHORITY OF INDIA LIMITED
EXPANSION OF IISCO STEEL PLANT
CAPTIVE POWER PLANT

INDICATIVE IMPLEMENTATION SCHEDULE

ID	Task Name
1	**ISP 4.08 MT Expansion - Captive Power Plant**
2	**Placement of Order (Zero-date)**
3	**Basic Engineering & Approval**
4	**Submission of Load Data for Civil / Strl**
5	**Tendering & Ordering on Sub-vendors**
6	**Detailed Engineering & Approval**
7	**Civil Work (by Purchaser)**
8	**Fabrication & Erection of Structures (by Purchaser)**
9	**Delivery of Equipment**
10	**Erection of Equipment**
11	**Testing, Trial Run & Commissioning**



File: ISP_CPP_TS_Schedule.mpp;

Task | Milestone | Summary | Task by purchaser

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DRG. NO. MEC//11/PY/M-0033/TS/CPP-1/5112

10. ERECTION, TESTING, COMMISSIONING, HANDING OVER & PERFORMANCE GUARANTEE TESTS

10.1. General

Erection of entire plant & equipment shall be in the scope of work of the Tenderer. Tenderer shall submit all the inputs, erection manuals, pre-conditions, standards & guidelines, manpower requirements, list of tools & tackles, list of equipment with weight, special instructions, type of testing, etc. for each plant and equipment to the Purchaser.

10.1.1. Erection Work Program

The Tenderer shall furnish the schedule for erection work to meet the targets and ensure that drawings, materials, equipment and services required from others are requisitioned well in advance to meet the demands of the erection schedule. Delays which may affect the progress of work shall be brought immediately to the notice of Purchaser / Consultant in writing.

10.1.2. Receiving, Handling and Storage into the Site

Tenderer scope shall include receiving of the consignment, gate entry, handling and intermediate storages for plant and equipment. Purchaser shall allocate temporary space, construction power and water, etc. for setting up the intermediate storage, and site offices, and also material handling facilities as available for handling of the consignment.

10.1.3. Unpacking

Tenderer shall carry out their internal Open Packaging Inspection (OPI). Tenderer shall take immediate action for replacement / repair of any missing items, damages, etc. noted during the OPI .

10.1.4. Preparation of the Erection Area

The Tenderer shall thoroughly inspect the area, foundation and structure before the start of erection. The area where the erection will be carried out must be suitably marked, cleared and cleaned in order to allow free movements of the operating personnel, devices and machine parts. Tenderer shall ensure that erection site is in full compliance with safety standards and also make sure that the area is properly lit to avoid the danger of accidents. Tender shall make sure that the feeding lines to the yard, such as electric current, compressed air, water, etc., are installed in compliance with the pre-conditions.

10.1.5. Markings and Leveling, Installation of Reference Plates and Leveling Plates on Foundations

The Tenderer shall submit a detailed layout indicating all the bench marks for installation before the start of erection. All the bench marks shall be set by the Tenderer as per the

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standard practice. The Tenderer shall be responsible for the true and proper setting-out of the facilities in relation to bench marks, reference marks, check lines and levels installed.

10.1.6. Erection Procedure

All assembly and erection procedures adopted by the Tenderer shall be open for inspection and approval by Purchaser/ Consultant. The Tenderer shall adopt methods and procedures for equipment erection to suit the nature of equipment according to the best modern practice and his own experience in such work. The Tenderer shall ensure that assembly, erection, testing and commissioning are in accordance with the drawings. Suitable joint inspection protocols shall be prepared by the Tenderer for certifying the completion of erections. The Tenderer shall not make any alteration to equipment to facilitate assembly or erection work, without prior approval of Purchaser / Consultant. Scope of supply of erection material, grouting, shim, general tools & tackles, etc. required shall be under the scope of the Tenderer.

10.1.7. Connection with Power and Utilities

Tenderer shall carry out complete assembly of plant and equipment, connection of all pipe work, ductwork, cables and conduits, bus bars, earthing, structural steelwork in pipe supports, cable trays, etc. and connect electric power supply, water and utility connections from the terminal points to make the equipment ready for commissioning. All the services shall be laid simultaneously as per the erection program prepared by the Tenderer to meet the target commissioning date.

10.1.8. Trials and Testing

Tenderer shall conduct all setting up of the facilities for start of the trials of the equipment. Before the start of trials, purchaser shall arranger permanent utilities, power, and O&M manpower. Purchaser's manpower shall work under the guidance and supervision of Tenderer during PAC, Start up, Commissioning and PGT. Tenderer shall also conduct all on-site training of the purchaser's personnel for smooth start up, trials and commissioning of the plant.

10.2. Erection

The Tenderer shall perform the following with respect to the erection of the Plant and equipment supplied.

The scope of work of the Tenderer shall be complete erection of the Plant and Equipment as given in the scope of work. The Tenderer shall make all arrangements to deliver the equipment at site by wagons / trucks / trailers, build his own stores (covered, uncovered, air-conditioned, as necessary) for the proper storage of equipment, maintain the stores and all related documents and records. All security (watch & ward) arrangements also shall be made by the Tenderer.

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The Tenderer shall unpack and do visual checking against physical damages to the equipment / cases, clean equipment at store before start of erection. Damage, shortage, if any, shall be reported to the Purchaser / Consultant and shall be rectified / replaced expeditiously, so as not to upset the erection and commissioning and shall not be considered an excuse for delay in completion of the work.

The Tenderer shall provide all necessary special tools & tackles, consumables, commissioning spares, etc. which may be required for carrying out the erection and commissioning work efficiently. The Tenderer shall ensure that proper procedure and documentation is maintained at entry gate of Purchaser's premises for all plant & equipment.

The Tenderer shall erect and maintain his own site offices and stores as required for the work and arrange for maintaining in neat manner the area placed at the Tenderer's disposal. The site office shall be handed over to Purchaser free of cost after completion of the project or dismantled and vacant land to be handed over as directed by Purchaser.

The Tenderer shall carry out base / primer and final painting of all Plant & Equipment, Structures, Pipe lines, Tanks & Vessels etc. supplied. The painting including its process shall be carried out as per the requirement as have been laid down in the detailed technical specification. Where not specified, the same shall be as per the standard codes & practices normally applicable and adopted internationally for the type of Plant & Equipment offered.

All safety, health and pollution control measures as required to be adopted as per the Statutory Regulations and the Safety Codes for projects issued along with the tender or otherwise required or implied by statutory regulations or the Technical Sprcification. The Tenderer shall set up a suitable safety organization of his own at site in this regard.

The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the working drawings, specification, and instructions etc. duly approved by the Purchaser. The Tenderer shall carry out the work in the presence of / as per the instructions of the site engineer / supervisory personnel deputed by the Purchaser. The supervision of erection shall be carried out by highly skilled workmen/ engineers.

The Tenderer shall supply all required consumables, flushing & initial fills of lube oils (as per manufacturer's/supplier's recommendation), gaskets, emery papers, etc. as required for the satisfactory completion of work.

The Tenderer shall provide adequate nos. of skilled, supervisory staff/ engineers, tools & tackles, spares, etc. for completion of all equipment and piping systems within scheduled time.

The Tenderer shall take care of positioning, leveling and plumbing of all equipment & pipelines within required accuracy and tolerance limit as specified by codes,

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manufacturer, client and consultant. It shall be deemed as a contractual obligation that equipment are not thrown out of alignment or lifted off during commissioning and subsequent operation.

The Tenderer shall be responsible for paying strict attention to statutory regulations for prevention of accidents and other safety rules.

The Tenderer shall be responsible for storage, safe handling of all equipment. If any damage takes place during erection and testing work due to reasons attributable to the tenderer, the same shall be repaired / replaced by the Tenderer to the satisfaction of purchaser without any financial implication.

Before erection all parts of equipment, Tenderer shall inspect to ensure that pipes, valves, fittings etc. shall be cleaned, checked, lubricated and inspected for ease of operation and any possible damage during transportation.

Tenderer shall inspect to ensure that all the pipelines shall be provided with suitable slopes, suitable vent with valve at the highest points and drains/steam trap with bypass arrangement at the lowest points.

Hooking up of all pipelines / services including supply of all fittings as required for the same for all pipelines / services with existing pipelines / services at battery limits shall be the responsibility of the Tenderer.

The Tenderer shall intimate the purchaser at least one month in advance for requirement of any shutdown of the existing services for hooking up purpose. The Tenderer shall also prepare shutdown plan indicating time required, manpower and equipment planning, availability of all fittings etc. well in advance to purchaser for approval.

10.3. Allotment of Land

Land shall be allotted for the purpose of Site Office and Stores. However, allotment of land shall be subject to mutual discussion and agreement because of limited availability of space.

The allotment shall remain valid till the period of contract agreement and shall automatically cease after expiry of the guarantee period of the contract agreement. The validity shall also automatically cease on termination of contract agreement due to any reason whatsoever.

The Tenderer may build only temporary structures on the land allotted to him.

On completion of the work and expiry of the guarantee period, the Tenderer shall remove all temporary structures built by him and restore the land to its original condition unless otherwise advised by the Purchaser.

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10.4. Testing

Tenderer shall ensure, that all the tests / inspection specified in Technical Specification, codes, data sheets etc. are carried out in full.

For pressure parts of steam piping and accessories, requirement for Indian Boiler Regulation (IBR) with its latest amendments shall be complied with in full.

10.4.1. Site Tests

The Tenderer shall prepare and submit detailed quality plan for all equipment under this Tender from the receipt of material at site, during storage, erection, pre-commissioning to final commissioning of the plant. These procedures shall necessarily include all check/tests to be 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 above shall be discussed and finalized with the Purchaser/ Consultant. The Tenderer shall also furnish detailed quality procedures proposed by him for storage, preservation, painting, acid cleaning, alkali boil out, steam blowing, hydraulic test, air / gas tightness test, commissioning and performance test etc. to the Purchaser/ Consultant. The same shall be discussed, finalized and approved by the Purchaser/ Consultant before the commencement of respective site tests and such approved copies shall be submitted in six sets.

10.4.2. Hydrostatic Tests of Pressure Parts

a) On completion of erection of pressure parts of steam generator, the unit with its fittings and mountings in position and pipelines shall be subjected to hydrostatic pressure test in accordance with requirements of Indian Boiler Regulations.

b) 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.

c) Hydrostatic test of all pipelines (except fuel gas pipelines) shall be done at 1.5 times the maximum allowable working pressure/ design pressure. However, pneumatic test of fuel gas pipelines such as BFG/BOFG, COG shall be done at a pressure not less than 0.2 kg/cm2g.

10.4.3. System Checking / Reliability Trials

Tenderer shall carry out tests at site to prove to the Purchaser that each equipment of the plant complies with requirements stipulated and is erected in accordance with requirements. Before the plant is put into trial operation the Tenderer shall be required to conduct tests to demonstrate to the Purchaser that each item of the plant is capable of correctly performing the functions for which it was specified.

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These tests may be conducted concurrently with those required under commissioning sequence.

The tests required shall specifically include the following:-

a) Checks on the operation of all controls of isolating gas and air dampers.

b) Checks on operation of all fans to ascertain level of noise and vibration.

c) Test running of pumps.

d) Checks on operation of all soot blowers and retraction gear and the sequence control.

e) Checks on operation of all individual control loops in the steam generator control system.

f) Checks on inter-relation between each separated control loop.

g) Checks on correct functioning of the BMS/ flame and furnace supervisory system.

g) Calibration tests of orifices, flow nozzles, instruments and control equipment to the extent included in these specifications.

i) Other tests shall be conducted if required by the Purchaser/ Consultant to establish that the plant & equipment are in accordance with requirements of the Tender. Such services shall be on mutually agreeable terms.

k) The instruments to be used for performance testing shall be certified by an independent, reputed agency approved by purchaser / consultant.

10.4.4. Test on Auxiliaries

The following shop tests shall be conducted as applicable on the various auxiliaries.

All the pressure vessels / heat exchangers shall be tested at a hydrostatic test pressure of 1.5 times the maximum working pressure or as required by IBR.

Radiography tests at welds as per requirements of IBR.

Functional tests of equipment wherever applicable.

Overall mechanical inspection.

10.4.5. Acceptance Tests

After erection of the equipment at site acceptance test shall be conducted in accordance

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with latest ASME PTC Codes or any other approved equal international standards. A detailed test procedure shall be prepared and submitted to the Purchaser / his Consultant for approval at least one month prior to testing. All instrument and accessories for the test shall be arranged by the Tenderer.

10.5. Definitions

a) Mechanical Completion

When all the engineering is completed, all the building work has been completed, all equipment and machinery are installed and aligned all piping and instrumentation work is completed, all hydrostatic / pneumatic testing is done, speed and direction of rotation of all prime movers is checked, relays are set and all scales, meters, measuring devices and recorder are calibrated, the Tenderer shall notify Purchaser in writing that the plant is ready for occupation in all respect and is ready to start.

b) Pre-commissioning Activities

Pre-commissioning activities defined as activities required to be performed after erection / installation, hydro testing, etc. of an equipment / system to make them ready for commissioning. This shall include but not limited to the activities like system checking as per P & I drawings, site modification, inspection of equipment, calibration of instruments, checking of the electrical equipment for proper earthing continuity, insulation resistance, primary and secondary injection test of relays after insulation resistance, conducting operability test on individual equipment / systems, supply and charging of lube oil and other chemicals.

c) Ready for Commissioning

The plant shall be considered "Ready for Commissioning" when all the facilities have been completed along with its auxiliaries and support facilities in every respect including charging of lube oil, any last minute modifications as recommended by the Purchaser / Consultant, all temporary structures, scaffolding, etc. used for carrying out pre-commissioning works have been removed, all the blinds / blanks have been put in position as required by process, all systems as recommended have been purged and pressurized, and the plant has reached to a stage of ready for commissioning and acceptable to the Purchaser / Consultant. .

The Tenderer shall issue a certificate of "Ready for Commissioning" of plant, for acceptance by Purchaser.

10.6. Pre-commissioning & Commissioning

Tenderer shall be responsible to carry out pre-commissioning and commissioning of complete Plant and equipment supplied. Tenderer shall document elaborating different activities with schedule for pre-commissioning and commissioning. The document shall

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cover the following as minimum:

a) Description of facilities / Equipment layout drawing with clear legends
b) Start up procedure
c) Normal operation procedure
d) Shut down procedure (normal / emergency)
e) Operating parameters and set points of different alarms and trips.
f) Summary of utilities consumption (normal & maximum)
g) Lubrication schedule and identification of equivalent available in India.
h) Fire and safety system.

The manual shall have the following attachments as a minimum:

a) Reduced size copies of line lists and valve schedules
b) Equipment and instrument data sheets
c) Electrical single line diagram
d) Area classification drawings
e) Pump characteristics curves
f) Piping and instrumentation diagrams
g) All shut down schemes
h) Safety logic diagrams
i) Recommended proforma of log books for major equipment

10.7. Commissioning

It shall be the responsibility of the Tenderer to carry out the commissioning activities of the plant (after successful mechanical completion and pre-commissioning activities duly witnessed by the Purchaser / Consultant), under necessary guidance and overseeing of Licensor, if any.

One month in advance of starting the commissioning, the Tenderer shall submit proposal to the Purchaser giving details of the programme to be followed during commissioning. This shall be checked by Purchaser / Consultant. Tenderer shall depute trained operation team to carry out plant start up and commissioning and process operations and maintenance under the overall guidance of the Purchaser / Consultant. Tenderer also be required to associate Purchaser's operation personnel in all the day to day pre-commissioning, commissioning, maintenance activities and process operations. However, responsibility for adequate manning and commissioning of the plant shall be that of the Tenderer.

The plant shall be considered to be commissioned successfully when all the systems, with instrumentation / control systems, process utilities and support systems have been on uninterrupted stable operation at minimum 66% of the Guaranteed Production Capacity, under specified conditions for not less than 72 hours. Whether the 72 hours operation has been successful or not, shall be decided by Purchaser based on observations recorded during the 72 hours. The countdown for the 72 hours operation shall start only after the

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plant has been on stable operation with all controls and safety system in normal operation for a period of not less than 24 hours.

10.8. Acceptance & Handing Over

a) The Tenderer shall supervise the Acceptance Tests to ensure that the plant and equipment supplied by them to meet Purchaser's system requirement.

b) Acceptance Test for system, equipment and pipelines covered in this Technical Specification shall be conducted unit wise or group wise within a reasonable period after the completion of erection work which shall be mutually agreed upon.

c) Commissioning certificate of the boiler plant as a whole shall be issued only after complete facilities have been commissioned and satisfactory operated for a period of 72 hours continuously at required parameters at rated output.

d) Any defects found in the supplied plant & equipment during commissioning, due to reasons attributable to the Tenderer, shall be rectified by the Tenderer at his own cost failing which the Purchaser reserves the rights to take remedial measures at the Tenderer's cost or reject the plant and equipment as deemed necessary.

e) After successful commissioning of the plant and equipment, there shall be formal handling over and taking over of the plant between Tenderer and the Purchaser. Final taking over certificate shall not be issued unless Purchaser is fully satisfied with the supply work in every respect as per requirement and all documents, drawings, manuals, etc. are furnished by the Tenderer as per the terms of the Tender.

10.9. Performance Guarantee Test

The performance guarantee test shall be carried out unit wise for Boiler, Steam Turbine Generator, Steam Turbine Driven Turbo Blower and DM Plant. The test will be done after the plant and equipment has attained stable operation at the end of the commissioning.

10.10. Deputation of experts for Erection, Testing, Commissioning and Performance Guarantee Tests

The Tenderer shall depute site Engineers / Specialists from various disciplines for erection, testing, commissioning and performance guarantee tests of the Plant and equipment along with their auxiliaries.

10.11. Manufacturer

It shall be the responsibility of the Tenderer to arrange to get service of Manufacturer's installation / commissioning engineer at site during mechanical completion/ commissioning of all the major equipment and systems for the plant.

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The Tenderer shall plan availability of personnel/experts indicated above, well in advance to match with the requirement. Also the Tenderer shall ensure the continuity for concerned experts / personnel till completion of the work. Short time deputations of different persons shall be avoided.

10.12. Spares and Consumables

Refer Commercial Volume/ SBD.

**** End of Clauses ****

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11. GUARANTEES & PENALTIES

11.1. The Tenderer shall guarantee performance of the individual equipment indicated in the subsequent clauses within a period of Six (06) months from the date of successful commissioning.

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11.2. Guarantee Test

The performance guarantee test shall be carried out unit wise as detailed below. The test shall be done after the plant and equipment has attained stable operation at the end of the commissioning.

The tests shall be conducted at the specified load points and as per the specified condition as practicable. The Purchaser/ Consultant shall apply proper correction in calculation to take into account of condition, which do not correspond to the specified conditions.

All test instruments for the guarantee tests shall be arranged by the Tenderer and shall be retained by him up to satisfactory performance of all such tests at site. The test instruments shall be taken back by the Tenderer after successful completion of PG test. All costs associated with the supply, calibration shall be included in the scope of the Tenderer. The test instruments for the performance tests shall be in accordance with the applicable code. All calibration procedures and standards shall be subject to the purchaser's approval. The instruments to be used for performance testing shall be certified by the independent, reputed agency, approved by consultant / purchaser.

The Tenderer shall supervise and direct the operation during Performance Test and shall take full responsibilities in this regard.

Any special equipment, tools, tackles required for the successful completion of the guarantee tests shall be arranged by the Tenderer free of cost.

The Tenderer shall be responsible for providing the following services also for successful completion of "Demonstration of Guarantee Parameters" of the plant/ unit/ sub unit/ package:

a) If the successful completion of guarantee Test Run of the plant is hindered on account of reasons attributed to design, engineering and manufacture by Tenderer, the Tenderer shall be responsible to rectify the same and without any loss of time or extra cost.

b) If the opinion of the Purchaser/ Consultant reveals that certain modifications in design are considered necessary for smooth and safe operation of the plant, the Tenderer is responsible to provide such services on mutually agreeable terms.

c) The instruments to be used for performance testing shall be certified by an independent, reputed agency approved by Purchaser/ Consultant. The specific tests to be conducted on equipment are indicated under "Guarantees" below.

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The tests shall be conducted as per latest applicable ASME PTC – Codes or any other approved equivalent international standards.

11.3. Failure to meet the Time Schedule for completion

Failure to meet the time for completion due to reasons attributable to the tenderer shall entitle the Purchaser to charge liquidated damages from the Tenderer as per SBD.

11.4. In case of non achievement of approved / accepted limits, necessary adjustments, rectification and replacements of piping systems is to be carried out by the Tenderer till the requirements are fulfilled.

Plant and equipment offered shall be under absolute guarantee for the attainment of parameters during the performance guarantee test. In case of no achievement of the guaranteed parameters, the Tenderer shall be advised for necessary rectification work. Even after two such consecutive rectification works, particular equipment fails to achieve the guaranteed parameters, it shall be assumed that the plant and equipment supplied is defective in its design and shall be liable for rejection. However, Purchaser at his own discretion can accept such defective plant after levying suitable liquidated damages (LD) payable by the Tenderer.

11.5. Gas Fired Boiler

PG Test shall be carried out as per ASME PTC – 4. Following recommended performance parameters for each Boiler shall be complied with:-

A. Performance Parameters

Sl. No.	Item Description	Guaranteed Value
1	Steam delivering capability of boiler at 100% BMCR, t/h	300
2	Gross efficiency of the boiler at 100 % BMCR, %	88
	Gross efficiency of the boiler at 80 % BMCR ,%	To be decided during detail engineering
	Gross efficiency of the boiler at 60 % BMCR, %	To be decided during detail engineering
3	Total Auxiliary Power consumption at 100% BMCR while firing BFG+BOFG (as main fuel) and COG/ CBM/ Natural Gas/ LPG/ Propane (as support fuel maximum up to 10% BMCR) i) ID Fans - 2 Nos. ii) FD Fans - 2 Nos.	To be decided during detail engineering

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	iii) Scanner Air Fan - 1 No.			
4	Steam flow from final Super Heater, t/h			300
5	Rated steam Temperature at super heater outlet between 60 BMCR % to 100 % BMCR with automatic control, ^{0}C			525 ± 5
6	Rated steam Pressure at superheater outlet between 60 % BMCR to 100 % BMCR, ata			90
7	Nox and Sox emission at 100% BMCR			To be decided during detail engineering
8	Steam purity at 100% BMCR			To be decided during detail engineering
9	Fuel consumption at i) 100 % BMCR ii) 80 % BMCR iii) 60 % BMCR			To be decided during detail engineering
10	Excess air at Economizer outlet at 100% BMCR load			To be decided during detail engineering
11	Minimum load with any gas firing - BFG+BOFG - COG - CBM/ Natural Gas - LPG/ PROPANE			To be decided during detail engineering
12	Noise level i) ID Fans ii) LD Fans iii) Boiler Feed Pumps iv) Any other equipment			90 dBA
14	Steam flow from Superheater, t/h	100 % BMCR	80 % BMCR	60 % BMCR
		300	240	180
15	Superheater De-superheating spray water flow, t/h	To be decided during detail engineering		
16	Auxiliary steam flow for soot blowing, t/h	To be decided during detail engineering		
17	BF Gas consumption, Nm^3/h	To be decided during detail engineering		
	BOF Gas consumption, Nm^3/h	To be decided during detail engineering		
	Coke Oven Gas consumption, Nm^3/h	To be decided during detail engineering		
	CBM/ Natural Gas consumption, Nm^3/h	To be decided during detail engineering		
	LPG/ Propane consumption, Nm^3/h	To be decided during detail engineering		

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B. Performance Guarantee under Liquidated Damage

Sl. No.	Description	Parameters
1	Steam delivering capability of boiler at 100% BMCR, t/h	300
2	Gross efficiency of the boiler at 100% BMCR, %	88
3.	Noise level i) FD Fans ii) ID Fans	90 dBA
3	Total Auxiliary Power consumption at 100% BMCR while firing 90% Main Fuel (BFG+BOFG) and 10% Support Fuel (COG/ CBM/ Natural Gas /LPG/Propane), kW i) ID Fans - 2 Nos. ii) FD Fans - 2 Nos. iii) Scanner Air Fan - 1 No.	To be decided during detail engineering

Note: 100% BMCR means Steam flow - 300TPH, Pressure - 90 ata & Temperature - 525 ^{0}C

11.6. Steam Turbine Generator (STG)

PG Test shall be carried out as per ASME PTC – 6. Following recommended performance parameters for each STG shall be complied with:-

A. Performance Parameters

Sl. No.	Description	Parameters/ Figures
1	Inlet steam quantity at specified inlet conditions as indicated below with specified Extractions and Exhaust parameters as indicated below at rated Power output of 40 MW, t/h	To be decided during detail engineering
2	Inlet Steam Pressure, ata	85
3	Inlet Steam Temperature, ^{0}C	515±5
4	Process Extraction Quantity, t/h	91
5	Process Extraction Pressure, ata	To be decided during detail engineering
6	Process Extraction Temperature, °C	To be decided during detail engineering
7	Extraction Quantity for HP Heater, t / h	To be decided during detail engineering
8	Extraction Pressure for HP Heater, ata	To be decided during detail engineering
9	Extraction Temperature for HP Heater, ^{0}C	To be decided

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		during detail engineering
10	Extraction Quantity for Deaerator, t/h	To be decided during detail engineering
11	Extraction Pressure for Deaerator, ata	To be decided during detail engineering
12	Extraction Temperature for Deaerator, ^{0}C	To be decided during detail engineering
13	Extraction Quantity for LP Heater, t/h	To be decided during detail engineering
14	Extraction Pressure for LP Heater, ata	To be decided during detail engineering
15	Extraction Temperature for LP Heater, ^{0}C	To be decided during detail engineering
16	Exhaust Pressure, ata	To be decided during detail engineering
17	Exhaust Quantity, t/h	To be decided during detail engineering
18	CW inlet temperature, ^{0}C	To be decided during detail engineering
19	CW outlet temperature, ^{0}C	To be decided during detail engineering
20	Rated maximum continuous generation at Generator Terminal with specified inlet conditions of steam as indicated above with specified Extractions and Exhaust parameters as indicated above with 0% make-up, kW	40,000
21	Auxiliary Power Consumption, kW i) Main oil pump – 1 No. ii) Vapour Extraction Fan -1 No. iii) Condensate Extraction Pump- 1 No.	To be decided during detail engineering
21	Turbine normal speed, rpm	To be decided during detail engineering
23	Turbine trip speed, rpm	To be decided during detail engineering

B. Performance Guarantee under Liquidated Damage (without process steam extraction)

Sl. No.	Description	Parameters
1	Inlet steam quantity at specified inlet conditions with specified Extractions and Exhaust parameters as indicated above (Cl. 11.6/ A) at rated Power output of 40 MW, t/h	To be decided during detail engineering
2	Rated maximum continuous generation at Generator	40,000

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	Terminal with specified inlet conditions of steam and specified Extractions and Exhaust parameters as indicated above (CI. 11.6/ A) with 0% make-up, kW	
3.	Noise level	90 dBA
3	Total Auxiliary Power consumption (Main Oil Pump, Vapour Extraction Fan and Condensate Extraction Pump) at rated Power output (40 MW) with specified Extractions and Exhaust parameters as indicated above (CI. 11.6/ A), kW	To be decided during detail engineering

C. Performance Guarantee under Liquidated Damage (with process steam extraction)

Sl. No.	Description	Parameters
1	Inlet steam quantity at specified inlet conditions with specified Extractions and Exhaust parameters as indicated above (CI. 11.6/ A) at rated Power output of 40 MW, t/h	To be decided during detail engineering
2	Rated maximum continuous generation at Generator Terminal with specified inlet conditions of steam and specified Extractions and Exhaust parameters as indicated above (CI. 11.6/ A) with 0% make-up, kW	40,000
3	Quantity of process steam extraction at specified conditions as indicated above (CI. 11.6/ A), t/h	91
4	Noise level	90 dBA
5	Total Auxiliary Power consumption (Main Oil Pump, Vapour Extraction Fan and Condensate Extraction Pump) at rated Power output (40 MW) with specified Extractions and Exhaust parameters as indicated above (CI. 11.6/ A), kW	To be decided during detail engineering

11.7. Steam Turbine Driven Blower (STB)

PG Test shall be carried out as per ASME PTC – 6 (for Steam Turbine) and ASME PTC – 10 (for Axial Blower). Following recommended performance parameters for each STB shall be complied with:

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A. Performance Parameters

At 40^{0}C Temperature & 60% Relative Humidity

Duty Points	1	2	3	4	5	6	7	8	9
Discharge Flow, Nm^3/min	5000	5000	5000	4500	4500	4500	3500	3500	3500
Discharge Pressure, ata	6.5	6.25	5.6	6.5	6.25	5.6	6.5	6.25	5.6
Blower power requirement kW	To be decided during detail engineering								
Turbine power rating, kW (As provided but not guarantee)	To be decided during detail engineering								
Air Temperature at Blower outlet, ^{0}C	To be decided during detail engineering								
Suction Pressure of blower kg/cm^2 a	To be decided during detail engineering								
Inlet steam quantity at 85 ata pressure & 515± 5^{0}C temperature with specified Extractions and Exhaust parameters as indicated by the Tenderer, t/h	To be decided during detail engineering								
Heat Rate of turbine, kcal/Brake kWh	To be decided during detail engineering								
Operating Speed, rpm	To be decided during detail engineering								
Auxiliary Power (Main Oil Pump, Vapour Extraction Fan and Condensate Extraction Pump), kW	To be decided during detail engineering								

At 48^{0}C Temperature & 90% Relative Humidity

Duty Points	1	2	3	4	5	6	7	8	9
Discharge Flow, Nm^3/min	5000	5000	5000	4500	4500	4500	3500	3500	3500
Discharge Pressure, ata	6.5	6.25	5.6	6.5	6.25	5.6	6.5	6.25	5.6
Blower power requirement kW	To be decided during detail engineering								
Turbine power rating, kW (As provided but not guarantee)	To be decided during detail engineering								
Air Temperature at Blower	To be decided during detail engineering								

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Duty Points	1	2	3	4	5	6	7	8	9
outlet, ^{0}C									
Suction Pressure of blower kg/cm^2 a	To be decided during detail engineering								
Inlet steam quantity at 85 ata pressure & 515± 5^{0}C temperature with specified Extractions and Exhaust parameters as indicated by the Tenderer, t/h	To be decided during detail engineering								
Heat Rate of turbine, kcal/Brake kWh	To be decided during detail engineering								
Operating Speed, rpm	To be decided during detail engineering								
Auxiliary Power (Main Oil Pump, Vapour Extraction Fan and Condensate Extraction Pump), kW	To be decided during detail engineering								

At 9^{0}C Temperature & 20% Relative Humidity

Duty Points	1	2	3	4	5	6	7	8	9
Discharge Flow, Nm^3/min	5000	5000	5000	4500	4500	4500	3500	3500	3500
Discharge Pressure, ata	6.5	6.25	5.6	6.5	6.25	5.6	6.5	6.25	5.6
Blower power requirement kW	To be decided during detail engineering								
Turbine power rating, kW (As provided but not guarantee)	To be decided during detail engineering								
Air Temperature at Blower outlet, ^{0}C	To be decided during detail engineering								
Suction Pressure of blower, kg/cm^2 a	To be decided during detail engineering								
Inlet steam quantity at 85 ata pressure & 515± 5^{0}C temperature with specified Extractions and Exhaust parameters as indicated by the Tenderer, t/h	To be decided during detail engineering								
Heat Rate of turbine, kcal/Brake kWh	To be decided during detail engineering								
Operating Speed, rpm	To be decided during detail engineering								
Auxiliary Power (Main Oil Pump, Vapour Extraction	To be decided during detail engineering								

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Duty Points	1	2	3	4	5	6	7	8	9
Fan and Condensate Extraction Pump), kW									

B. Performance Guarantee under Liquidated Damage

Sl. No.	Description	Parameters
1	Air discharge flow at discharge pressure 6.5 ata (40^0C ambient & 60% RH), Nm^3/min	5000
2	Inlet steam quantity at 85 ata pressure & 515± 5^0C temperature with specified Extractions and Exhaust parameters as indicated by the Tenderer, t/h at blower discharge flow of 5000 Nm^3/min at discharge pressure 6.5 ata (40^0C ambient & 60% RH), kg/h	To be decided during detail engineering
3	Noise level	90 dBA
4	Total Auxiliary Power consumption (Main Oil Pump, Vapour Extraction Fan and Condensate Extraction Pump), at blower discharge flow of 5000 Nm^3/min at discharge pressure 6.5 ata (40^0C ambient & 60% RH), kW	To be decided during detail engineering

11.8. DM Plant

11.8.1. Preconditions for Performance Guarantee Tests for the employer:

i) Input water to DM Plant at required flow rate
ii) Quality of Input make-up water (refer clause no. 7.12 of Water System Annexure)

11.8.2. Preconditions for the Tenderer:

i) Erection, Testing and commissioning of the complete DM water plant has been completed
ii) All equipment of DM plant along with tanks, pumps, blowers, pipes, valves, supports, and other facilities has been operated.
iii) Painting of new equipment & structure has been completed.

11.8.3. Performance Guarantee Parameters

Tenderer shall have to demonstrate following parameters as listed hereunder. Plant shall be rejected beyond the guaranteed value.

Sl. No.	Description	Parameters	Guaranteed Values
1.	After activated carbon filter	Turbidity	<2 ppm
2.	After Cation Exchanger	pH	3 -4

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Sl. No.	Description	Parameters	Guaranteed Values
		Total Cations	Notgreaterthan1 ppm as $CaCO_3$
3.	After degasser	Free CO_2	< 5 ppm as CO_2
4.	After anion exchanger	pH	7.5 -9.0
		TDS	< 2 mg/1
		Conductivity	< 10 micro mho/cm at 20 degC.
		SiO_2	< 0.2 ppm as SiO_2
5.	After mixed bed units	pH	6.8 to7.2
		TDS	< 0.15 ppm as $CaCO_3$
		Conductivity	< 0.2 micro mho/cmat25^{0}C
		Silica as SiO_2	< 0.02 ppm
		Fe	< 0.01 ppm
		Hardness	Nil
		Turbidity	Nil
6.	Flow rate of DM Plant (after MB Unit)	m³/hr	175
7.	Output between regeneration (OBR)	m³/hr	Min. 3500 m³ for SAC for 20hr. cycle time Min. 3500 m³ for SBA for 20hr. cycle time Min. 31500 m³ for MB for 180hr. cycle time

11.8.4. Variance of input Conditions for PG Parameters

In the event of any variance in the input conditions w.r.t quality, quantity which has a bearing on the PG parameter, the output PG parameter shall be mutually discussed and revised as per the agreement between the employer and Tenderer, before the start of PG tests.

11.8.5. Non fulfillment of Performance Guarantee Parameters and Liquidated Damage

Sl. No.	PG Parameter	Guaranteed Values	Acceptable Limit with LD	LD in %
1	Quality of DM water	As specified in TS	No deviation	--
2	DM water capacity (Of each stream) after MB unit	175 m³/hr	175 m³/hr or more	--
3	DM water Output between regeneration (OBR)	As specified in TS	No deviation	--

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11.9. Liquidated Damage (LD) Calculation

11.9.1. Liquidated Damage (LD) for Boilers

Boilers shall be guaranteed for the output (t/h), efficiency & auxiliary power consumption (kW). Any reduction in output and efficiency and any increase in auxiliary power consumption from the guaranteed parameters shall attract the following penalty per boiler.

Sl. No.	Output (t/h): % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	99	0.2%
3.	98	0.4%
4.	97	0.6%
5.	96	0.8%
6.	95	1.0%

Sl. No.	Efficiency: % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	99.9	0.1%
3.	99.8	0.2%
4.	99.7	0.3%
5.	99.6	0.4%
6.	99.5	0.5%
7.	99.4	0.6%
8.	99.3	0.7%
9.	99.2	0.8%
10.	99.1	0.9%
11.	99	1.0%

Sl. No.	Auxiliary power consumption (kW): % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	101	0.1%
3.	102	0.2%
4.	103	0.3%
5.	104	0.4%
6.	105	0.5%
7.	106	0.6%
8.	107	0.7%
9.	108	0.8%
10.	109	0.9%
11.	110	1.0%

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11.9.2. Liquidated Damage (LD) for Steam Turbine Generators

Steam Turbine Generators shall be guaranteed for the output (MW), process steam quantity from controlled extraction, steam consumption & auxiliary power consumption.

Any reduction in rated output and quantity of process steam and any increase in auxiliary power consumption & steam consumption from the guaranteed parameters shall attract the following LD:

Sl. No.	Output (MW): % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	≥ 99 <100	0.2%
3.	≥ 98 < 99	0.4%
4.	≥ 97 < 98	0.6%
5.	≥ 96 < 97	0.8%
6.	≥ 95 < 96	1.0%

Sl. No.	Process Steam Extraction Quantity (t/h): % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	≥ 99 < 100	0.1%
3.	≥ 98 < 99	0.2%
4.	≥ 97 < 98	0.3%
5.	≥ 96 < 97	0.4%
6.	≥ 95 < 96	0.5%
7.	≥ 94 < 95	0.6%
8.	≥ 93 < 94	0.7%
9.	≥ 92 < 93	0.8%
10.	≥ 91 < 92	0.9%
11.	≥ 90 < 91	1.0%

Sl. No.	Steam Consumption (t/h): % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	> 100 ≤101	0.2%
3.	> 101 ≤ 102	0.4%
4.	> 102 ≤ 103	0.6%
5.	> 103 ≤ 104	0.8%
6.	> 104 ≤ 105	1.0%

Sl. No.	Auxiliary power consumption (kW): % of Guaranteed Value	LD (% of contract price)
1.	100	No LD
2.	> 100 ≤101	0.1%

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3.	> 101 ≤ 102	0.2%
4.	> 102 ≤ 103	0.3%
5.	> 103 ≤ 104	0.4%
6.	> 104 ≤ 105	0.5%
7.	> 105 ≤ 106	0.6%
8.	> 106 ≤ 107	0.7%
9.	> 107 ≤ 108	0.8%
10.	> 108 ≤ 109	0.9%
11.	> 109 ≤ 110	1.0%

11.9.3. Liquidated Damage (LD) for Steam Turbine Driven Blowers

Turbo Blowers shall be guaranteed for the inlet steam flow of the turbine at rated cold blast air flow & discharge pressure of blower, rated cold blast air flow at rated discharge pressure of blower and auxiliary power consumption. Any reduction of rated cold blast air flow and increase in inlet steam flow of the turbine at rated cold blast air flow & discharge pressure of blower and increase in auxiliary power consumption from the guaranteed parameters shall attract following penalty:

Sl. No.	Air Flow from Blower (Nm^3/min): % of Guaranteed Value	LD (% of contract price)
1	100	No LD
2	99	0.2%
3	98	0.4%
4	97	0.6%
5	96	0.8%
6	95	1.0%

Sl. No.	Inlet Steam Flow of Turbine (t/h): % of Guaranteed Value	LD (% of contract price)
1	100	No LD
2	101	0.2%
3	102	0.4%
4	103	0.6%
5	104	0.8%
6	105	1.0%

Sl. No.	Auxiliary Power Consumption (kW) : % of Guaranteed Value	LD (% of contract price)
1	100	No LD
2	101	0.1%
3	102	0.2%

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4	103	0.3%
5	104	0.4%
6	105	0.5%
7	106	0.6%
8	107	0.7%
9	108	0.8%
10	109	0.9%
11	110	1.0%

**** End of Clauses ****

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12. DRAWINGS / DOCUMENTS / INFORMATION TO BE SUBMITTED ALONG WITH THE TENDER

12.1. Technological

i) Layout showing locations of all the equipment and cross sectional view of each major equipment including dimensions.

ii) System scheme & process flow diagram and P & I diagram of the steam, feed water, condensate, Fuel gas systems, nitrogen, cooling water systems, lube oil systems, air & exhaust gas including that of chimney using ISA symbol.

iii) Descriptive information, catalogues, drawings etc. of all equipment offered under these specification and pertinent engineering data as per Technical particulars so that Purchaser/ Consultant may have full and complete knowledge/assessment of equipment offered.

iv) A detailed experience list about supply and execution of similar type of plant by the Tenderer.

v) A comprehensive write up or brochures on details of manufacture and testing facilities and quality control procedures in the shops of the manufacturer/supplier.

vi) Layout of various services pipelines, cabling, power supply distribution, etc. indicating terminal points.

vii) Technical particulars duly filled-up as per Chapter-15**.**

viii) List of O&M spare parts for two years of operation as per SBD.

ix) List of commissioning spares as per SBD.

x) List of tools and tackles for repair and maintenance.

xi) Schedule of submission of drawings for Purchaser's/ Consultant’s approval.

xii) Schedule of design, manufacture, shop testing and delivery at site.

12.2. Electrics

i) Detailed scope of work with general description of the system & equipment offered specifying the important features and design philosophy
ii) Key Single line diagram
iii) Equipment layout
iv) Bill of Quantities (un-priced) in a specific format, with division list of supplies from foreign and indigenous sources.
v) Specific exclusions, if any, from scope of work in a specific chapter.

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vi) List of deviations from technical specifications in a specific chapter.

vii) Equipment wise List of commissioning spares and consumables with item wise description and quantity included in the main offer.

viii) List of 2 years operation spares, recommended by the bidder equipment wise (un-priced), in addition to the spares asked by the purchaser, if any. The list shall indicate description and quantity for each item.

ix) List of special tools and tackles, test jigs and special instruments required for operation and maintenance of equipment. For all other electrical equipment, individual list of special tools and accessories required is to be furnished for each item.

x) Work Schedule with bar chart indicating all activities for electrics of boiler, generator, blower, GIS and other equipment/items.

xi) Phase-wise construction power requirements for erection / testing activities. .

xii) Quantity, rating/capacity of UPS & DC system offered

xiii) Dimensional details & weights of each equipment offered (approximate)

xiv) Reference list of similar jobs carried out

xv) List of HT motors with ratings (working+stand-by)

xvi) Number, name and details of HT & LT switchboard, MCCs/DBs considered

xvii) List of LT drives with kW rating (working+stand by).

xviii) Connected load and Maximum demand of each section of switchboard/MCC.

xix) Type test certificates for major categories of equipment, issued by independent testing authority.

xx) Technical catalogues of major equipment offered.

xxi) Services to be provided by owner at battery limit with specification

xxii) Capacity of DG sets and number and name of panels proposed.

12.3. Control & Instrumentation

i) Filled-in questionnaire for Instrumentation, control & DDCMIS based automation system.

ii) Tentative BOQ for Instrumentation, control & DDCMIS based automation system, which are to be considered under erection package.

iii) System configuration diagram for DDCMIS based automation system.

iv) Tentative power consumption (UPS & non-UPS) for instrumentation, control & DDCMIS based automation system.

v) Tentative instrument air, compressed air & Nitrogen consumption (as applicable) for instrumentation & control equipment.

vi) List of deviation if any w.r.t Instrumentation, control DDCMIS based Automation system, indicating clause no. along with details.

vii) List of exclusion if any w.r.t Instrumentation, control &DDCMIS based Automation system, indicating clause no. along with details.

**** End of Clauses ****

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13. DRAWINGS/ DOCUMENTS TO BE SUBMITTED BY THE TENDERER AFTER PLACEMENT OF ORDER

13.1. General

13.1.1. The Tenderer shall furnish a comprehensive programme of submission of drawings for Purchaser's approval. Submission of drawings shall commence within two weeks after placement of order and shall be completed keeping in view the overall completion schedule of the project.

13.1.2. The Tenderer shall submit requisite number of sets of all the drawings, documents, performance curves and manuals for Purchaser's approval, records and use. After erection of equipment the Tenderer shall submit all final and as-built drawings.

13.1.3. All civil and structural work (except the technological structures of the equipment) including civil foundation shall be arranged by the Purchaser. However, all feedback design data / drawings for the equipment supplied, loading both static as well as dynamic, outline drawings, details of embedment, assignment, etc. shall be furnished by the Tenderer for this package for design of the stated civil and structural works (except the technological structures of the equipment) as well as foundations by the Purchaser.

13.1.4. The Tenderer shall observe strict logical sequence in submission of drawings for Purchaser's approval. The drawings shall be fully dimensioned and complete to the extent that may facilitate Purchaser's approval in conjunction with other drawings submitted earlier by the Tenderer. Each set of drawings submitted for approval shall be accompanied by detailed bill of materials giving quantity, material specification, unit and total weights and applicable standard code in respect of each item.

13.1.5. Shop test certificates, test reports and curves for various pumps, motors and equipment shall be submitted for approval before clearance for despatch of equipment.

13.2. Submission of Drawings

Submission of following drawings/ documents shall be commenced in soft form (PDF) within four weeks from the date of placement of order for Purchaser's approval/ information/ further working.

13.2.2. Technological

13.2.2.1. Drawings / documents for approval

a) List of drawings with schedule of submission (Technological, Mechanical, Electrical, Instrument & Control, etc.) within four (04) weeks from the date of placement of order.

b) QC & QA plan.

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c) Equipment and piping layout drawing showing the location of Plant & equipment & its auxiliaries, pipelines, ducts, trenches, etc. (plan and cross section).

d) G.A. and Cross Sectional drawings of all equipment indicating weights, material of construction, bill of material, dimension, specification, etc.

e) Piping layout drawing indicating support location and load data.

f) Flexibility analysis of pipelines with isometric drawings as applicable.

g) Schedule and Specification of pipes, valves, pipe fittings, thermal insulation, etc.

h) Final design calculations and assumptions.

i) Actual performance data based on the testing at site.

j) Technical specifications of major Plant & equipment and all other accessories.

k) P & I diagrams of Steam, Feed Water, flue gas system, nitrogen, lube oil, cooling system with scheme and process flow diagram indicating battery limits.

l) Characteristics curves of all the equipment.

m) Final list of drawings.

n) As built drawings.

13.2.2.2. Technical document for Reference / Information

a) Equipment foundation plan with anchor bolt details, load data (static & dynamic) of all equipment indicating cable trench, pipe trench, conduits, inserts, cable entries to alternator, motors, field devices etc.

b) Technical literature and catalogue of bought out items.

c) Drive list

d) List of special tools & tackles to be supplied

e) Test certificates.

- Material test certificates of all equipment & their components
- Hydrostatic test certificate of valves, pipes, shells, fittings, etc.
- Static and dynamic balancing of all rotor parts / equipment as applicable.
- Shop test performance data of Plant & Equipment, etc.

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f) Part number and description of all spare parts.

g) Installation, operation & maintenance manual.

h) Reproducible of all final drawings.

i) Total list of all equipment with dispatch schedule.

j) All other relevant drawings / documents / certificates not specifically mentioned above but deemed essential for successful functioning of the equipment.

13.2.2.3. Submission of Operation & Maintenance Instruction Manuals

The Tenderer shall furnish operation and maintenance instruction manuals meeting the following requirements:

a) Instruction manuals shall present the following basic categories of information in practical, complete and comprehensive manner prepared for use by operating and/or maintenance personnel.

- Instruction for initial installation
- Instructions for operation, maintenance, repair and safety regulations.
- Ordering information for all replaceable parts.
- Lubrication chart.
- Recommended inspection points/ areas and period of inspection.

b) Information shall be organized in a logical and orderly sequence. A general description of all systems and equipment including detailed drawings identifying parts / items and significant technical characteristics shall be included to familiarize operating and maintenance personnel with the equipment.

c) A parts list shall be included showing nomenclature, manufacturer's part numbers and/ identification and ordering of replaceable parts.

d) Instruction and parts list shall be clearly legible and prepared on good quality paper. Instruction manuals shall be securely bound in durable folder.

e) If a standard manual is furnished covering more than the specific equipment purchased, the applicable model(or other identification) number, parts number and other information for the specific equipment purchased shall be clearly identified.

f) Instruction manuals shall include list of all special tools and tackles furnished with

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complete drawings and instructions for use of such tools and tackles.

13.2.3. Water System

13.2.3.1. Drawings / documents to be furnished by the Tenderer for approval

i) Scheme of the complete water supply system with descriptive and illustrative literature.

ii) Process flow diagram indicating the water consumption figures complete with temperature, pressure and quality requirements.

iii) P&IDs of each circuit of the complete water supply system showing all the consumers, flow rate, pipe diameters, broad parameters of each equipment, instruments, alarms & interlocks functions using ISA symbols, water losses etc.

iv) Write -up detailing the control logic for the entire water system.

v) Pipeline materials and specifications considered for various systems.

vi) All equipment and piping sizing calculations.

vii) Layout drawing showing the battery limits of make –up water, drinking water, fire fighting water and the pipeline route to various consumers including requirement of make-up water, drinking water, fire fighting water and construction water at battery limits.

viii) General arrangement and cross-sectional drawings, characteristics curves and technical details of all the equipments (pumps, strainers, cooling tower & its components, valves, expansion joints, conditioning chemicals, sluice gates, on line automatic filter, side stream filter, fire hydrants, etc.), valves and piping including GA drawings showing plan, elevation and sectional views of the water system units and installations.

ix) Data, Drawing and Information for DM Plant shall be submitted in line with clause no. 8.15.02, page 76-77 of 238.General arrangement and cross-sectional drawings of DM plant, design calculation, characteristics curves and technical details of all the equipments valves and piping.

x) GA drawings of all equipments and valves.

xi) Layout of piping system-indicating pipe routing, location of supports, valves and other fittings as required.

xii) General arrangement drawings of pump houses and sump / tank (including civil, structural and other facilities) showing dispositions of various equipment and piping.

xiii) General arrangement drawings, sectional views, of cooling towers indicating the

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schematic view, detail view, basin details, cold-water outlet, sludge disposal arrangement etc.

xiv) Equipment drawings for cooling tower components viz- fan, gearbox, motor, shaft, spray nozzles, drift eliminators, hot water piping, fill arrangement etc. and predicted performance curves of the cooling tower along with selection criterion of cooling tower vis-à-vis heat load.

xv) GA drawings, data sheets, characteristic curves and technical details of all the equipments, valves and piping.

xvi) List of safety interlocks.

xvii) Test procedures for preliminary and final acceptance tests.

xviii) Quality Assurance Plan.

xix) GA drawings and details of air conditioning & ventilation facilities.

xx) List of special tools and tackles.

xxi) List of commissioning spares.

xxii) List of spares for two years of normal operation and maintenance with item wise prices.

xxiii) Any other drawing/ documents as required by the Purchaser / Consultant.

13.2.3.2. Drawings / documents to be furnished by the Tenderer for reference and record

i) The Tenderer shall submit required sets of all the approved drawings, documents and manuals for Purchaser's/ Consultant's record and use. After erection of equipment, the Tenderer shall submit one set of linen tracings/ reproducible in required number of prints along with soft copies in CD (in AutoCAD format) of each "As built drawings".

ii) Operating and maintenance manual.

iii) Spare parts recommendation and price list.

iv) Instruction for erection, testing and commissioning.

v) Manufacturer's test certificates.

vi) Lubrication schedule, quantity, and quality of lubricant for one year's normal operation.

vii) Various equipment assembly drawings and bill of material.

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viii) Catalogues, literatures of all equipments and valves.

ix) List of instruments comprising bill of materials and instrumentation data sheets.

x) Welding procedure.

xi) Hydraulic test logs.

xii) Characteristics curves of the pumps, motors and other equipments.

xiii) Bill of Quantities covering all equipments, valves, strainers, pipelines, etc. and associated civil, structural, electrics, instrumentation, handling & hoisting facilities, air conditioning and ventilation facilities etc.

xiv) Test certificates for the following:

- Material test certificate for all major equipment and their components.
- Hydraulic test of equipment, pipefittings & valves.
- Static and dynamic balancing of all rotary parts/ equipments.

xv) Operation and maintenance manuals for all equipments, valves and complete water system along with soft copies.

xvi) Test and calibration certificates.

xvii) Warranty/ guarantee certificates.

xviii) Technical literature, catalogues and manufacturer's drawings for all brought out equipment, valves and other items.

xix) All inspection/ test report/ certificates.

xx) Any other drawing / documents as required by the Purchaser/Consultant.

13.2.4. Air Conditioning and Ventilation System

The drawings / documents given below shall be suitably complemented / supplemented by Succesful tenderer as per the requirement. Succesful tenderer shall furnish a list of drawings with schedule of submission. The Succesful tenderer shall furnish any civil assignment drawing to purchaser within the given time period. The drawings shall be revised based on comments and finalized. All drawings shall be submitted in editable auto-cad version.

13.2.4.1. List of following Drawings minimum for approval

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a) Technological ACVS Drawings

i) List of drawings.
ii) Civil assignment drawing of air conditioning system / Ventilation system.
iii) Overall system layout of each air conditioning System/ Ventilation system in plan & section.
iv) Ventilation system ducting network (wherever applicable) layout of individual premises in plan and section.
v) GA of all equipment of air conditioning and ventilation systems such as Split AC, ventilation fans, filter, air intake louver, MCC.
vi) GA of any other equipment considered.
vii) Drive list.
viii) Design heat load calculation of Air conditioning and ventilation System capacity in editable soft copy.

Notes:

i) The above list is indicative and minimum. The Succesful tenderer shall furnish any other drawings & documents which may become necessary or required by Purchaser/ Consultant
ii) All drawings & documents shall be submitted with approved title block and drawing-numbering system as per standard format handed over to the Succesful tenderer.
iii) Soft copy of approved vendor drawings shall be provided by successful Tenderer to MECON.

b) Technological data and drawings

- General arrangement drawings along with cross sections of all the equipment indicating overall dimensions complete technical parameters with all accessories and bill of material and material specification.
- Ducting layout drawings with sections and all details.
- Detailed design calculation for selection of different equipment with capacity & pressure balance calculation for arriving at selected head etc.

c) Schedules

- Schedule of manufacturer/ procurement of equipment and materials.
- Schedule of inspection at manufacturer's works.
- Schedule of supplies of equipment and materials.
- Schedule of erection.

13.2.4.2. To be submitted During Inspection / Dispatch of Equipment

- Manufacturer's test certificates for all equipment including fan, AHU, motors, instrument, etc.

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- Type test certificates and performance record at works for fans, AHU,etc.
- Description of equipment and technical leaflets.
- Operation, maintenance and service manuals.
- Assembly and erection instructions.

13.2.4.3. To be submitted Before Handing over of The Plants/ Systems:

- 'AS-BUILT' drawing incorporating all changes / modifications done during erection & commissioning and FAT.
- Any other relevant final document.

13.2.5. Electrical

13.2.5.1. General

i) Name of co-ordinators with address, telephone/Fax numbers for all sub-bidders, pertaining to electrical job.
ii) List of equipment/tools and manpower proposed to be arranged for installation / erection supervision and site handling of the equipment.
iii) Detailed list of drawings and documents to be submitted indicating Reference/Approval category

13.2.5.2. For Approval

Calculations

i) Sizing of all equipment within 4 weeks of placement of order
ii) Calculations for voltage drop and short time rating of cables
iii) Relay settings with calculations and protection coordination charts.
iv) Calculations for lux level of illumination for various premises/area of the plant
v) Sizing/Capacity calculation of UPS
vi) Sizing/Capacity calculation of Battery and charger
vii) Calculation w.r.t. generator busduct sizing, temp rise and insulator spacing
viii) Calculations for short time withstand of transformers.
ix) Design calculation and assumptions for DG set

Drawings and Documents

a) Single line diagram indicating all electrical equipment like, breaker CT, meters, cable sizes, details of CT ratio, VA burden V_k value, type and nominal and short time ratings of breakers, busbars etc. for complete network (composite drawing).
b) Single line diagram of 33kV GIS, 6.6kV Switchboard, PMCC, MCC/DB, etc indicating all equipment such as circuit breakers, CT, PT, relay, meters, drive, feeder details, protection, metering and control elements etc. along with ratings.
c) GA of 33kV GIS, 6.6kV Switchboard, PMCC, MCC/DB.
d) Guaranteed Technical Particulars of all Switchboards & Electrical equipments.

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e) Control schematics with all interlocks and bill of materials.
f) Foundation plan and fixing details for each equipment
g) Type test reports for short ckt, temp. rise, enclosure class etc.
h) Generator busducts layout drawing.
i) Equipment Layout drawing for all areas within battery limit.
j) Cable routing diagram and Cable tray layout
k) GA & foundation drawing for each Power transformers
l) Technical data sheets for each Power transformer
m) Data sheets and characteristic curves of all equipment.
n) Front view and GA diagrams for all Control panel, LDB/SLDB, PDB, ACDB, DCDB, aux. ACDB and aux. DCDB.
o) Control schematics for annunciation points, fan cooling system, OLTC operation for Power Transformers.
p) Earthing layout drawing covering external grid internal/external rings and connections to equipment, structures etc.
q) Sequence of annunciator and list of annunciation points for the control panel.
r) Lighting layout for each of switchyard and plant outdoor areas, type of fittings, wiring arrangement, switching of fittings and single line diagram.
s) List of electrical inputs/outputs to/from DDCMIS
t) List of performance tests proposed by the bidder to demonstrate the guaranteed parameters.
u) Cable schedule, Cable interconnection diagram
v) Terminal plan of all feeders of MCCs/DBs
w) Quality Assurance plan for each equipment
x) Termination arrangement of bus duct
y) Switchboard/MCC wise drive list
z) Data sheets and characteristic curves of all equipment.
aa) Control and schematics drgs. for local/remote control/ protection for each equipment and drives.
bb) Plant Operational philosophy
cc) Logic diagrams for start/stop of various HT & LT drives/Equipment.
dd) Interlocking schemes
ee) Details of protection logic (various class tripping) indicating list of electrical and mechanical protection leading to tripping of switching devices/equipment.
ff) Synchronisation schemes
gg) Battery and charger schemes.
hh) Layout of electrical premises/electrical rooms/control rooms and bus ducts.
ii) Earthing layout drawing covering external grid internal/external rings and connections to equipment, structures etc.
jj) Generator auxiliaries P&I diagrams
kk) Auto change over arrangement for HT/LT switchboard/MCCs
ll) Sequence of annunciation and list of annunciation points for all the panels/desk of each areas.
mm) Technical data sheet for each equipment
nn) Complete schematic diagram of UPS systems
oo) Complete schematic diagram of DC systems

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pp) Complete schematic diagrams of electrical actuators
qq) Complete protection scheme for the unit
rr) Complete annunciations scheme for the unit
ss) Complete GA drawings, schematic drawings, wiring diagram and drawing of each and every components of excitation system
tt) GA drg of DG sets and other panels and DG board
uu) Technical specification of generator and other electrical equipment of DG set

13.2.5.3. For Information (Within 4 weeks of order placement)

i) Exact dimensional details and weights of each and every equipment
ii) Static & dynamic loading of each equipment, Flange details of Bus duct termination

During detailed engineering

i) Foundation details of 33kV GIS & all switchboards
ii) Section plan of the panels 33kV GIS & all switchboards
iii) Control and schematic diagram for all the feeders of 33kV GIS & all switchboards
iv) Panel wise schedule of material indicating type, make and brief tech. particulars of all items/ accessories mounted on the panels of 33kV GIS & all switchboards
v) Busbar sizing calculation along with short circuit Thermal and mechanical withstand calculation and insulator sizing as per short circuit calculation of 33kV GIS & all switchboards
vi) Details of painting for all equipment
vii) Bus wire arrangement for control/signal/annunciation control panels/switch boards/Local Control device/ I/O panels.
viii) Cable schedule indicating type of cables, from to via. route, total length, size of each cable and a final summary sheet indicating total requirement of all types of cables (for control, instrumentation). Core-wise control cable termination details indicating ferrule no./terminal block no. for each cable / each equipment.
ix) Internal wiring diagrams for all panels.
x) Catalogues for each type of equipment like transformers, control panels, relays, meters etc.
xi) VI characteristics of and RCT value of CTs used in differential protection
xii) Type test certificates for all the equipment.
xiii) Operation and maintenance manuals indicating trouble-shooting procedure for all equipment.
xiv) Spare part list number and ordering procedure for all recommended spares.
xv) As built drawings incorporating site changes along with reproducible as well as in electronic form in CDROM/DVDROM.
xvi) All the type test certificates, routine test certificates and site test results bound separately in requisite copies.

Instruction Manuals

Minimum ten copies of Instruction manual shall be furnished by the bidder in addition to

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soft copy in CDROMs/DVDROMs.

Instruction manual shall give step by step procedure for:

i) Erection, testing and commissioning
ii) Operation
iii) Maintenance and
iv) Repair.

Operation & Maintenance Manuals/ instruction shall include:

i) Diagnostic trouble shooting / fault location charts
ii) Tests for checking of proper functioning.

Instruction manual shall also contain:

i) Manufacturer's catalogues with ordering specification for all items.
ii) List of consumables with specifications, brand names and annual consumption figures.
iii) Drawings relevant for erection, operation, maintenance and repair of the equipment.
iv) Procedure for erection, storage, welding technique, material for construction, instrumentation, limits and tolerances, alignment, structures etc.
v) Procedure for ordering spares.
vi) Operation and maintenance manual.
vii) Quality manual covering quality related aspects and As Built Status.
viii) List of spares supplied with individual equipment
ix) As built drawings incorporating all changes till handing over the installation to the Owner.

13.2.5.4. DG Set (Electrics)

a) Datasheet of generator and their control, protection, metering, interlocking, synchronisation and annunciation systems
b) G.A. drawing of D.G. set and auxiliaries.
c) Dimensional layout and sectional drawings for the complete scope of work
d) GA / Facia diagram of control panel, local control boxes, push button starter etc with complete dimension and weight.
e) Bill of Material / Schedule of complete equipment/devices.
f) Single line diagram, power and control schematics complete with rating, metering, protection and annunciation circuit diagrams.
g) Terminal wiring and external cable connection diagrams
h) A brief write-up giving description of control and annunciation scheme and safety interlocks.
i) I/O list for all interfacing signals to/from DG and their termination details
j) Generator curves and characteristics
   i) O.C. & S.C. characteristics
   ii) 'V' curves

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iii) Capability curves
iv) Generator transient and sub-transient reactance
v) Generator losses: fixed and variables.
vi) Communication non-interference test curves.
vii) All other necessary curves for the generator, exciter, AVR and auxiliaries.

k) Layout and mounting arrangement of battery
l) Battery sizing calculation
m) Type and Routine Test certificates
n) Catalogues for all electrical equipment
o) Detailed instruction manuals for equipment supplied presenting the following basic categories of information in a comprehensive manner, shall be submitted for approval of authority in the same fashion as that for other drawings.

i) Instruction for erection.
ii) Instruction for pre-commissioning check-up, operation
iii) Write-up on controls and interlocks provided.
iv) Recommended inspection points and periods of inspection
v) Schedule of preventive maintenance.
vi) Quality Assurance Plan
vii) In addition to the above drawings/documents, any other information deemed necessary during detailed engineering shall also be furnished.
viii) The drawings and data are subject to approval of Purchaser/ Consultant prior to manufacture.

13.2.6. Control & Instrumentation

13.2.6.1. For Approval

Instrumentation & Control system

i) Process and instrumentation (P & I) diagram indicating all local & remote measurements, alarms and interlock functions.
ii) Detailed specification datasheet for each instrumentation item, incorporating all the details indicated in specification data sheets (included in this TS), process parameters and vendor specific data (eg. Make, model no., etc.).
iii) Fabrication/assembly drawings of Flow sensors.
iv) List of Instruments indicating tag no., quantity, service details, location, range, signal output, process conn., make, model no., etc.
v) Single line power supply diagram (UPS & non-UPS) and bill of quantities of electrical accessories.
vi) Overall General arrangement drawings & sectional views of instrumentation panels, showing internal disposition of all components/ units, with dimensional details and bill of materials.
vii) List of commissioning spares (indicating make & model no. of each instruments &

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accessories).

DDCMIS based Automation system

i) System configuration diagram for the automation system along with its peripherals.

ii) Bill of Materials for automation system hardware & IT components.

iii) List of software (i.e. application software, operating system software, HMI software, engineering software, database software, anti-virus software, etc. and number of licenses with validity (as applicable) for each type of software).

iv) Data Sheets of DDCMIS hardware (i.e. Processors, each type of I/O modules, Communication modules, Power supply modules, etc. as applicable).

v) Data Sheets of all the IT components and accessories (eg. Operator stations, Eng Stations, Servers, Ethernet switches, Large display unit, printers, printer cum scanners, Bus cables, Bulk power supply unit with redundancy module, RLM, OLM, etc. as applicable).

vi) Overall General arrangement drawings & sectional views of various cabinets, consoles, etc., showing internal disposition of all components/ units, with dimensional details.

vii) Bill of materials for each DDCMIS cabinets.

viii) Single line power supply diagram (UPS, non-UPS & 24 VDC) and bill of quantities of electrical accessories for automation system.

ix) Control room layout drawing showing disposition of panels, consoles, desks, etc. with dimensional details.

x) Factory Acceptance Test procedure for DDCMIS based automation system.

xi) List of commissioning spares (indicating make & model no. of each module & accessories).

13.2.6.2. For Scrutiny and Reference

Instrumentation & Control system

i) Design data, sizing calculation & selection criteria along with all related charts, curves, tables of control valves & actuators.

ii) Sizing calculation of all types of Flow elements.

iii) Sizing calculation along with flow vs pressure loss & accuracy curve for all types of flow meter.

iv) GA drawings for all field instruments.

v) Instrument Installation/ Hook up diagrams with bill of materials.

vi) Instrument air distribution scheme with BOQ, as applicable.

vii) Loop schematic drawings.

viii) Cable schedules (separately for signal cable, control cable & power cable).

ix) Instrument & JB/local panel location drawing (showing location of each field instruments and considering manufacturer's guideline for straight pipe length requirement for online instruments).

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x) Tray and Cable layout drawing (from field to JBs/panels and from JBs to panels/ marshalling racks/cabinets).

xi) Wiring and termination diagrams (with details of termination of field signals to local JBs/ panels and from JBs to panels/ marshalling racks/ cabinets).

xii) List of 2 years operation & maintenance spares indicating make & model no. of each instruments & accessories. For accessories (eg. Fittings & valves), for which model no. will not be available, brief specification (eg. size, rating, etc.) shall be mentioned for those. Separate list shall be submitted for indigenous supply and for foreign supply items. For foreign supply items, for which data sheet approval will not be taken, for those items the list shall also include brief specification (eg. make, model no., range, set point, connection size, rating, etc.) of each instruments. The list shall also include all machine mounted instruments.

xiii) Manufacturer's test, calibration and guarantee certificates for all instrumentation &control equipment as per approved QAP.

DDCMISbased Automation system

i) Input/ Output list.

ii) Terminal diagram of all the RI/O & Marshalling panels, showing connection between I/O card and input field cable termination point.

iii) System grounding scheme.

iv) Earth pit sizing calculation & GA drawing.

v) HMI Graphic display (of overview, groups covering all the units as per P&ID, loops, alarms, operator's guide messages, real time & historical trends, etc.)

vi) HMI Graphic display for different production reports (shift wise, day wise, monthly & yearly).

vii) Internal Test report and guarantee certificates for all automation equipment as per approved FAT document/QAP.

viii) Application software details in documentation and CDs.

ix) List of 2 years operation & maintenance spares indicating make & model no. of each DDCMISmodules, IT components & electrical accessories. For electrical accessories (eg. MCB, TBs, etc.), for which model no. will not be available, brief specification (eg. rating, etc.) shall be mentioned for those. Separate list shall be submitted for indigenous supply and for foreign supply items.

13.2.6.3. Manuals & Documents for Record

i) Detailed technical literature/ catalogue for each instrumentation & control and automation equipment with peripherals, highlighting the selected model numbers.

ii) "As-built" documentation (for sl. no. 5 under approval category of Instrumentation & Control system, for sl. nos. 8 & 9 under approval category of DDCMIS based automation system, for sl. nos. 7-11 under scrutiny & reference category of Instrumentation & Control system, for sl. nos. 1, 3 under scrutiny & reference category of DDCMIS based automation system).

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iii) Soft copy of all the drawings & documents included in Pen drive/CDs/ DVDs after approval/ clearance.

13.2.6.4. Drawings & Documents to be forwarded with Supply of equipment

Copy of following drawings & documents shall be forwarded along with each consignment:

i) Packing list, which shall list out all the equipment dispatched.

ii) Inspection certificate/ inspection waiver certificate.

iii) Dispatch clearance certificate

iv) Operation & maintenance manuals of respective instrumentation, control and DDCMISbased automation equipment.

v) Approved data sheet of respective instruments & control equipment.

vi) Approved schematic diagram & BOQ for any system (eg. Analyzer) along with dispatch of respective system.

vii) Approved configuration diagram & BOQ for DDCMIS based automation system along with dispatch of DDCMIS based system.

viii) Test & calibration certificates.

ix) Guarantee certificates

x) Any other document mentioned in approved QAP/ TS.

**** End of Clauses ****

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14. LIST OF PREFERRED MAKES

Makes of the plant & equipment envisaged under this package shall be as per the "LIST OF ACCEPTABLE MAKES OF EQUIPMENT & SUPPLIES" attached as Annexure with the Technical Specification.

**** End of Clauses ****

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ANNEXURE - I

सेल SAIL CET

Experience that delivers

LIST OF ACCEPTABLE MAKES OF EQUIPMENT & SUPPLIES

(Indigenous Supplies Only)



FEBRUARY 2024

PREAMBLE

This document "ACCEPTABLE MAKES OF EQUIPMENT AND SUPPLIES" is for indigenous supplies/ bought out items only and is a part of the tender specification for various packages.

The "makes" of various equipment and supplies are listed out in this document. It is essential that the equipment/ component/ materials to be supplied indigenously by the bidder will be of any one of the makes listed against that particular equipment/ component/ material in this document as further detailed subsequently.



CATEGORY 'A' ITEMS

These are critical equipment and items. Contractor/ bidder to ensure that items listed under this category shall be supplied only from the makes listed.

In exceptional cases, if only two or less makes out of the listed makes for a particular equipment/ item are available to the bidder/ contractor for supply then additional makes can be proposed. However, bidder/ contractor shall establish the non-availability of the listed makes. Additional makes proposed by bidder/ contractor shall be approved subject to fulfilling the acceptance criteria stipulated alongside.



ACCEPTANCE CRITERIA

- Vendor shall have established Quality Management System certified as per ISO-9001 or equivalent
- Vendor should have installed/ supplied at least any of the following within last 7 years for the item(s):

  Either at least 2 reference in any of the SAIL plants/ RINL

  Or at least 3 references in any of the private Integrated Steel Plants

  Or at least 3 references in Maharatna Public Sector Undertakings/ Navratna Public Sector Undertakings/ Listed Indian companies (excluding financial institutions) having turnover in excess of ₹5000 crores in last financial year.

  Copy of purchase orders along with satisfactory performance certificate/ inspection certificates for the above references shall be provided from the clients
- Self-declaration from vendor that the company is not blacklisted in any SAIL plants or PSUs



CATEGORY 'B' ITEMS

These equipment/ items are for general purpose. Bidder may suggest additional makes, if any, during tendering stage with credentials to fulfil the acceptance criteria stipulated alongside.

In case of non-availability of listed makes during implementation, procedure listed under category A will apply.



ACCEPTANCE CRITERIA

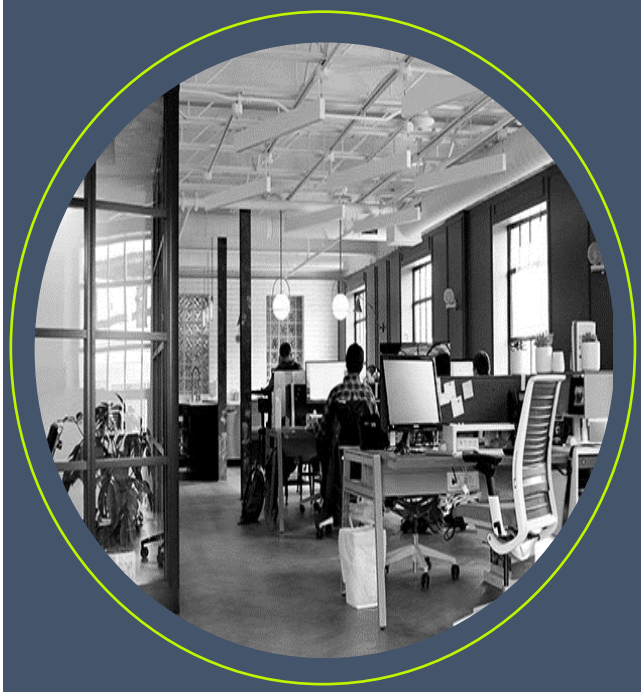
- Vendor shall have established Quality Management System certified as per ISO-9001 or equivalent
- Vendor should have installed/ supplied at least any of the following within last 7 years for the item(s):

  Either at least 2 references in any of the SAIL plants /RINL

  Or at least 3 references in any of the private Integrated Steel Plants

  Or at least 3 references in Maharatna Public Sector Undertakings/ Navratna Public Sector Undertakings/ Listed Indian companies (excluding financial institutions) having turnover in excess of ₹5000 crores in last financial year.

  Copy of purchase orders along with satisfactory performance certificate/ inspection certificates for the above references shall be provided from the clients
- Self-declaration from vendor that the company is not blacklisted in any SAIL plants or PSUs

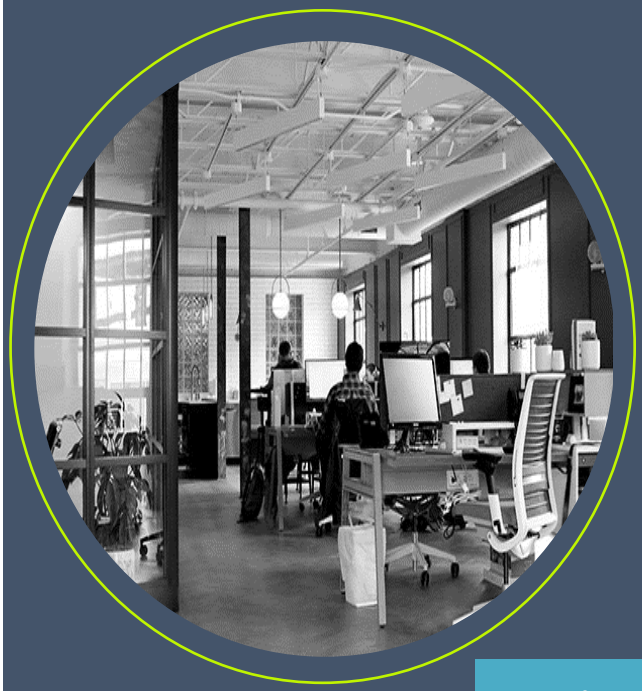


Note: *The above categorization has been given for ease of project management. However, in exceptional cases, empowered committee of the plant may approve additional makes.*

Other Items not listed

Contractor may supply any other item not mentioned in this list from any make.

- Self-declaration from vendor is required that the company is not blacklisted in any SAIL plants or PSUs



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SECTION-A

ELECTRICAL

S No.	ITEMS	CATEGORY	MAKE
1.	**132 kV & ABOVE EQUIPMENT**		
1.1.	132 kV/ 220 kV Gas Insulated Switchgear	**A**	**CG POWER & INDUSTRIAL SOLUTIONS LTD, GE T&D, HITACHI ENERGY INDIA LIMITED, HYOSUNG T&D INDIA PRIVATE LIMITED, SIEMENS**
1.2.	132kV/ 220 kV outdoor Isolator/ Disconnecting Switch	**A**	**CG POWER & INDUSTRIAL SOLUTIONS LTD, GR POWER, HITACHI ENERGY INDIA LIMITED, RAYCHEM, SIEMENS, SWITCHGEAR & STRUCTURALS, ELPRO**
1.3.	132kV/ 220 kV outdoor Circuit Breaker	**A**	**BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, GE T&D, HITACHI ENERGY INDIA LIMITED, SIEMENS**
1.4.	132kV/ 220 kV outdoor CT/ PT/CVT	**A**	**BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, GE T&D, HITACHI ENERGY INDIA LIMITED, MEHRU, SIEMENS, TELK**
1.5.	132kV/ 220 kV outdoor Lightning Arrestor	**A**	**BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, ELPRO, OBLUM, RAYCHEM**
1.6.	132kV/ 220 kV cable XLPE	**A**	**CCI (Cable Corporation of India), KEC, KEI, UNIVERSAL**
1.7.	132kV/ 220 kV outdoor Insulator & Bushing	**B**	**ADITYA BIRLA INSULATORS, BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, CJI, JAYSHREE INSULATORS, MODERN, OBLUM, WSI**
1.8.	ACSR Conductor for 132kV/ 220 kV Transmission Line	**B**	**APAR, CABCON, STERLITE**
2.	**33kV EQUIPMENT**		
2.1.	33 kV Indoor Switchgear	**A**	**ABB, SCHNEIDER, SIEMENS**

S No.	ITEMS	CATEGORY	MAKE
2.2.	33 kV Gas Insulated Switchgear	**A**	**ABB, SCHNEIDER, SIEMENS,**
2.3.	33kV outdoor Isolator/ Disconnecting Switch	**A**	**ABB POWER PRODUCTS & SYSTEMS INDIA LIMITED, CG POWER & INDUSTRIAL SOLUTIONS LTD, GR POWER, RAYCHEM, SCHNEIDER, SIEMENS, SWITCHGEAR & STRUCTURALS, ELPRO**
2.4.	33kV outdoor Circuit Breaker	**A**	**ABB, BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, SCHNEIDER, SIEMENS**
2.5.	33kV outdoor CT/ PT	**A**	**BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, ECS, MEHRU, TELK**
2.6.	33kV outdoor Lightning Arrestor	**A**	**BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, ELPRO, OBLUM, RAYCHEM**
2.7.	33kV outdoor Insulator & Bushing	**B**	**ADITYA BIRLA INSULATORS, BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, CJI, JAYSHREE INSULATORS, MODERN, OBLUM, WSI**
2.8.	ACSR Conductor for 33kV transmission line	**B**	**APAR, CABCON, STERLITE, GUPTA POWER**
3.	**MEDIUM VOLTAGE – INDOOR (3.3 kV to 11kV)**		
3.1.	Switchgear (Circuit Breaker with panels)	**A**	**ABB, BHEL, L&T, SCHNEIDER, SIEMENS**
3.2.	Vacuum Contactor	**A**	**ABB, ANDREW YULE, BHEL, JYOTI, SCHNEIDER, SIEMENS, L&T**
3.3.	CT & PT	**B**	**AEL, JYOTI, KALPA, KAPPA, PRAGATI, PRAYOG, ECS, SCHNEIDER**
3.4.	Isolator	**B**	**ABB, A BONDSTRAND, MEGAWIN, PANICKKERSWITCHGEAR PVT. LTD,**

S No.	ITEMS	CATEGORY	MAKE
3.5.	HT Bus duct	**B**	**BHEL, C&S, ECC, STARDRIVE BUSDUCTS LTD.**
4.	**PROTECTION & METERING**		
4.1.	Protective Relays	**A**	**ABB, GE T&D, HITACHI ENERGY INDIA LIMITED, SIEMENS, SCHNEIDER**
4.2.	SCADA/ SAS System	**A**	**ABB, ECIL, ETAP ,GE T&D, HITACHI ENERGY INDIA LIMITED, HONEYWELL, SIEMENS**
5.	**LT SWITCHGEAR**		
5.1.	Intelligent motor controller for IMCC	**A**	**ABB, L&T, ROCKWELL AUTOMATION, SCHNEIDER, SIEMENS**
5.2.	Power Control Centre (PCC)	**B**	**ABB, BCH, IEE PROJECTS, L&T, PCE PROJECTS PVT. LTD., SCHNEIDER, SIEMENS**
5.3.	Motor Control Centre (MCC) up to 1000 Amps and PDB	**B**	**ABB, BCH, C&S, DIVYA ENGINEERS, HAVELLS, IEE PROJECTS , L&T, MARINE ELECTRICAL, MEDITRON, PCE PROJECTS PVT. LTD, SCHNEIDER, SEN & SINGH, SIEMENS, SWITCHING CIRCUITS**
5.4.	Motor Control Centre (MCC) above 1000 Amps	**B**	**ABB, BCH, C&S, L&T, SCHNEIDER, SIEMENS**
5.5.	Air circuit breaker (ACB)	**B**	**ABB, L&T, SCHNEIDER, SIEMENS**
5.6.	Moulded case circuit breaker (MCCB) (with positive isolation)	**B**	**ABB, BCH, C&S, HAVELLS, L&T, SCHNEIDER, SIEMENS, EATON, ANDREW YULE**
5.7.	Motor Protection Circuit Breaker (MPCB)	**B**	**ABB, BCH, C&S, L&T, SCHNEIDER, SIEMENS, SPRECHER & SCHUH,HAVELLS, EATON, ROCKWELL AUTOMATION**

S No.	ITEMS	CATEGORY	MAKE
5.8.	Power Contactors, Auxiliary contactors/ Auxiliary relays	**B**	**ABB, BCH, C&S, L&T, SCHNEIDER, SIEMENS , ANDREW YULE, SPRECHER & SCHUH, EATON, ROCKWELL AUTOMATION-ALLEN BRADLEY, OEN (AUXILIARY/CONTROL RELAY ONLY)**
5.9.	Control switches	**B**	**ABB, BCH, EPCC, GE POWER CONVERSION, KAYCEE, L&T, SCHNEIDER, SIEMENS, SALZER**
5.10.	Thermal bimetallic Overload relays	**B**	**ABB, ANDREW YULE, BCH, C&S, L&T, ROCKWELL AUTOMATION, SCHNEIDER, SIEMENS**
5.11.	Electronic over current relay/ Electronic motor protection relay (EOCR/ EMPR)	**B**	**ABB, BCH, C&S, L&T, SCHNEIDER, SIEMENS, SPRECHER & SCHUH, ROCKWELL, EATON**
5.12.	LT bus duct	**B**	**C&S, ECC, LOTUS POWER, L&T, SPEARHEAD, STARDRIVE BUSDUCTS LTD.**
6. **ILLUMINATION**			
6.1.	Lighting fixtures	**B**	**BAJAJ, CROMPTON GREAVES, EVEREADY, FORUS ELECTRIC PVT. LTD., GE LIGHTING, HALONIX TECHNOLOGIES PVT. LTD, HAVELLS, J TRON ELECTRONICS , ORIENT ELECTRIC LIMITED, PHILIPS, SURYA, SYSKA, TRANSRAIL LIGHTING LIMITED, TURNPOINT TECHNOLOGIES PRIVATE LIMITED, WIPRO**
6.2.	High Mast Tower	**B**	**BAJAJ, CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED, PHILIPS, SURYA ROSHNI LIMITED, TRANSRAIL, VALMONT, CONSOUL, BP PROJECTS, VENTURA**
7. **TRANSFORMER**			

S No.	ITEMS	CATEGORY	MAKE
7.1.	Up to 33 kV (Oil Type)	**A**	**BHARAT BIJLEE, BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, INDCOIL TRANSFORMER (UPTO 1 MVA), ESENNAR TRANSFORMER, HITACHI ENERGY INDIA LIMITED, KIRLOSKAR ELECTRIC COMPANY, PROLEC GE, RAYCHEM-RPG, SAI ELECTRICALS (UPTO 1 MVA), SCHNEIDER, SIEMENS, VOLTAMP TRANSFORMERS LTD, ANDREW YULE, TRANSFORMER & RECTIFIER, KOTSONS (UPTO 630kVA only)**
7.2.	Above 33 kV (Oil Type)	**A**	**BHARAT BIJLEE, BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, GE T&D, HITACHI ENERGY INDIA LIMITED, TELK, SCHNEIDER, SIEMENS, TBEA ENERGY (INDIA) PRIVATE LIMITED, TRANSFORMER & RECTIFIER, KIRLOSKAR ELECTRIC COMPANY**
7.3.	Dry type	**A**	**BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD, INDCOIL TRANSFORMER (UPTO 1 MVA), ESENNAR TRANSFORMER, HITACHI ENERGY INDIA LIMITED, KIRLOSKAR ELECTRIC COMPANY, RPG-RAYCHEM, VOLTAMP TRANSFORMERS LTD, SUDHIR**
8.	**MV REACTOR**	**A**	**CG POWER & INDUSTRIAL SOLUTIONS LTD, GE T&D, PS ELECTRICALS, QUALITY POWER, SHRIHANS ELECTRICALS PVT. LTD., TRANSFORMER & RECTIFIER, SCHNEIDER**
9.	**DRIVES**		

S No.	ITEMS	CATEGORY	MAKE
9.1.	Variable frequency drive (VFD)<1.1kV	**B**	**ABB, CG POWER & INDUSTRIAL SOLUTIONS LTD. (for motor upto 30 kW), CONTROL TECHNIQUES INDIA PRIVATE LIMITED (for motor upto 200 kW), DANFOSS, DELTA ELECTRONICS INDIA PVT LTD, FUJI, GE POWER CONVERSION, HITACHI-HIREL, MITSUBISHI ELECTRIC INDIA PRIVATE LIMITED, ROCKWELL AUTOMATION, SCHNEIDER, SIEMENS, TMEIC, YASKAWA**
9.2.	Thyristor Converter/ DC DRIVE	**B**	**ABB, GE POWER CONVERSION, PARKER, ROCKWELL AUTOMATION, SIEMENS, FUJI**
9.3.	Soft starter	**B**	**ABB, L&T, PARKER, ROCKWELL AUTOMATION, SIEMENS, SCHNEIDER, DANFOSS**
9.4.	FCMA /series reactor type soft starter	**B**	**ABB, INNOVATIVE TECHNOMICS, JAYASHREE, SHRIHANS ELECTRICALS PVT. LTD., ROCKWELL AUTOMATION, SCHNEIDER, SIEMENS, LECON ENERGETICS PVT LTD**
9.5.	MV Drive	**B**	**ABB, INNOMOTICS INDIA PVT LTD, SCHNEIDER**
10. **MOTORS**			
10.1.	Synchronous Motor	**A**	**ABB, BHEL, SIEMENS, GE**
10.2.	HT – AC	**A**	**ABB, BHEL, CG POWER & INDUSTRIAL SOLUTIONS LTD., INNOMOTICS INDIA PVT LTD, KIRLOSKAR ELECTRIC COMPANY, WEG, TMEIC, JEUMONT ELECTRIC INDIA PVT LTD**

S No.	ITEMS	CATEGORY	MAKE
10.3.	LT – AC	**B**	**ABB, BHARAT BIJLEE, CG POWER & INDUSTRIAL SOLUTIONS LTD., HINDUSTAN ELECTRIC MOTORS (For up-to 22 kW), KIRLOSKAR ELECTRIC COMPANY, LHP, SIEMENS, WEG, NGEF, BHEL, NORD**
10.4.	DC	**B**	**BHEL, IEC, KIRLOSKAR ELECTRIC COMPANY, CG POWER & INDUSTRIAL SOLUTION**
11. **CABLES**			
11.1.	33kV cable XLPE	**A**	**CCI (Cable Corporation of India), CRYSTAL, GLOSTER, KEC, KEI, POLYCAB,UNIVERSAL**
11.2.	HT (up to 11kV) cable XLPE	**A**	**CCI, GEMSCAB INDUSTRIES LTD.,GLOSTER, HAVELLS, KEC, KEI, POLYCAB, STERLITE POWER ,UNIVERSAL**
11.3.	LT power & control cable	**B**	**CCI, FINOLEX CABLES, GEMSCAB INDUSTRIES LTD.,GLOSTER, HAVELLS, INSUCON, KEC, KEI, POLYCAB,RAVIN, SPECIAL CABLE PVT. LTD., SUYOG ELECTRICALS LIMITED, SVARN INFRATEL PVT. LTD. (for control cable only), THERMO CABLES, UNIVERSAL, LAPP, NANGALWALA INDUSTRIES (P) LTD**
12. **MISCELLANEOUS**			
12.1.	Battery charger	**B**	**AMARA RAJA POWER SYSTEMS LTD, APLAB, CHLORIDE (EXIDE), CHABI ELECTRICALS, LIVELINE ELECTRONICS, NELCO, SABNIFE (HBLNIFE POWER SYSTEMS), STANDARD**

S No.	ITEMS	CATEGORY	MAKE
12.2.	Battery Bank	**B**	**AMARA RAJA, AMCO, EXIDE, FURUKAWA, PANASONIC, SABNIFE (HBLNIFE POWER SYSTEMS), STANDARD**
12.3.	Master controller	**B**	**EATON, ELECTROMAG, EPCC, KAYCEE, L&T, SIEMENS, KAKKU, SPHONBUCKART, GESMANN, SCHNEIDER**
12.4.	Un-interruptible power supply (UPS):	**B**	**FUJI ELECTRIC CONSUL NEOWATT P LTD, HITACHI-HIREL, LIVE LINE ELECTRONICS, NUMERIC, SCHNEIDER (APC), VERTIV ENERGY PRIVATE LIMITED**
12.5.	Nitrogen injection fire protection system	**B**	**CTR, EASUN-MR TAP CHANGERS(P) LTD., TECTONICUS, VENDERE**
13.	**GENERATOR**	**B**	**ABB, BHEL, SIEMENS, TOYO DENKI**



SECTION-B

MECHANICAL

S No.	ITEMS	CATEGORY	MAKE
1.	**GENERAL**		
1.1.	Gearbox (50 kW and above)	**A**	**BONFIGLIOLI, ELECON, SIEMENS-FLENDER, ROSSI, SUMITOMO, HEC, KIRLOSKAR, SHANTHI**
	Gearbox (below 50 kW)	**B**	**BONFIGLIOLI, ELECON, SIEMENS-FLENDER, ROSSI, SUMITOMO, ESSENTIAL POWER TRANSMISSION, HEC, KIRLOSKAR, NAW, SHANTHI, PREMIUM TRANSMISSION, SAN ENGG. LOCOMOTIVE COMPANY LTD., SUMI- CYCLO DRIVE INDIA PVT. LTD., TRIVENI, SCHMIEDE AND MASCHINEN**
1.2.	Geared Motor (5 kW and above)	**A**	**BONFIGLIOLI, CYCLO TRANSMISSION, ROSSI, SIEMENS, NORD, SEW-EURO DRIVE**
	Geared Motor (below 5 kW)	**B**	**BONFIGLIOLI, CYCLO TRANSMISSION, ROSSI, SIEMENS, NORD, SEW-EURO DRIVE, ESSENTIAL POWER TRANSMISSION, IC INDIA LTD., POWER BUILD, SHANTHI, SUMI-CYCLO DRIVE INDIA PVT.LTD.**
1.3.	Geared Coupling (50 kW and above)	**A**	**ELECON, FLEX-TRAN INDUSTRIES, RATHI (LOVEJOY), SIEMENS-FLENDER, TIMKEN, FENNER**
	Geared Coupling (below 50 kW)	**B**	**ELECON, FLEX-TRAN INDUSTRIES, RATHI (LOVEJOY), SIEMENS-FLENDER, TIMKEN, ALLIANCE ENGG. CO., CONCORD STEEL WORKS PVT. LTD., ESCO, GBM, NAW, ROMA MECHANICAL ENGINEERING CO, WELLMAN WACOMA, FENNER, SCHMIEDE AND MASCHINEN**
1.4.	Pin Bush/ Bibby Coupling (10kW and above)	**A**	**ELECON, GBM, RATHI (LOVEJOY)**
	Pin Bush/ Bibby Coupling (below 10kW)	**B**	**ELECON, GBM, RATHI (LOVEJOY), NAW, ROMA MECHANICAL ENGINEERING CO, FENNER**

S No.	ITEMS	CATEGORY	MAKE
1.5.	Barrel Coupling	**A**	**JAURE, MALMEDIE, RINGFEDER POWER TRANSMISSION**
1.6.	Fluid Coupling	**A**	**ELECON, FLUIDOMAT, GHATGE-PATIL INDUSTRIES, PREMIUM TRANSMISSION, VOITH**
1.7.	Resilient Coupling	**A**	**ELECON, FENNER, RATHI (LOVEJOY), NAW, TIMKEN, WELLMAN WACOMA**
1.8.	Transmission Chain & Sprocket	**B**	**DIAMOND, REYNOLD, ROLKOBO, ROLCON, ROLON, GOLDEN ENGG & ENTERPRISE**
1.9.	DCEM Shoe Brake	**A**	**BCH ELECTRIC LTD, ELEKTROMAG, KAKKU, KATEEL, SIBRE, SPEED-O-CONTROL, EMCO PRECIMA ENGINEERING PVT LTD.(BUBENZER BREMSEN)**
1.10.	DCEM Disc Brake	**A**	**BCH ELECTRIC LTD, ELEKTROMAG, KAKKU, KATEEL, PETHE, SIBRE, SPEED-O-CONTROL, EMCO PRECIMA ENGINEERING PVT LTD.(BUBENZER BREMSEN)**
1.11.	Hydraulic thruster brake	**A**	**EMCO PRECIMA ENGINEERING PVT LTD.(BUBENZER BREMSEN), KATEEL, SIBRE**
1.12.	Non-metallic Liner	**B**	**KAVERI, TEGA, THEJO**
1.13.	Wearing Plates (Metallic)	**B**	**NLMK INDIA, QUARD, HARDOX**
1.14.	Lathe & Shaper	**B**	**BATLIBOI, GUJARAT LATHE MANUFACTURING COMPANY PVT. LTD., HEC, HMT**
1.15.	Welding Rectifier/ transformer	**B**	**ADVANI, ADOR, ESAB, MOGORA COSMIC, MEMCO**
1.16.	Bearing	**A**	**FAG, NTN, SKF, TIMKEN, KOYO, SCHAEFFLER**
1.17.	Slew Bearing	**A**	**ROTHE ERDE, SKF, LIEBHERR**
1.18.	Split Bearing	**A**	**COOPER, TIMKEN, SKF**

S No.	ITEMS	CATEGORY	MAKE
1.19.	Passenger cum Goods Elevator (544 kg and above)	**A**	**MITSUBISHI, OTIS, THYSSENKRUPP, SCHINDLER**
	Passenger cum Goods Elevator (below 544 kg)	**B**	**MITSUBISHI, OTIS, THYSSENKRUPP, SCHINDLER, ECE, KONE ELEVATOR, OMEGA**
1.20.	Hook (up to 10 t)	**B**	**FREE TRADING CORPORATION, HERMAN MOHTA, SMRITI FORGING & ENGG, MACHINE TOOLS, ESKAY MACHINERY, STEEL FORGINGS & ENGINEERING**
1.21.	Hook (above 10t)	**A**	**FREE TRADING CORPORATION, HERMAN MOHTA, SMRITI FORGING & ENGG, STEEL FORGINGS & ENGINEERING**
1.22.	Wire Rope	**B**	**BHARAT WIRE ROPES, FORT WILLIAM, BOMBAY WIRE ROPE, ORION ROPES, USHA MARTIN**
1.23.	Expansion Joint for Hot Blast system (metallic)	**A**	**FLEXATHERM, FLEXICAN, LONE STAR, MB METALLIC BELLOWS**
1.24.	Stove Valves (two lever/ three lever/ double eccentric butterfly valve)	**A**	**FOURESS, JOSHI & JAMPALA, L&T**
1.25.	Hot Blast Valve	**A**	**FOURESS, JOSHI & JAMPALA**
1.26.	Coil Strapping M/c	**B**	**KOHAN KOGYO CO., SIGNODE, SUND BRISTA, TITAN**
2.	**MATERIAL HANDLING EQUIPMENT**		

S No.	ITEMS	CATEGORY	MAKE
2.1.	Conveyor Belt	**B**	**CENTURY INDUSTRIAL PRODUCTS, FORECH INDIA LTD, FENNER-DUNLOP, HINDUSTAN RUBBER, JONSON RUBBER INDUSTRIES LTD., NORTH LAND RUBBER, ORIENTAL RUBBER, PHOENIX CONVEYOR BELT (INDIA) PVT. LTD, SEMPERTRANS NIRLON**
2.2.	Idler	**B**	**AMPS ENGG. & EQUIPT. PVT. LTD., BENGAL TOOLS, BEVCON, ELECON, GOLDEN ENGG & ENTREPRISE, GOLDEN ENGINEERING INDUSTRIES, HITECH EQUIPMENTS PVT. LTD., INDIANA CONVEYORS, L & T, MACMET, MCNALLY SAYAJI ENGINEERING LIMITED, NEWALL INDUSTRIES, SANRAJ PROJECTS PVT. LTD., SANDVIK ASIA, SOLCON, TECHNO IMPEX, VINAR SYSTEMS, VN INDUSTRIES**
2.3.	Pulley	**B**	**AMPS ENGG. & EQUIPT. PVT. LTD., BENGAL TOOLS, BEVCON, ELECON, GOLDEN ENGG & ENTREPRISE, GOLDEN ENGINEERING INDUSTRIES, HITECH EQUIPMENTS PVT. LTD., INDIANA CONVEYORS, L & T, MACMET, MCNALLY SAYAJI ENGINEERING LIMITED, NEWALL INDUSTRIES, SANRAJ PROJECTS PVT. LTD., SANDVIK ASIA, SOLCON, TECHNO IMPEX, VINAR SYSTEMS, VN INDUSTRIES**
2.4.	Belt Weigher / Weigh feeder System	**A**	**ACME, FLSMIDH, PFISTER, PRECIA MOLEN, SCHENCK, SIEMENS (MILTRONICS)**
2.5.	Plummer Block (100mm shaft dia at bearing and above)	**A**	**FAG, MASTA, SKF, TIMKEN**
	Plummer Block (below 100mm shaft dia at bearing)	**B**	**FAG, MASTA, NANDY ENGINEERING CONCERN, SKF, TIMKEN**

S No.	ITEMS	CATEGORY	MAKE
2.6.	Belt Scraper (belt width 1000mm and above)	**B**	**HOSCH, KAVERI, THEJO**
	Belt Scraper (belt width below 1000mm)	**B**	**HOSCH, KAVERI, INDIANA CONVEYORS, THEJO**
2.7.	Vibrating Screen (100tph and above)	**A**	**METSO, SCHENK PROCESS, SANDVIK, FLSMIDTH**
	Vibrating Screen (below 100tph)	**B**	**ELECTRO ZAVOD, ELEKTROMAG-JOEST VIBRATION PVT. LTD., IC INDIA LTD., McNALLY SAYAJI ENGINEERING LIMITED, METSO, SCHENK PROCESS, SANDVIK, FLSMIDTH,**
2.8.	Vibrating Feeder	**A**	**ELECTRO ZAVOD, ELEKTROMAG-JOEST VIBRATION PVT. LTD, IC INDIA LTD., McNALLY SAYAJI ENGINEERING LIMITED, METSO, SCHENK PROCESS, SANDVIK, FLSMIDTH,**
2.9.	Apron Feeder (500tph and above)	**A**	**L & T, THYSSEN KRUPP, SANDVIK, METSO**
	Apron Feeder (below 500tph)	**B**	**ELECON, HAZEMAG, L & T, McNALLY SAYAJI ENGINEERING LIMITED, TENGL, THYSSEN KRUPP, SANDVIK, METSO**
2.10.	Screw Conveyor	**B**	**GMV ENGG, MASYC, VINAR SYSTEMS**
2.11.	Electro mechanical Actuator	**B**	**AUMA, LIMITORQUE, PREPEC, ROTORK**
2.12.	EOT Crane (all capacities)	**A**	**ANUPAM INDUSTRIES, HEC, JINDAL STEEL & POWER, MUKAND, TATA GROWTH SHOP, UNIQUE INDUSTRIAL HANDLERS**

S No.	ITEMS	CATEGORY	MAKE
	EOT Crane (maximum 50 t)	**A**	**CENTURY CRANE, ELECTROMECH, MELTECH CRANES PVT. LTD., FAFECO, SMACO, ALPHA**
	EOT Crane (maximum 10 t)	**B**	**EDDY CRANE, SHIVPRA, TUOBRO FURGUSON, ELECTRO THERAPY, REVA INDUSTRIES**
2.13.	Electric Hoist	**B**	**BRADY & MORRIS, CENTURY CRANE, EDDY CRANE, ELECTROTHERAPY, GRIP ENGRS., HERCULES HOIST LTD. (INDEF) , HI-TECH INDUSTRIES, MELTEC, REVA ENGG, SHIVPRA**
2.14.	Electric Winch	**B**	**EDDY CRANE, ELECTROMECH MHS PVT. LTD. ENGG, ELECTROTHERAPY, HMTC ENGG. CO., PULLMAN**
2.15.	Jib Crane	**A**	**BRADY & MORRIS, CENTURY CRANES, GRIP ENGG, MELTEC, EDDY CRANE**
2.16.	Chain Pulley Block & Hand Operated Travelling Crane	**B**	**BRADY& MORRIS, CENTURY CRANES, HERCULES HOIST LTD. (INDEF), HI-TECH., LIGHT LIFT IND., REVA ENGG,TRACTEL TRIFOR**
2.17.	Underslung Cranes	**B**	**EDDY CRANE , CENTURY CRANES, FAFECO, MUKAND, KONE CRANES & DEMAG, REVA ENGG, ALPHA, BRADY & MORRIS, SHIVPRA, TUOBRO FURGUSON**
2.18.	Shock Absorbers /Hydraulic Buffer	**A**	**ENIDINE, OLEO, ACE CONTROLS**
2.19.	Electro Magnet	**A**	**EAST COAST ENTERPRISERS, ELEKTROMAG, SGM, SUPERLIFT**
2.20.	Tongs	**B**	**BUCK, HEPPENSTALL, SOMERS, YELLOW STONE INDIA**
2.21.	Stacker or Reclaimer	**A**	**ELECON, FLSMIDTH, HEC, L & T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, SANDVIK ASIA, TENOVA TAKRAF, THYSSENKRUPP**

S No.	ITEMS	CATEGORY	MAKE
2.22.	Stacker-cum-Reclaimer	**A**	**FLSMIDTH, HEC, L & T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, SANDVIK ASIA, TENOVA TAKRAF, THYSSENKRUPP**
2.23.	Bucket-Wheel Reclaimer	A	**FLSMIDTH, HEC, L & T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, TENOVA TAKRAF, THYSSENKRUPP, SANDVIK ASIA**
2.24.	Wagon Tippler	A	**ELECON, FLSMIDTH, HEC, L & T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, THYSSENKRUPP**
2.25.	Hanging Magnet/ Cross belt/ Inline Magnetic Separator	A	**ELECTRO ZAVOD, ELEKTROMAG, HUMBOLDT WEDAG, MAGNET INDUSTRIES (CAL) PVT. LTD., McNALLY SAYAJI ENGINEERING LIMITED, METSO**
2.26.	Fork Lift	B	**GODREJ, TIL, VOLTAS**
2.27.	Crusher (Cone / Gyratory / Jaw)	A	**FLSMIDTH, HEC, L&T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, SANDVIK, THYSSENKRUPP, URALMASH**
2.28.	Impact / Hammer Crusher	A	**HEC, L&T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, SANDVIK, TERRASOURCE, THYSSENKRUPP**
2.29.	Roll Crusher	A	**ELECON, FLSMIDTH, HEC, L&T, McNALLY SAYAJI ENGINEERING LIMITED, SANDVIK, THYSSENKRUPP, URALMASH**
2.30.	Rotary Breaker	A	**L&T, McNALLY SAYAJI ENGINEERING LIMITED, TERRASOURCE, THYSSENKRUPP**
2.31.	Industrial/ Cabin/ Crane e-room AC	A	**FRIGORTEC, KABU, LINTERN**
3.	**HYDRAULICS SYSTEM**		
3.1.	Hydraulic Cylinder	A	**APEX FLUIDOMATICS PVT. LTD., CANARA HYDRAULICS, DANVER, EATON, HYDRO PNEUMATIC CONTROLS, OSCAR, PARKER, REXROTH, VEKTRA ENGG., VELJAN, WIPRO, YUKEN**

S No.	ITEMS	CATEGORY	MAKE
3.2.	Hydraulic System with Accessories	A	**EATON, HYDAC, PARKER, REXROTH, YUKEN**
3.3.	Hydraulic Valves	A	**CANARA HYDRAULICS, EATON, HYDAC, MOOG, PARKER, REXROTH, YUKEN**
3.4.	Accumulator	A	**BOSCH, EATON, EPE, HYDAC, PARKER, REXROTH, YUKEN**
3.5.	Hydraulic Fitting & Clamp	B	**EPE, FLUID CONTROL HYDROCRIMP, HYDAC, HYDAIR, HYDROMATIK, HYTECH, PTS, STAUFF**
3.6.	Hydraulic Filter	B	**HYDAC, INTERNORMEN, PARKER**
3.7.	Hydraulic Motor	A	**EATON, MAHA HYDRAULICS, PARKER, REXROTH, SAUER DANFOSS, YUKEN**
3.8.	Hydraulic Pump	A	**SAUER DANFOSS, EATON, MAHA HYDRAULICS, PARKER, REXROTH, YUKEN**
3.9.	Hose	B	**AEROFLEX, EATON, HYDROKRIMP, HYDROLINE, INDIA FLEX INDUSTRIES, INDO INDUSTRIAL SERVICES, PARKER, PSI HYDRAULICS, SONI RUBBER PRODUCTS LTD., SUPERSEAL**
4.	**PNEUMATIC SYSTEM**		
4.1.	Pneumatic Cylinder	B	**CANARA HYDRAULICS, EL-O-MATIC (INDIA) PVT. LTD., GABRIEL PNEUMATICS, HYDAIR, HYDRO PNEUMATIC CONTROLS, I.L. PALAKKAD, NUCON, ROTEX, SHRADER, SMC, VELJAN, WIPRO**
5.	**LUBRICATION SYSTEM**		
5.1.	Oil Lubrication System for Rolling Mills, Sinter Plant, Blast Furnace, Bulk material equip	A	**HYDAC, SKF LINCOLN, LUBRICATION SYSTEM LTD., BIJUR DELIMON, REBS LUBRICATION**

S No.	ITEMS	CATEGORY	MAKE
5.2.	Oil Lubrication System other than above (Cl. 5.1)	B	**HYDAC, SKF LINCOLN, LUBRICATION SYSTEM LTD., PRAKASH LUBRIQUIPMENT, SHAAN LUBE, BIJUR DELIMON, REBS LUBRICATION**
5.3.	Screw Pump	B	**ROTO, TUSHACO, UT PUMPS & SYSTEM**
5.4.	Gear Pump	B	**ALFA, PARKER, REXROTH, ROTO, ROTODEL, TUSHACO**
5.5.	Filter Strainer	B	**MULTITEX FILTRATION, OTOKLIN, SPAN ASSOCIATES PUNE, SUPERFLOW FILTERS**
5.6.	Oil Mist / Oil-Air Lubrication System	A	**BIJUR DELIMON, SKF LINCOLN, REBS LUBRICATION**
5.7.	Grease Lubrication System for Rolling Mills, Sinter Plant, Blast Furnace, Bulk material Handling Equipment	A	**BIJUR DELIMON, SKF LINCOLN, REBS LUBRICATION, AFMC**
5.8.	Grease Lubrication System other than above (Cl 5.7)	B	**AFMC, BIJUR DELIMON, CENLUB SYSTEMS, SKF LINCOLN, PRAKASH LUBRIQUIPMENT, REBS LUBRICATION**
5.9.	Hose	B	**AEROFLEX, HYDROKRIMP, HYDROLINE, INDO INDUSTRIAL SERVICES, PSI HYDRAULICS, SONI RUBBER PRODUCTS LTD., SUPERSEAL**



SECTION-C

MINING & MINERAL PROCESSING AREA

S No.	ITEMS	CATEGORY	MAKE
1.	Sizer	A	**FLSMIDTH, MMD, SANDVIK, THYSSENKRUPP**
2.	Ball / Rod / Ag Mill	A	**CEMTEC, CHANDERPUR WORKS PVT. LTD., FLSMIDTH, HEC, L&T, McNALLY SAYAJI ENGINEERING LIMITED, METSO, OUTOTEC, SANDVIK , THYSSENKRUPP, URALMASH**
3.	Classifier	A	**DORR OLIVER, DURGA METALS, EIMCO-KCP, FLSMIDTH,METSO, MBE-CMT**
4.	Thickener	A	**EIMCO-KCP, FLSMIDTH, McNALLY SAYAJI ENGINEERING LIMITED, METSO, OUTOTEC, TENOVA-DELKOR, WESTECH**
5.	Jig	A	**ALLMINERAL, MBE-CMT, TENOVA-DELKOR**
6.	Filter(Vacuum /Pressure)	A	**ANDRITZ, EIMCO-KCP, FLSMIDTH, METSO, OUTOTEC, TENOVA-DELKOR, TH COMPANY, WESTECH**
7.	Wet High Intensity Magnetic Separator / High Gradient Magnetic Separator	A	**ALLMINERAL, ERIEZ, MBE-CMT, METSO, LONGI MAGNET, MINERAL TECHNOLOGIES, OUTOTEC**
8.	Low Intensity Magnetic Separator	A	**ERIEZ, LONGI MAGNET, MBE-CMT, METSO, MINERAL TECHNOLOGIES, MULTOTEC**
9.	Dewatering Screen	A	**DERRICK, FLSMIDTH –LUDOWICI, IC , METSO, McNALLY SAYAJI ENGINEERING LIMITED, SCHENCK PROCESS, WEIR MINERALS**
10.	Spiral – Gravity Concentrator	A	**AKW A+V GMBH, FLSMIDTH, MINERAL TECHNOLOGIES, MULTOTEC, OUTOTEC**
11.	Hydrocyclones	A	**CDE, FLSMIDTH KERBS, McNALLY SAYAJI ENGINEERING LIMITED, METSO, MOZLEY, MULTOTEC, WEIR MINERALS**
12.	Metal Detector	A	**ELECTRO ZAVOD,ELEKTROMAG, ERIEZ, MBE-CMT, METSO**



SECTION-D

PROCESS CONTROL & AUTOMATION

S No.	ITEMS	CATEGORY	MAKE
1.	**FIELD INSTRUMENTATION**		
1.1.	Pressure/differential pressure/Level/Flow Transmitter	A	**ABB, EMERSON, E&H, FUJI, HONEYWELL, YOKOGAWA, SIEMENS**
1.2.	Temperature Transmitter	A	**ABB, E&H, EMERSON, HONEYWELL, SIEMENS, YOKOGAWA**
1.3.	Pressure / DP switch	A	**ASHCROFT, BAUMER, DANFOSS, INDFOS, WIKA, SWITZER,**
1.4.	Tuning Fork/ Rod type Level Switch	A	**ABB, E&H, EMERSON, NIVO CONTROL, SAPCON, SIEMENS, VEGA**
1.5.	Conductivity/RF/Capacitance type Level Switch	A	**E&H, NIVO CONTROL, P&F, SAPCON, VEGA,**
1.6.	Float type Level Switch	A	**BAUMER, EMERSON, ENDRESS & HOUSER, KROHNE MARSHALL, LEVCON, NIVO CONTROL, SAPCON, TRAC**
1.7.	Ultrasonic Level Sensor	A	**E&H, EIP ENVIRO, EMERSON, KROHNE MARSHALL, P&F, SIEMENS, SICK, VEGA**
1.8.	Radar Type Level Sensor	A	**E&H, EIP ENVIRO, EMERSON, KROHNE, MARSHALL, SIEMENS, VEGA**
1.9.	Electro Magnetic Flow Meter	A	**E&H, EMERSON, KROHNE MARSHALL, ROCKWIN, YOKOGAWA, SIEMENS**
1.10.	Flow Elements (Orifice / Venturi / Flow nozzle / Pitot tube / Annubar)	A	**ENGG SPECIALTIES, EMERSON, MECHANICAL ENGINEERS, UNI CONTROL, WIKA**
1.11.	Radiation Pyrometer (online/portable)	A	**CHINO, EUROTHERM, LAND, WILLIAMSON CORPORATION, FLUKE**

S No.	ITEMS	CATEGORY	MAKE
1.12.	Level SW/ Transmitter (Nucleonic type)	B	**BERTHOLD, E&H, THERMOFISHER**
1.13.	Temperature Switch	B	**E&H, IFM, HYDAC, WIKA**
1.14.	Flow Switch	B	**EMERSON, IFM, KROHNE MARSHAL, KOBOLD**
1.15.	Vortex Flow Meter	A	**E&H, EMERSON, KROHNE MARSHAL, SIEMENS, YOKOGAWA**
1.16.	Mass (Coriolis) Flow	A	**ABB, E&H, EMERSON, KROHNE MARSHAL, SIEMENS, YOKOGAWA,**
1.17.	Level Switch/Transmitter (Displacer Type)	B	**CHEMTROL, DK INSTRUMENTS, EMERSON, LEVCON**
2.	**CONTROL VALVES**		
2.1.	Globe Valve	A	**FISHER, FORBES MARSHALL, IL PALAKKAD, KOSO, SAMSON, SEVERN, UNIFLOW CONTROLS**
2.2.	Butterfly Valve	A	**AIRA, DEL VAL, FISHER, FOURESS, IL PALAKKAD, KOSO, SEVERN**
2.3.	Pneumatic Actuator	A	**DEL VAL, FORBES MARSHALL, IL PALAKKAD, KOSO, OM CONTROL, ROTEX, SAMSON, UNIFLOW CONTROLS**
2.4.	Electrical Motor Actuator	A	**AUMA, BERNARD, LIMITORQUE, ROTORK,**
2.5.	Electro Pneumatic Positioner	A	**ABB, EMERSON, FORBES MARSHALL, SIEMENS**
3.	**CONTROL SYSTEM EQUIPMENT**		

S No.	ITEMS	CATEGORY	MAKE
3.1.	Signal Isolator	A	**MASIBUS, MICROSYSTEMS & CONTROLS, MTL, P&F, PHOENIX, STAHL, YOKOGAWA**
3.2.	Distributed Control System	A	**ABB, EMERSON, HONEYWELL, SCHNEIDER, SIEMENS, ROCKWELL, TOSHIBA, YOKOGAWA,**
3.3.	PLC System	A	**ABB, ECIL, HITACHI, HONEYWELL, EMERSON AUTOMATION (FORMERLY "GE INTELLIGENT"), ROCKWELL, SCHNEIDER, SIEMENS**
3.4.	Technological Control System/ Multi Tasking Control System/ Embedded Control System	A	**ABB, DANIELI, EMERSON AUTOMATION (FORMERLY "GE INTELLIGENT"), SIEMENS, SMS, TMEIC**
3.5.	PDA	A	**DANIELI, IBA, LMS, MICA, SOMAT**
3.6.	Panel / Enclosure / Rack	B	**APW PRESIDENT, DIVYA ENGINEERS, HOFFMANN, PYROTECH, RITTAL, VALRACK**
3.7.	Surge Protection	A	**DEHN, MTL, P&F, PHOENIX CONTACT, OBO BETTERMANN**
4.	**PANEL BASED INSTRUMENTATION**		
4.1.	Single Loop Stand Alone Controller	A	**ABB, FUJI, HONEYWELL, SIEMENS, TOSHIBA, YOKOGAWA**
4.2.	Paperless Recorder	A	**CHINO, EUROTHERM, FUJI, HONEYWELL, LAXONS, YOKOGAWA,**
4.3.	Alarm Annunciator	B	**IIC, IL, MINILEC, PROCON, SEMUDA**
4.4.	Regulated DC Power Supply Unit / SMPS	A	**APLAB, COSSEL, PHOENIX CONTACT, SIEMENS, WAGO**
5.	**ANALYSERS**		

S No.	ITEMS	CATEGORY	MAKE
5.1.	Gas Analyser	A	**ABB CHEMTROL (AMETEK), EMERSON, FUJI, FORBES MARSHALL, HONEYWELL, PANAMETRICS, SICK, SIEMENS, YOKOGAWA**
5.2.	Gas Detector	A	**BEILER & LANG, DETRONICS, DRAGGER, INDUSTRIAL SC. CORPN MSA, TELEDYNE**
5.3.	Flame Detector	A	**DURAG, ENDEE, HONEYWELL, SICK, YAMATAKE**
5.4.	Moisture Analyzer (Nucleonic)	A	**CHINO, BERTHOLD, EMERSON, THERMO FISHER**
5.5.	Moisture Analyzer (Microwave/ Capacitance Type)	A	**ABB, CHEMTROL, MOISTECH, NDC, SIEMENS**
5.6.	Opacity Analyser	A	**DURAG, FORBES MARSHALL, MAIHEK, SICK,**
5.7.	Calorific Value Analyser	A	**CHEMTROL(AMS), REINEKE, UNION CALORIMETER, YOKOGAWA, IGCA**
5.8.	pH / Conductivity / ORP Analyser	A	**ABB, E&H, EMERSON, FORBES MARSHAL, HONEYWELL, YOKOGAWA,**
5.9.	SOX / NOX/ CO Analyser	A	**ABB, AIC (FUJI), EMERSON, FUJI, FORBES MARSHAL, HONEYWELL, SICK, SIEMENS, YOKOGAWA**
5.10.	Elemental Analyser	A	**JICO, MAYA, PANALYTICAL, REAL TIME, SCANTECH, THERMO SCIENTIFIC**
6.	**WEIGHING**		

S No.	ITEMS	CATEGORY	MAKE
6.1.	Electronic Weighing System (Hopper Weighing / Platform / Scales / In-motion W.B.)	A	**ABB, ACME, AVERY KELK, BEST, MINEBEA INTEC (FORMERLY SARTORIOUS), PRECIA MOLEN, RICE LAKE, SCHENK, TRANSWEIGH**
6.2.	Load Cells & Accessories	A	**ABB, FLINTEK, HBM, MINEBEA INTEC (FORMERLY SARTORIOUS), PRECIA MOLEN, PRECISION, RICELAKE, SCHENCK, SIEMENS, KELK**
7.	**SPECIAL INSTRUMENTS**		
7.1.	Thickness Gauge	A	**IMS, IRM, MESACON, TOSHIBA, THERMO SCIENTIFIC,**
7.2.	Hot Metal Detector	A	**AMERICAN SENSORS, DANIELI, DELTA, SICK,TOSHIBA, HOKUYO AUTOMATIC CO. LTD.**
7.3.	Width Gauge	A	**ABB, DELTA, DANIELI, IMS, PSYSTEME, THERMO SCIENTIFIC, TOSHIBA**
7.4.	Vibration Monitoring System	B	**GE OIL & GAS, IRD MECHANALYSIS, SCHENCK, SHINKAWA**
7.5.	Portable Vibration Monitor with analysis software	B	**BENTLEY NEVADA, FORBES MARSHAL, IRO**
7.6.	Test & Measuring Equipment	B	**APLAB, FLUKE, KANE, SCIENTIFIC, TECHNOFIX,**
7.7.	Laboratory Equipment	B	**BEAMEX, FLUKE, SCANDURA,WIKA**
7.8.	Digital Multi-Function Meter	B	**ACORD, CONSERVE, L&T, RISHAV, SECURE**
7.9.	Strip Profile Gauge	A	**IMS, MESACON, NDC (IRM), THERMO SCIENTIFIC, TOSHIBA,**

S No.	ITEMS	CATEGORY	MAKE
7.10.	Flatness/ Shape Gauge	A	**ABB, DELTA, IMS, P-SYSTEME, SIEMENS, THERMO SCIENTIFIC,**
7.11.	Laser Doppler Velocity Meter	A	**ACCUSPEED, AMERICAN SENSORS, DELTA, KELK, LASER SPEED,**
7.12.	Optical Barrier	A	**ABB, AMERICAN SENSORS, DELTA, PAULI, SICK,**
7.13.	Position Transducer	A	**LEONARD BAUR, NSD, SONY MAGNESCALE, TEMPOSONIC, DELTA**
7.14.	Optical Encoder	A	**HUBNER, LINE & LINDEY, STEGMANN**
7.15.	Surface Inspection System	A	**ABB,COGNEX, PARSYTEC, SIEMENS, SURCON**
8.	**COMMUNICATION EQUIPMENT**		
8.1.	Wireless Communication Equipment	A	**CISCO, EXTREME, GE, JUNIPER, LOTUS WIRELESS, MOTOROLA, MOXA, RADIUS, SATELLINE, SHEETAL WIRELESS, STAHL, PHOENIX CONTACT**
8.2.	EPABX	A	**ALCATEL, AVAYA, ERICSON, ITI, SIEMENS**
8.3.	PA System/ Conferencing system	B	**AHUJA, BOSCH, HONEYWELL, PHI AUDIO COM**
9.	**DISPLAY & FDA SYSTEM**		
9.1.	Alpha Numeric Display/ Jumbo Display	B	**AGLA, BLE BELL, GE, LECTROTEK, MICROTECH, PYROTECH ELECTRONICS, VINAY**
9.2.	Large Screen Display	B	**HITACHI, LG, PANASONIC, SAMSUNG, SONY**

S No.	ITEMS	CATEGORY	MAKE
9.3.	Video Walls (LED)	B	**DELTA, HITACHI, LG, PANASONIC, SAMSUNG, SONY**
9.4.	Fire Detection and Alarm (FDA) System	A	**BOSCH, HONEYWELL (ESSER), HONEYWELL (NOTIFIER), SCHRACK SECONET, SECURITON, SIEMENS, TYCO**
10.	**INSTRUMENTATION CABLES**		
10.1.	Instrumentation/ Screened/ Co-axial/ Special Cables	A	**CCI, CORDS, DELTON, FINOLEX, LAPP, MEM, NICCO, SPECIAL CABLES, SUN, THERMOCABLES, TOSHNIWAL, UNIVERSAL**
10.2.	Telephone Cable	B	**BELDON, DELTON, FINOLEX, NICCO, TELE LINK, UNIVERSAL,**
10.3.	Load Cell Cable	A	**FLINTEC, HBM, PRECIA MOLEN, RICELAKE, SARTORIOUS, SCHENK, SIEMENS**
10.4.	T/C Extension cable, Compensating cable, PTFE cable	A	**BELDEN, LAPP, MEM, TEMCON, TEMPSENS, THERMOCABLE, TOSHNIWAL CABLES**



SECTION-E

REFRACTORY

S No.	ITEMS	CATEGORY	MAKE
1.	Fireclay Refractories (Alumina Up to 44 %)	B	**ARUN REFRACTORIES, ARVIND INDUSTRIES, ASSOCIATED CERAMICS LTD., BRAHMA REFRACTORIES PVT. LTD., BURNPUR CERAMICS, BURNPUR INDUSTRIES, CHAMPION CERAMICS PVT. LTD., INDUSTRIAL ASSOCIATES, MAHAKOSHAL REFRACTORIES PVT. LTD., MAITHAN CERAMIC LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., PREMIER REFRACTORIES PVT. LTD., RAJHANS REFRACTORIES PVT. LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SAIL REFRACTORY UNIT, SHREEKANT INDUSTRIES, TRL KROSAKI REFRACTORIES LTD., VALLEY REFRACTORIES PVT. LTD.**
2.	High Alumina Refractories (Alumina Above 44 %)	B	**ASSOCIATED CERAMICS LTD., BRAHMA REFRACTORIES PVT. LTD., CHAMPION CERAMICS PVT. LTD., INDUSTRIAL ASSOCIATES, MAHAKOSHAL REFRACTORIES PVT. LTD., MAITHAN CERAMIC LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., PREMIER REFRACTORIES PVT. LTD., RAJHANS REFRACTORIES PVT. LTD., RANCHI REFRACTORIES (INDIA) PVT. LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SAIL REFRACTORY UNIT, SAINT-GOBAIN PERFORMANCE CERAMICS & REFRACTORIES, TRL KROSAKI REFRACTORIES LTD.**
3.	Silica Refractories	B	**TRL KROSAKI REFRACTORIES LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SAIL REFRACTORY UNIT**

S No.	ITEMS	CATEGORY	MAKE
4.	Insulation Refractories	B	**ACHINT CHEMICALS, ASSOCIATED CERAMICS LTD., CALDERYS INDIA REFRACTORIES LTD., CARBORUNDUM UNIVERSAL LTD., MAITHAN CERAMICS LTD., MURUGAPPA MORGAN THERMAL CERAMICS LTD., NAVRANG REFRACTORIES PVT. LTD., NEWKEM PRODUCTS CORPOPRATION, NUTECH REFRACTORIES PVT. LTD., PREMIER REFRACTORIES PVT. LTD., RAJASTHAN CERAMICS INDUSTRIES, RELIABLE REFRACTORIES PVT. LTD., VALLEY REFRACTORIES PVT. LTD., SHREE CERAMICS FIBERS PVT. LTD.**
5.	Basic Refractories (Magnesite/ Mag Chrome/ Chrome Mag/ Magnesia-Carbon/ Alumina Magnesia Carbon)	B	**CHAMPION CERAMICS PVT. LTD., MAITHAN CERAMIC LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., RANCHI REFRACTORIES (INDIA) PVT. LTD., RHI MAGNESITA INDIA LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SAIL REFRACTORY COMPANY LTD., SAIL REFRACTORY UNIT, SARVESH REFRACTORIES PVT. LTD., TRL KROSAKI REFRACTORIES LTD., VESUVIUS INDIA LTD.**
6.	Purging Refractories (Porous Plug/ Purging Plug)	B	**IFGL REFRACTORIES LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., RHI MAGNESITA INDIA LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SARVESH REFRACTORIES PVT. LTD., TRL KROSAKI REFRACTORIES LTD., VESUVIUS INDIA LTD.**
7.	Pouring Refractories (Well block/ Inner Nozzle/ Outer Nozzle/ Slide gate)	B	**IFGL REFRACTORIES LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., RANCHI REFRACTORIES (INDIA) PVT. LTD., RHI MAGNESITA INDIA LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SARVESH REFRACTORIES PVT. LTD., TRL KROSAKI REFRACTORIES LTD., VESUVIUS INDIA LTD.**
8.	Black Refractories (Shroud/ Mono block Stopper/ Tundish Nozzle/ SEN/ Single Taphole Sleeve)	B	**IFGL REFRACTORIES LTD., RHI MAGNESITA INDIA LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, SARVESH REFRACTORIES PVT. LTD., TRL KROSAKI REFRACTORIES LTD., VESUVIUS INDIA LTD.**

S No.	ITEMS	CATEGORY	MAKE
9.	Silicon Carbide Refractories	B	**CARBORUNDUM UNIVERSAL LTD., SAINT-GOBAIN PERFORMANCE CERAMICS & REFRACTORIES**
10.	Alumina-Silicon Carbide-Carbon (ASC) Refractories	B	**CHAMPION CERAMICS PVT. LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., RAASI REFRACTORIES LTD., RHI MAGNESITA INDIA LTD., RHI MAGNESITA INDIA REFRACTORY LIMITED, TRL KROSAKI REFRACTORIES LTD.**
11.	**Acid Resistant Refractories**	**B**	**CHAMPION CERAMICS PVT. LTD., MAHAKOSHAL REFRACTORIES PVT. LTD., MANISHRI REFRACTORIES & CERAMICS PVT. LTD., RAJHANS REFRACTORIES PVT. LTD., BURNPUR CERAMICS, SB STEEL, ORIENT REFRACTORIES, JARIDIH CHEMICALS & INDUSTRIES**



SECTION-F

UTILITIES & SERVICES

S No.	ITEMS	CATEGORY	MAKE
1.	**PUMPS**		
1.1.	Centrifugal Pumps (Horizontal Split Casing / Horizontal Back Pullout / Vertical axial, Volute & Mixed flow Types – All ranges)	A	**BHEL, FLOWMORE, FLOW SERVE, KIRLOSKAR (KBL), KSB, SAM, SULZER, WILO-MATHER & PLATT, WPIL, JYOTI PUMPS**
1.2.	Centrifugal Pumps (Horizontal Split Casing / Horizontal Back Pullout / Vertical axial, Volute & Mixed flow Types – Less than 100 m3/h)	A	**BEST & CROMPTON, CALAMA, CHEMFLO, CRI, SAM, SJ INDUSTRIES, SPX FLOW (JOHNSON)**
1.3.	Boiler Feed Pumps / Condensate Extraction Pump	A	**BHEL, KIRLOSKAR EBARA PUMPS LIMITED (For boiler capacity upto 50 tph), KSB, SULZER**
1.4.	Submersible pump	B	**CALAMA, CRI, DARLING, FLOWMORE, GOODWIN PUMPS (for handling slurry), KISHOR PUMPS, KSB, LUBI, SAM, SU MOTORS, SULZER, VARAT, WPIL, XYLEM, KBL, WILO-MATHER & PLATT**
1.5.	Horizontal Centrifugal Pumps For Slurry Handling	A	**BEST & CROMPTON, CRI, FL SMIDTH (DORR OLIVER), FLOWMORE, FLOW SERVE, GOODWIN PUMPS, METSO, SAM, WEIR MINERALS**
1.6.	Reciprocating Slurry Pump	A	**FL SMIDTH (DORR OLIVER), ROTO, WEIR MINERALS**
1.7.	Vertical Centrifugal Pumps for Slurry Handling	A	**METSO, SAM, WEIR MINERALS**
1.8.	Reciprocating Pumps	A	**ACME, AIRAUTO, CHEMTROL ENGG., FLOW SERVE, SWELORE**

S No.	ITEMS	CATEGORY	MAKE
2.	**VALVES & GATES**		
2.1.	**FLUIDS (EXCEPT STEAM & OXYGEN) SERVICE** **General Services-Make-up water system, Cleaning & Washing, Service air system, Purging system**		
2.1.1.	Gate and Globe (Cast Steel) **General Services**	B	**BHEL, DEMBLA VALVES LTD, FLUIDTECH EQUPT., FOURESS, GM ENGG., INTERVALVE, IVC, JOSHI JAMPALA, KIRLOSKAR, KSB, L&T, MASCOT, OSWAL INDUSTRIES, STEELSTRONG, TYCO VALVES, UNIVERSAL ENGG. CONCERN, VALVE TECH IND., LEADER, S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK)**
2.1.2.	Gate and Globe (Cast Steel) **ALL Process**	A	**BHEL, DEMBLA VALVES LTD , FLUIDTECH EQUPT., FOURESS, KSB, L&T, TYCO VALVES, S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK), VALVE TECH IND.**
2.1.3.	Non-return Valves (Cast Steel) **General Services**	B	**ADVANCE VALVES (NOIDA), BHEL, DEMBLA VALVES LTD, DEZURIK, FLUIDTECH EQUPT., FOURESS, GM ENGG., INTERVALVE, KIRLOSKAR, KSB, L&T, OSWAL INDUSTRIES, STEELSTRONG, UNIVERSAL ENGG. CONCERN, UNIVERSAL ENGG., VALVE TECH IND, LEADER, S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK)**
2.1.4.	Non-return Valves (Cast Steel) **All Process**	A	**ADVANCE VALVES (NOIDA), BHEL, FLUIDTECH EQUPT., FOURESS, KSB, L&T, SWIMS (BDK), VALVE TECH IND.**

S No.	ITEMS	CATEGORY	MAKE
2.1.5.	Gate, Globe and Non-return Valves (Forged Steel) **General Services**	B	**BHEL, FLUIDTECH EQUIPMENTS Pvt. Ltd., FOURESS, HYDRO TECH ENGG., INTERVALVE, JOSHI JAMPALA, KIRLOSKAR (KBL), KSB, L&T, OSWAL INDUSTRIES, VALVE TECH IND., S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK)**
2.1.6.	Gate, Globe and Non-return Valves (Forged Steel) **All Process**	A	**BHEL, FOURESS, KSB, L&T, SWIMS (BDK) , VALVE TECH IND.**
2.1.7.	Gate and Globe Valves (SS & Alloy Steel)	A	**BHEL, FLUIDTECH EQUIPMENTS Pvt. Ltd., FOURESS, INTERVALVE, KSB, L&T, OSWAL INDUSTRIES, SWIMS (BDK), VALVE TECH IND.**
2.1.8.	Gate, Globe, Non-Return Valves (Cast Iron, & SG Iron) **General Services**	B	**BANKIM, CALSEN, CHEMTECH, DURGA VALVES, FLUIDTECH EQUPT., GM DALUI, IVC, JOSHI JAMPALA, KIRLOSKAR, LEADER, S&M INDUSTRIAL VALVES (KOLKATA), SHIVA DURGA, SIGMA FLOW, UNIVERSAL ENGG. CONCERN, UNIVERSAL ENGG., UPADHYAY, VALVE TECH IND**
2.1.9.	Gate, Globe, Non-Return Valves (Cast Iron, & SG Iron) **All Process**	A	**FLUIDTECH EQUPT., IVC, JOSHI JAMPALA, KIRLOSKAR, S&M INDUSTRIAL VALVES (KOLKATA), SHIVA DURGA, UPADHYAY**
2.1.10	Double Eccentric Butterfly Valves	A	**ADVANCE VALVES (NOIDA), DELVAL FLOW CONTROLS, DEMBLA VALVES LTD, FOURESS, INTERVALVE, JOSHI JAMPALA, L&T, STAFFORD (VIRGO), VALVE TECH IND., SWIMS (BDK), KSB, KIRLOSKAR, IL**

S No.	ITEMS	CATEGORY	MAKE
2.1.11	Triple Eccentric Butterfly Valves	A	**ADVANCE VALVES (NOIDA), DELVAL FLOW CONTROLS, DEMBLA VALVES LTD, EMERSON (VIRGO), FOURESS, INTERVALVE, JOSHI JAMPALA, L&T, PENTAIR (TYCO), SWIMS (BDK) , VALVE TECH IND.**
2.1.12	Butterfly Valve **General Services**	B	**BRAY CONTROLS, DELVAL FLOW CONTROLS, DEMBLA VALVES LTD, DEZURIK, DURGA VALVES, CHEMTECH, , FLUIDTECH EQUIPMENTS Pvt. Ltd., FLOW SERVE, FOURESS, INTERVALVE, JOSHI JAMPALA., KIRLOSKAR, KSB, L&T, MASCOT, METSO, ROTEX, S&M INDUSTRIAL VALVES (KOLKATA), SIGMA FLOW, STAFFORD CONTROLS, TYCO VALVES, UNIVERSAL ENGG. CONCERN, UNIVERSAL ENGG., VALVE TECH IND.,AVCON, SWIMS (BDK) , LEADER, VICTRAM VALVES**
2.1.13	Butterfly Valve **All Process**	A	**ADVANCE VALVES (NOIDA), BRAY CONTROLS, DELVAL FLOW CONTROLS, DEMBLA, FLOW SERVE , FOURESS, INTERVALVE, KSB, L&T, METSO, TYCO VALVES, S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK) , VALVE TECH IND.**
2.1.14	Fabricated Valves (Gate Valves)	A	**FLUIDTECH EQUPT., FOURESS, JOSHI JAMPALA, L&T, CHEMTECH, VALVE TECH IND.**
2.1.15	Fabricated Valves (Butterfly Valves)	A	**FLUIDTECH EQUPT., FOURESS, IL, INTERVALVE, JOSHI JAMPALA, L&T , VALVE TECH IND.**

S No.	ITEMS	CATEGORY	MAKE
2.1.16	Goggle Valves	A	**FOURESS, JOSHI JAMPALA, Zimmerman & Jhonson-India, CHEMTECH, VALVE TECH IND.**
2.1.17	3 or 4 Way Cock/Plug valve (CI / CS/ FS)	B	**FLUIDTECH EQUIPMENTS Pvt. Ltd., FLOWSERVE, UNIVERSAL ENGG. CONCERN, L&T, S&M INDUSTRIAL VALVES (KOLKATA)**
2.1.18	Ball Valve (SS/CS / FS / CI) **General Services**	B	**AQUA VALVES, DELVAL FLOW CONTROLS, DEMBLA VALVES LTD, EMERSON (VIRGO), FLUIDTECH EQUIPMENTS Pvt. Ltd., INTERVALVE, KSB, L&T, MASCOT, OSWAL INDUSTRIES, MICROFINISH, NSSL, PENTAIR (TYCO), ROTEX, VALVE TECH IND., S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK)**
2.1.19	Ball Valve (SS/CS / FS / CI) **All Process**	A	**DELVAL FLOW CONTROLS, EMERSON (VIRGO), INTERVALVE, KSB, L&T, MICROFINISH, PENTAIR (TYCO), ROTEX, S&M INDUSTRIAL VALVES (KOLKATA), SWIMS (BDK) , VALVE TECH IND.**
2.1.20	Float Valve	B	**CALSEN, IVC, LEADER, LEVCON, SHIVA DURGA, UPADHAYA,**
2.1.21	Foot Valve	B	**CALSEN, DEZURIK, IVC, KIRLOSKAR (KBL), LEADER, LEVCON, SHIVA DURGA, UPADHAYA, SWIMS (BDK)**
2.1.22	Diaphragm Valve	A	**CRANE PROCESS, FLUID SYSTEM, MASCOT, SWIMS (BDK)**
2.1.23	Air Release Valve	B	**BANKIM, CALSEN, FLUIDTECH EQUIPMENTS Pvt. Ltd., IVC, LEADER, LEVCON, S&M INDUSTRIAL VALVES (KOLKATA), SHIVA DURGA, SIGMA FLOW, UPADHYAY**

S No.	ITEMS	CATEGORY	MAKE
2.1.24	Safety Valve	A	**BHEL, IL, FORBES MARSHALL, MEKASTAR, PENTAIR (TYCO), SWIMS (BDK)**
2.1.25	Needle Valve	A	**AIR CHEM, DUNCUN, SCHRODER, SEIMAG, VALVE TECH IND**
2.1.26	Knife-edge Gate Valve	A	**DEZURIK, FLOWLINK SYSTEMS, HABONIM VASS, JASH, JOSHI JAMPALA, METSO, ORBINOX, PENTAIR (TYCO), VALVE TECH IND, WEIR-MINERALS, BRAY CONTROLS**
2.1.27	Pressure Reducing Valve	A	**CRESCENT, FLOWTEK, FORBES MARSHALL, IL, MEKASTER**
2.1.28	Sluice Gate	B	**FLUIDTECH EQUIPMENTS Pvt. Ltd., IM ENGG, INTERVALVE, JASH, LEVCON, S&M INDUSTRIAL VALVES (KOLKATA), VICTRAM VALVES, VALVE TECH IND.**
2.1.29	Non-Ferrous Valves (General Purpose)	B	**AKSONS, ASCO, BOMBAY METAL, CRESCENT, FLUIDLINE, GM DALUI, LEADER, SANT VALVES, VALVE TECH IND**
2.1.30	Dampers – (in Flue duct)	B	**DTL, FOURESS, INTERVALVE, JOSHI JAMPALA, STAFFORD, VALVE TECH INDUSTRIES**
2.2.**STEAM SERVICE**			
2.2.1.	Gate and Globe (Cast Steel & Forged Steel)	A	**BHEL, FLUIDTECH EQUIPMENTS Pvt. Ltd., FOURESS, HOPKINSONS-WEIR, HYDRO TECH ENGG., INTERVALVE, KSB, L & T, OSWAL INDUSTRIES, PRUSS(HS), SWIMS (BDK), VALVE TECH IND.**
2.2.2.	Non-return Valves (Cast Steel & Forged Steel)	A	**BHEL, DEZURIK, FOURESS, INTERVALVE, KSB, L&T , SWIMS (BDK)**

S No.	ITEMS	CATEGORY	MAKE
2.2.3.	Gate, Globe & Non-return Valves (SS & Alloy Steel)	A	**BHEL, FOURESS, HOPKINSONS-WEIR, KSB, L & T, OSWAL INDUSTRIES, VALVE TECH IND.**
2.2.4.	Ball valves (Cast Carbon Steel and alloy Steel)	A	**BHEL, KSB, L & T, OSWAL INDUSTRIES, THERMAX**
3.	**HEAT EXCHANGERS**		
3.1.	Heat Exchanger (Plate Type)	A	**ALFA LAVAL, APV, HRS, IDMC, SWEP, TRANTER, KELVION INDIA**
3.2.	Heat Exchanger (Shell & Tube Types)	B	**AIR CARE EQUIPMENTS, ALFA LAVAL, APV, BHEL, EASTERN EQUIP ENG (EEE), EUREKA ENGG., GODREJ, HRS HEAT EXCHANGERS, ING-TECH ENGG. CO., L&T, PRECISION COOLING, REILIENCE, RELIANCE, TEMA INDIA, TEXMACO, THERMAL SYSTEMS, THERMAX**
4.	**COOLING TOWERS**	A	**GAMMON, GEA COOLING TOWERS, PAHARPUR, PALTECH, SHRIRAM TOWER, WET BULB**
5.	**FILTERS / STRAINERS**		
5.1.	Filters (Manual/ Automatic Self Cleaning) /Strainers	A	**AMIAD, FILTRATION ENGINEERS, HYDAC FILTERS, OTOKLIN, SUPERFLO, SUREFLO PUROLATOR, TECHNOMAX ENTERPRISES (I) Pvt Ltd (MUMBAI), YAHA WATER SYSTEMS**

S No.	ITEMS	CATEGORY	MAKE
5.2.	Pressure Filters/ Pressure Sand Filters	A	**DOSHI ION-VEOLIA, DRIPLEX, ING- TECH ENGG. CO., EFFWA, EUREKA ENGG. RESIN INDIA, FILTERATION ENGINEERS, ION EXCHANGE, McLANAHAN, OTOKLIN, PENTAIR WATER, TECHNOMAX ENTERPRISES (I) Pvt Ltd (MUMBAI), THERMAX, VA TECH, VOLTAS, YAHA WATER SYSTEMS**
5.3.	Activated Carbon Filter/ Pressure Sand Filter/ Activated Filter Media	A	**ARUDRA, ION EXCHANGE, OTOKLIN, PENTAIR WATER, RESIN INDIA, SUREFLO, THERMAX, VASMYL, VOLTAS, YAHA WATER SYSTEMS**
5.4.	Iron Removal Filter	A	**ION EXCHANGE, SPARKLE, THERMAX, VOLTAS, ZEOLITE INDIA (P) LTD**
5.5.	Y-Strainer	B	**CADILLAC, DRAYTON-GREAVES, FILTERATION ENGINEERS, FORBES MARSHALL, OTOKLIN, SUPERFLO, UNIKLINGER**
5.6.	Cyclone Separator	B	**Filtration Engineers India Pvt. Ltd., LAKOS, SUPERFLO, TIMEX (AMIAD)**
6.	**EXPANSION JOINTS/COMPENSATORS (Utility & Services)**		
6.1.	Expansion Joints / Compensators (Metallic)	A	**ATHULYA, DWREN, FLEXICAN, FLEXITHERM, LONE STAR, BD ENGINEERS, METALLIC BELLOWS, PRECISION ENGINEERS, SUR INDUSTRIES**
6.2.	Expansion Joints/Compensators (Rubber)	B	**CORI ENGG., DWREN, GBM , KELD ELLENTOFT INDIA, PRECISION ENGRS., STANDARD PRECISION BELLOWS, SUR INDUSTRIES**

S No.	ITEMS	CATEGORY	MAKE
7.	**CENTRIFUGAL GAS BOOSTER (BF/CO/BOF/MIXED FUEL GAS)**	A	**AEROTO BOLDROCCHI, ANDREW YULE, BHEL, HOWDEN, TLT**
8.	**INSULATION MATERIAL AND WORK**	B	**BAKELITE HYLAM, FINLAY INSULATIONS, LLYOD INSULATION, RAYCHEM, UP TWIGA**
9.	**PRESSURE VESSELS / BUFFER VESSELS**	A	**BHEL, L&T, NTPC-ALSTOM, PRESSURE VESSEL INDIA (P) LTD., TEXMACO, TITAN ENGINEERING**
10.	**GAS HOLDER (DRY SEAL TYPE)**	A	**MB Engg (CLAYTON WALKER GROUP -UK), LAZARUS & ASSOCIATES**
	GAS HOLDER (WET SEAL TYPE)	A	**MB Engg (CLAYTON WALKER GROUP -UK), LAZARUS & ASSOCIATES**
11.	**PIPES**		
11.1.	Steel Pipes	B	**INDIAN SEAMLESS (ISMT), JSW, JINDAL SAW, JCO GAS PIPE LTD, LALBABA SEAMLESS TUBES, KHANDELWAL, MAHARASHTRA SEAMLESS, SAIL, SURYA TUBES, TATA TUBES, UTKARSH, RATNADEEP METAL & TUBES LTD.**
11.2.	Stainless Steel Pipes	B	**CHOKSY, DIVINE TUBES, JINDAL SAW, MAHARASHTRA SEAMLESS, MEC TUBES, SURAJ LTD., QUALITY STAINLESS, STANDARD (INDIA), STERLING, ZENITH, RATNADEEP METAL & TUBES LTD**
11.3.	Cast Iron Pipes & Specials	B	**KALINGA IRON WORKS, KESORAM INDIA LTD.**

S No.	ITEMS	CATEGORY	MAKE
11.4.	DI Pipes	B	**ELECTRO STEEL CASTINGS., JINDAL SAW, TATA METALIKS DI PIPE LTD.**
12.	**WATER TREATMENT AND DM WATER PLANT**		
12.1.	DM , Soft Water Plant, RO PLANT	A	**VEOLIA, DRIPLEX, EFFWA, EUREKA FORBES, GE POWER & WATER, GEA ENERGY SYSTEMS, ION EXCHANGE, ISGEC (Except RO Plant), PENTAIR WATER, RESIN INDIA, SPARKLE, THERMAX, TRIVENI ENGG., VOLTAS**
12.2.	Clarifier	B	**EIMCO-KCP, EUREKA FORBES, JORD ENGINEERS, McNALLY SAYAJI, TECHNOMAX ENTERPRISES (I) Pvt Ltd (MUMBAI), TRIVENI ENGG. Water Systems India Pvt. Ltd., YAHA WATER SYSTEMS**
12.3.	Thickener	-	**As per makes of Thickener mentioned in MINING & MINERAL PROCESSING AREA**
12.4.	Chemical Dosing	B	**CHEMBOND, GE POWER & WATER, NALCO, SJ INDUSTRIES, TELLABS CHEMICALS, TRIVENI ENGG**
12.5.	Filter Press	A	**ANDRITZ, DINSHAW, FILTER MACHINE, FL SMITH, PANAMA, SUREFLO**
13.	**EQUIPMENT & SYSTEM FOR AIR AND GAS**		
13.1.	Turbo Blower	A	**BHEL (For Centrifugal), Howden CKD Compressors (For Centrifugal), KAWASAKI, Mitsui E&S Machinery Co., MAN Energy Solutions, SIEMENS**
13.2.	Compressor (Centrifugal)	A	**ATLAS COPCO, FS-ELLIOTT, INGERSOLL RAND, KAZANCOMPRESSORMASH, KIRLOSKAR, KOBELCO, SIEMENS**

S No.	ITEMS	CATEGORY	MAKE
13.3.	Compressors (Screw)	A	**ATLAS COPCO, ELGI, INGERSOLL RAND, KAEZER, KIRLOSKAR PNEUMATIC**
13.4.	Compressors (Reciprocating)	A	**BURCKHARDT COMPRESSION, ELGI, INGERSOL RAND, KIRLOSKAR PNEUMATIC**
13.5.	Portable Air Compressors	B	**ATLAS COPCO, ELGI, HOLMAN CLIMAX, INGERSOLL RAND, KIRLOSKAR**
13.6.	**Centrifugal Blowers & Fans – For all applications except fuel gas**		
	Capacity < 80,000 m3/h	A	**AEROTO BOLDROCCHI, ANDREW YULE, BATLIBOI, BHEL, C.DOCTOR, HOWDEN, MAXFLOW, REITZ, TLT ENGG.**
	Capacity > 80,000 m3/h	A	**AEROTO BOLDROCCHI, ANDREW YULE, BHEL, HOWDEN, MAXFLOW, TLT ENGG**
13.7.	Air Drier	B	**ATLAS COPCO, DELAIR, EXAL, INGERSOL RAND, ROOS TEMPKOOL, SANPAR, TRIDENT**
13.8.	Air Trap	B	**DRAYTON GREAVES, FORBES MARSHAL, UNI KLINGER**
13.9.	Moisture Separator	B	**DRYTECH ENGINEERS, FESTO CONTROL, HYDAIR, NUCON, ROSS, SCHRADER, SMC, THERMAX, UNIKLINGER, VELJAN**
14.	**POWER PLANT EQUIPMENT**		
14.1.	Boilers (Stoker, Pulverised, AFBC, CFBC)	A	**BHEL, GE, ISGEC, THERMAX, THYSENKRUPP**
	Gas Fired Boiler	A	**BHEL, GE, ISGEC, THERMAX**
	Waste Heat Boilers	A	**BHEL, ISGEC, THERMAL SYSTEM (less than 50 tph capacity), THERMAX**
14.2.	Steam Turbines (For turbo-blower)	A	**BHEL, MAN Energy Solutions, SIEMENS**

S No.	ITEMS	CATEGORY	MAKE
14.3.	Steam Turbines (For power generation)	A	**BHEL, MAN Energy Solutions, SIEMENS, SKODA, TRIVENI TURBINE**
14.4.	Auxiliary Steam Turbines (Range less than 1000 kW)	A	**KEPL, FORBES, TRIVENI TURBINE**
14.5.	Gas Turbines	A	**ALFA LAVAL, ALSTOM, BHEL, GE, MITSUBISHI, SIEMENS**
14.6.	Top Pressure recovery Turbine	A	**KAWASAKI, Mitsui E&S Machinery Co., MAN Energy Solutions**
14.7.	Condenser (Water)	A	**ALSTHOM, BHEL, GE GODAVARI, MAZDA, SIEMENS, UNIVERSAL HEAT EXCHANGER**
14.8.	De-aerator	A	**BHEL, ION EXCHANGE, ISGEC, THERMAX**
14.9.	PRDU	A	**BHEL, CHEMTROL, FORBES MARSHAL, THERMAX, KOSO FLUID CONTROL, EMERSON PROCESS MANAGEMENT**
14.10.	HP / LP Dosing	A	**ASIA LMI, ENPRO, META CHEM, VK PUMPS**
14.11.	Soot Blowers	A	**BERGMAN, BHEL, SISTON**
14.12.	HP Heater & LP Heater	A	**BHEL, ISGEC, SIEMENS, THERMAX**
14.13.	Steam Traps	B	**DRAYTON, FORBES MARSHALL, GREAVES, THERMAX, UNIKLINGER, ESCO, UNISON VALVES, PENANT ENGG, ECON STEEL**
15.	**POLLUTION CONTROL EQUIPMENT**		
15.1.	ESP		------

S No.	ITEMS	CATEGORY	MAKE
	Capacity < 5,00,000 m3/h	A	**ANDREW YULE, BATLIBOI ENVIRONMENTAL ENGG, BHEL, ELEX, FL SMIDTH, GEA PROCESSING, HARMONY ENVIRONMENTAL SYSTEMS (HES), K. C COTTRELL INDIA, RIECO INDUSTRIES, SOIL & ENVIRO INDUSTRIES, THERMAX INDIA**
	Capacity > 5,00,000 m3/h	A	**BHEL, ELEX, FL SMIDTH, GEA PROCESSING, K. C COTTRELL INDIA, SOIL & ENVIRO INDUSTRIES, THERMAX**
15.2.	BAG FILTERS		**------**
	Capacity < 2,50,000 m3/h	A	**ANDREW YULE, APC SYSTEMS, BATLIBOI ENVIRONMENTAL ENGG., BEVCON WAYORS, CK AIRTECH, CLAIR ENGINEERS, F. HARLEY, GLOBAL ENVIRO SYSTEM, RIECO INDUSTRIES, SOIL & ENVIRO INDUSTRIES, THERMAX**
	Capacity > 2,50,000 m3/h	A	**ANDREW YULE, BATLIBOI ENVIRONMENTAL ENGG., BOLDROCCHI, RIECO INDUSTRIES, SOIL & ENVIRO INDUSTRIES , THERMAX**
15.3.	DUST SUPPRESSION SYSTEM	B	**CHEMTROL SAMIL, DUST SOLUTION SYSTEM, F. HARLEY, KAVERI ULTRAPOLYMERS, SPRAYING SYSTEMS, TPS INFRASTRUCTURE**
15.4.	CYCLONES AND MULTI CYCLONES	B	**AEROTO BOLDROCCHI, AIR TECHNICO, ANDREW YULE, BATLIBOI ENVIRONMENTAL ENGINEERING, F. HARLEY, RAJDEEP ENGG, RIECO INDUSTRIES, THERMAX**
16.	**AIR CONDITIONING, REFRIGERATION & VENTILATION**		

S No.	ITEMS	CATEGORY	MAKE
16.1.	Window/Tower/Split AC/ Ductable Split AC	B	**BLUE STAR, CARRIER, DAIKIN, FEDDERS LLYOD, HITACHI, MITSUBISHI, SAMSUNG, VOLTAS, ZAMIL**
16.2.	Packaged Chillers	A	**BLUE STAR, CARRIER, DAIKIN, DUNHUM BUSH HITACHI, TRANE, VOLTAS, YORK**
16.3.	Package AC	B	**ACCEL, BLUE STAR, DAIKIN, VOLTAS**
16.4.	Precision Air Conditioning	A	**CLIMAVENETA, EMERSON, STULLZ-CHSPL (INDIA)**
16.5.	Cooling Tower (ACVS)	B	**ADVANCE COOLING TOWERS, ARMEC, DBR, FRICK INDIA, GAMMON INDIA, HIMGIRI, MIHIR ENGINEERS, PAHARPUR, SOUTHERN COOLING TOWERS,VOLTAS, WET BULB**
16.6.	Air Handling Unit	B	**DAIKIN, EDGETECH, ETA, ROOTS COOLING, VOLTAS, ZAMIL, ZECO AIRCON**
16.7.	Tube Axial Fan	B	**ABLE AIR-O TECH, AEROVENT, ANDREW YULE, CARYAIRE, DUSTVEN, EFE, FLOWLINK, HUMIDIN, KHAITAN, KRUGER, MAXFLOW, MESINA, SH ENGG., TUBOFLOW**
16.8.	Panel Filter For Air	B	**ABB, ACCO, BHARAT, C.DOCTOR, CADILLAC, EFE, FLOW LINK, FMI, GEC, PUROLATOR, WFI**
16.9.	Air Washer	B	**AIRLINK, EFE , HUMIDIN, MARCO, MESINA, ROOTS COOLING , SYMPHONY**
16.10.	Propeller Fan	B	**ABB, ACCO, AEROVENT, DUVENT, INDVENT FANS, MESINA, SH ENGG., TUBOFLOW, VENTURA**

S No.	ITEMS	CATEGORY	MAKE
16.11.	Roof Extractors	B	**AIRLINK, ALMONARD, ANDREW YULE, C. DOCTOR, CARYAIRE, EFE, FLOWLINK, HUMIDIN, KRUGER, VENTURA**
16.12.	Vapor Absorption Machine	A	**BLUE STAR, CARRIER, KIRLOSKAR, THERMAX, VOLTAS**
17.	**OXYGEN & CRYOGENIC SERVICE**		
17.1.	Cryogenic Pump	A	**CRYOPUMP, CRYOSTAR, ICL**
17.2.	Oxygen Filter / Y-Strainer	A	**BEE, BLUESTAR, CARBERN, CLASSIC, Filteration Engineers India Pvt. Ltd., NOVINTEC, ORSEAL, SHIPHAM, VEE**
17.3.	Non Ferrous Control Valves	A	**BLACKHALL, FISHER, LEEDS, METSO, SAMSON, SEVERN GLOCON**
17.4.	Non Ferrous Self-regulating Valves	A	**BALEY BRIKETT, BROADY, FISHER, SAMSON, SEVERN GLOCON, TYCO**
17.5.	Non Ferrous Valves (Gate, Globe, Ball) - < DN50	B	**CRESCENT, FLUIDLINE, LEADER, MICROFINISH**
17.6.	Non Ferrous Valves (Gate, Globe, Ball) - > DN50	A	**BESTOBELL, BROOKSBANK, FISHER, HEROSE, LEEDS, MACK, METSO, SAMSON, SEVERN GLOCON, SHIPHAM**
17.7.	Safety Relief Valve	A	**ARCA, BAILEY BRIKETT, BROADY,CROSSBY, DARLING MUESEO, FARRIS, IL, JN MARSHALL, KEYSTONE, KUNKLE, SEBIM, SEMPELL, TYCO**
17.8.	Vaporizers	A	**CRYOQUIP, ICL, INOX, IWI CRYOGENICS, SHELL & TUBE**
18.	**FIRE FIGHTING EQUIPMENT**		

S No.	ITEMS	CATEGORY	MAKE
18.1.	Portable Fire Extinguishers	B	**DEFLAME, FIRE SHIELD, FIREX, GUNNEBO, INTIME FIRE, KANADIA FYR FYTER, MINIMAX, NITIN, SAFEX, SUPREMEX, ZENITH**
18.2.	Fire hydrant	B	**ASCO, GUNNEBO, MINIMAX, NEWAGE, NITIN,STEELCO, ZENITH**
19.	**REHEATING FURNACE (Pusher/Rotary)**	A	**ANDRITZ, ENCON, FIVESTEIN, HYPERTHERM, TECHNOTHERM, TENOVA, WESMAN**
20.	**MISCELLANEOUS ITEMS**		
20.1.	Surge Tanks	B	**ANUP ENGG., PERFECT ENGG., SAKTHI HITECH, ZENITH ERECTORS**
20.2.	Oil Skimmer	B	**HI-TECH ENGRS, JVM ENG., POTENTIAL ENGG, PREMIER OIL SKIMMER**
20.3.	Traveling Water Screen	B	**MACMET, MAHINDRA ASTECH, McGALE, OTOKLIN, SWAMINA INT., TRIVENI**
20.4.	**Electrical Heat Tracer**	**B**	**NICROPAD, RAYCHEM, THERMON, THERMOPAD**



SECTION-G

COMPUTERIZATION & INFORMATION TECHNOLOGY

S No.	ITEMS	CATEGORY	MAKE
1.	**IT EQUIPMENT**		
1.1.	Desktop PC	B	**DELL, HP, LENOVO**
1.2.	Industrial PC / Semi-Rugged Laptop	B	**ADVANTECH, DELL, PANASONIC, SIEMENS**
1.3.	Laptop	B	**DELL, HP, LENOVO**
1.4.	Server	A	**DELL, HPE, FUJITSU, LENOVO/IBM, ORACLE/SUN**
1.5.	Network Switch/ Router/ WAP (IT, Office)	A	**CISCO, DELL, EXTREME, HP/HPE, RUCKUS**
1.6.	Network Switch/ Router/ WAP (Industrial)	A	**ADVANTECH, CISCO, HIRSCHMANN, ROCKWELL, SCHNEIDER, SIEMENS**
1.7.	Cyber Security Solutions (Hardware/ Software)	A	**CHECKPOINT, CISCO, FORTINET, JUNIPER, SOPHOS, PALO ALTO**
1.8.	Passive network components / accessories	B	**DIGILINK/SCHNEIDER, MOLEX, RiT, ROSENBERGER, SYSTIMAX, TYCO (AMP)**
1.9.	UTP cable	B	**DIGILINK/SCHNEIDER, ELKAY, MOLEX, RiT, SYSTIMAX, TELELINK, TYCO(AMP), UNIVERSAL**
1.10.	FO cable	B	**BELDEN, DIGILINK/SCHNEIDER, FINOLEX, LUCENT, MOLEX, RiT, STARLITE, SYSTIMAX, TYCO(AMP), ROSENBERGER**
1.11.	Data storage system	A	**DELL/ EMC, FUJITSU, HP/HPE, HITACHI, IBM, NETAPP, ORACLE**
2.	**CCTV SYSTEM**		
2.1.	CCTV system	B	**BOSCH, CP PLUS, HONEYWELL, , PANASONIC, PELCO, PRAMA, SAMSUNG, SEIMENS, SONY, TYCO**
2.2.	LED display (40" or more)	B	**HITACHI, LG, PANASONIC, SAMSUNG, SONY**
2.3.	Video wall	B	**DELTA, HITACHI, LG, PANASONIC, SAMSUNG, SONY**

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15. TECHNICAL PARTICULARS TO BE FURNISHED BY THE TENDERER

A. Boiler & Auxiliaries

1.		Steam delivering capability of boiler at 100% BMCR	:
2.		Gross efficiency of the boiler at	
	(i)	100% BMCR	:
	(ii)	Gross efficiency at 80% BMCR	:
	(iii)	Gross efficiency at 60% BMCR	:
3.		Total auxiliary power consumptions (ID fan, FD fan, BFP and other motors)	:
4.		Rated steam temperature at superheater outlet between 60 % to 100 % BMCR (control range) with automatic control.	:
5.		Rated steam pressure at superheater outlet between 60 % to 100 % BMCR (control range)	:
6.		NO_X and $S0_x$ emission at 100 % BMCR NOx emission at 100% BMCR SOx emission at 100% BMCR	:
7.		Steam purity at 100% BMCR	:
8.		Fuel consumption at	
	i)	100 % BMCR	:
	ii)	80 % BMCR	:
	iii)	60 % BMCR	:
9.		Excess air at Economiser outlet at 100 % load.	:
10.		Minimum load with only Oil firing	:
		Minimum load with only gas firing	:
11.		Noise level at source	
	i)	ID Fan	:
	ii)	FD Fan	:
	iii)	BFPs	:
	iv)	Any other equipment	:

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12. Total auxiliary power consumption at 100% BMCR

i) ID Fans :
ii) FD Fans :
iii) Boiler Feed Pumps :
iv) CEP :
v) Feed water Transfer Pump :

13. General Technical Particulars

	100% BMCR	80% BMCR	60% BMCR
(BMCR=Boiler max. continuous rating)			
	1)	2)	3)

13.01 Performance Data

a) Steam flow from superheater, TPH

b) Superheater Desuperheating spray water flow, t/h

c) Auxiliary steam flow for soot blowing, preheater, oil burner, atomisation etc., kg/h
(Give break-up)

d) Fuel Consumption

i) BF gas consumption, Nm^3/h
ii) BOF Gas consumption, Nm^3/h
iii) CO Gas consumption, Nm^3/h
iv) CBM Gas consumption, Nm^3/h (for 60% BMCR only)
v) LPG/ Propane consumption, Nm^3/h (for 60% BMCR only)

13.02 Calculated flow quantities, t/h

a) Total combustion air to Tubular air preheater (TAPH) inlet

b) Total Combustion air at Wind-boxes

c) Flue gas at TAPH inlet

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d) Flue gas at TAPH outlet

e) FD fan outlet air

f) ID fan inlet flue gas

13.03 Steam/Water Pressure & Pressure Drops, kg/cm^2 abs

a) Steam pressure at final superheater outlet, i.e. at MSV

b) Pressure drop in superheater(s)

c) Steam Pressure in Boiler drum

d) Pressure drop in Economiser

e) Water pressure at Economiser inlet

13.04 Steam / Water Temperature, deg.C

a) Steam at superheater outlet

b) Water at Economiser inlet

c) Water at Economiser outlet

d) Steam temperature before spray

e) Steam temperature after spray

13.05 Flue Gas Temperature, deg.C

a) Theoretical Combustion Zone temp.

b) Furnace Exit

c) Primary Superheater inlet

d) Primary Superheater outlet

e) Secondary (Final) superheater inlet

f) Secondary (Final) superheater outlet

g) Final superheater inlet

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h) Final superheater outlet

i) Economiser inlet

j) Economiser outlet

k) TAPH inlet

l) TAPH Outlet

m) I.D. Fan Inlet

n) I.D. Fan Outlet

o) Stack Inlet

p) Boiler bank inlet

q) Boiler bank outlet

13.06 Air Temperature, deg.C

a) FD fan inlet

b) Air at TAPH inlet

c) Secondary Air at burner inlet.

13.07 Air Pressure Drop (Combustion Air), mm WC

a) FD and inlet duct

b) Thru' TAPH-air side

c) Duct & dampers from TAPH to Furnace Windbox

d) Burner windbox to furnace

e) Between inlet and throat of air flow measuring device

f) Unrecovered loss across air flow measuring device

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g) Total loss through the system

13.08 Flue Gas Pressures & Pressure Drops, mm WG

a) Furnace pressure (suction)

b) Total drop Across Superheater + banks

c) Drop Across Economiser

d) Drop thru' Ducts & dampers from

i) TAPH inlet to ID fan inlet

ii) ID fan outlet to Stack inlet

e) Total drop through the system

f) Pr. Drop across superheater

g) Pr. Drop across boiler bank

13.09 Excess air (%)

a) At Burners

b) At Furnace Exit

c) At Economiser Outlet

d) At TAPH Outlet

e) At ID fan Inlet

13.10 Steam Purity (ppm)

a) Total dissolved solids

b) Silica

c) Sodium

d) Chlorides

e) Copper

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	f)	Iron
13.11		Percentage load change per minute while maintaning safe flame conditions
13.12		Acid dew point temp. adopted, deg.C for design gas firing
13.13		Flue gas/air velocities, m / sec.
	a)	In superheater Section
	b)	In Economiser Section
	c)	In Ducts
		(i) Cold air (ii) Hot air/ gas
13.14		Percentage of Oxygen in Flue Gas
	a)	At Furnace exit
	b)	At Economiser outlet
	c)	At TAPH outlet
13.15		Heat absorbed @ BMCR
	a)	In TAPH
	b)	In Economiser
	c)	In Superheater
	d)	In Water walls
	e)	Total heat absorbed by the unit
	f)	In boiler bank
13.16		Losses and Efficiency,%
	a)	Standard / Code as per which the losses & efficiency shall be measured

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b) Unburnt combustible loss

c) Radiation loss

d) Dry gas loss

e) Moisture & H2; air loss

f) Other losses, if any,

g) Total losses

h) Efficiency

13.17 Energy Quantities, kcal/h

a) Net heat input per unit of Furnace volume, kcal/h/m3

b) Maximum net heat input per unit of Furnace plan, area, kcal/h/m2

c) Maximum Burner Zone heat release rate, kcal/h/m2 or kcal/h/m3

d) Effective Projected radiant surface (kcal/h/m2)

13.18 Power requirement of Auxiliaries, kW (Including ID, FD.) Also furnish drive list separatly.

i) Each motor capacity
ii) Type
iii) Rated Volt/ Current
iv) RPM
v) Quantity

13.19 Recommended time (in hours) periods to bring boiler on load

a) After cold start

b) After tewnty four (24) hours' shutdown

c) After eight (8) hours shutdown

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d) Hot restart after trip out
(less than 1 hr. shutdown)

13.20 Control point of Boiler (%MCR)

13.21 Cooling water requirement for the Boiler & Auxiliaries (Furnish equipment wise break up also)

a) Total quantity, m3/h

b) Pressure, kg/cm2g

c) Inlet temperature, ^{0}C

d) Temperature rise, deg.C

13.22 Feed water requirement

13.23 Service air and Instrument air requirement for the boilers & auxiliaries

a) Total Quantity, Nm^3/h

b) Pressure, kg/cm^2g

c) Pressure Dew Point (PDP), deg.C

13.24 Noise level

i) ID fan
ii) FD fan
iii) BFP
iv) Other equipment

13.25 Emission

a) NOx emission

b) CO emission

c) SOx emission

14.0 Boiler and Pressure Parts

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14.01		General Data		
	a)	Manufacturer		
	b)	Design Code		
	c)	Minimum load at which Boiler can be operated continuously with complete flame stability with gas firing,(%MCR)		
	e)	Water holding capacity, m3 Drum Water wall SH		
	f)	Total water requirement of the Boiler for hydraulic test, m^3		
14.02		Furnace		
	a)	Explosion/Implosion withstand capacity, mmWC		
	b)	Protective measures provided to prevent implosion /explosion		
	c)	Height from furnace bottom to furnace roof, m		
	d)	Depth, m		
	e)	Width, m		
	f)	Furnace projected area, m^2		
	g)	Furnace volume, m^3		
14.03		Water Walls		
	i)	Front Wall (Floor wall, if applicable)	Front Walls -------	Floor Walls -------
	a)	Number/Type		
	b)	Outside diameter, mm		
	c)	Design thickness, mm		

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d) Pitch, mm

e) Actual thickness used, mm

f) Design standard

g) Material

h) Total projected surface, m^2

i) Method of joining long tubes

j) Method of attachment to drum

k) Method of joining to headers

l) Design pressure of tubes, kg/cm^2

m) Maximum of tubes, kg/cm^2(abs)

n) Design metal temperature, ^0C

o) Total weight of tubes, kg

ii)	Side walls, rear walls & roof	Side walls	Rear walls	Roof
a)	Number/Type			
b)	Outside diameter, mm			
c)	Design thickness, mm			
d)	Pitch, mm			
e)	Actual thickness, mm			
f)	Design standard			
g)	Material			
h)	Total projected surface area of tubes, m^2			
i)	Method of attachment to drum			

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j) Method of joining long tubes

k) Method of joining to headers

l) Design pressure of tubes, kg/cm^2(abs)

m) Maximum working pressure of tubes, kg/cm^2 (abs)

n) Total weight of of tubes, kg

.

o) Design metal temperature, ^{0}C

.

14.04	Water Wall Headers	Bottom Header	Top Header
a)	Number of headers		
b)	Height of the lowest header above the ground level, m		
c)	Outside diameter, mm		
d)	Design thickness, mm		
e)	Actual thickness provided, mm		
f)	Length of each header, m		
g)	Design standards		
h)	Maximum header unbalance		
i)	Design pressure of headers, kg/cm^2 (abs)		
j)	Maximum working pressure, kg/cm^2 (abs)		
k)	Material specification		

14.05	Boiler Drum	Steam Drum	Water Drum
a)	Number		
b)	Construction		
c)	Material specification and composition		

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d) Manufacturer of plate material

e) Composition

f) Ultimate tensile strength of plates, kg/cm^2

g) Design pressure, kg/cm^2abs

h) Design metal temperature, ^0C

i) Design stress at working metal temperature (0.2% proof stress), kg/cm^2

j) Maximum operating pressure, kg/cm^2 abs

k) Design standard

l) Design thickness for straight portion, mm

m) Design thickness for dished ends, mm

n) Actual thickness used for straight portion, mm

o) Actual thickness used for dished ends, mm

p) Overall length of drum, mm

q) Outside diameter of drum, mm

r) Internal diameter, mm

s) Corrosion allowance, mm

t) Maximum permissible temperature differential between any two parts the drum, ^0C.

i) During Normal operation
ii) During accelerated starting

14.06 Water capacity at MCR condition between normal and lowest water level permitted. (m3)

14.07 Superheater Primary Secondary

a) Type (Radiant/convection)

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b) Horizontal headers (drainable/non- drainable)

c) Material specification and composition

d) Gas flow path area, m^2

e) Depth of each bank in the direction of the gas

f) Clear space between the two banks in the direction of gas flow, mm

g) Maximum steam side metal temperature, ^0C

h) Maximum gas side metal temperature, ^0C

i) Material of tube support (composition)

j) Design standard

k) Design tube thickness, mm

l) Outside diameter, mm

m) Actual thickness used, mm

n) Margin on tube thickness over and above pressure requirement, mm

o) Number of elements/ section

p) Total number of tubes

q) Tube pitch, mm
i) Parallel to gas flow
ii) Across gas flow

r) Number and type of thermocouples fitted to

14.8	Headers of Superheater	Primary Inlet/ Outlet	Secondary Inlet/ outlet
a)	Material specification		
b)	Location (outside/inside gas path)		

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c) Maximum operating pressure, kg/cm^2 abs

d) Design pressure, kg/cm^2 abs

e) Design standard

f) Outside diameter, mm

g) Thickness, mm

14.9 Superheater Temperature Control Superheater attemperator

a) Type

b) Number of stages of attemperation

c) Position in steam superheater circuit

d) Specification of material

e) Superheated steam temperature range that can be maintained between 60% to 100% of Boiler MCR,^{0}C.

f) Spray nozzle material

14.10 Economiser

a) Type (plain, Drainable, Non-steaming)

b) Material specification and composition

c) Design pressure of tubes, kg/cm^2 abs

d) Outside diameter of tubes, m

e) Design tube thickness, mm

f) Actual thickness used, mm

g) Pitch, mm

h) Pitch, across gas flow, mm

i) Design standard

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j) Minimum allowable inlet feed water temperature the economiser can handle safely, ^{0}C.

14.11 Boiler Mounting and Fittings

i) Drum safety valves

a) Manufacturer

b) Type and rating

c) Number

d) Specification of material for
- Body
- Trim/Spring
- Seat

e) Set pressure, kg/cm^{2}g

f) Flow capacities, kg/h

g) Type of end connections

ii) Superheater safety valves (for each safety valve)

a) Manufacturer
b) Type and rating
c) Number
d) Specification of material for
- Body
- Trim/spring
- Seat

e) Set pressure, kg/cm^2

f) Flow capacity, t/h

g) Type of end connections

iii) Power operated impulse safety valve

a) Manufacturer

b) Type of actuator

c) Number

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d) Capacity of valve, t/h

e) Set pressure, kg/cm^{2}g

iv) Drum Level Gauges

a) Manufacturer

b) Type gauge

c) Number

d) Location

e) Size

v) High pressure valves for Isolation Regulation etc. on steam & feed water service

a) Manufacturer of
- Main steam stop valve
- Valve electric actuators
- Valves on feedwater Service
- Blowdown valves
- Other special valves

b) Double isolation valves provided as per specification

c) Control valve for aux. Steam system

i) Make & Model
ii) Type
iii) Number offered per boiler
iv) Material of construction

15.0 Tubular Air Preheaters (TAPH)

i) Manufacturer

ii) Type

iii) Number offered per boiler

iv) Mounting (Vertical/ Horizontal)

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and clearance from ground, m

v) Maximum handling capacity, Nm^3/hr.

a) Flue gas
b) Air

vi) Handling capacity at 100% MCR, Nm^3/hr

a) Flue gas
b) Air

vii) Flue gas temperature at air heater outlet, ^0C.

a) at 100% BMCR
b) at 100% TMCR
c) at 80% BMCR
d) at 60% BMCR

viii) Tube plate Thickness, mm

ix) Material

x) Tubes
No. off
OD & Thickness, mm
Material

16.0 Flue And Air Ducts

a) Thickness and material of flue gas duct

b) Thickness and material of air duct

c) Velocity of flue max. min.

d) Velocity of air max. (cold/hot) min

17.0	Draft Plant	FD Fan	ID Fan
		---	---
i)	Manufacturer		
ii)	Type		
iii)	Number of fans per boiler		

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iv) Capacity (flow rate for each fan) m^3/h

a) At 100% Boiler MCR
b) At design (test block) conditions
c) Max. flow rate the fan can handle
d) Min. flow rate the fan can handle

v) Static pressure, mm WC

a) At 100% Boiler MCR
- For fan inlet
- For fan outlet

b) At design (test block) condition
- For fan inlet
- For fan outlet

c) At shut off condition

d) Min. safe pressure

vi) Design margin provided

a) Flow rate, %
b) Static pressure, %

vii) Density of air/gas at working temperature, kg/cm^3

viii) Synchronous speed of connected electric motor

ix) Normal fan spped, RPM

x) Critical speeds of fan

a) First critical speed, RPM

b) Second critical speed, RPM

xi) Fan efficiency at

a) Design (Test block) condition

b) 100% Boiler MCR

c) 80% Boiler MCR

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e) 60% Boiler MCR

xii) Impeller details

a) Impeller diameter, mm
b) Shaft diameter, mm
c) Moment of inertia of shaft and impeller, kg/m^2

xiii) Overall dimensions of fan & motor

xiv) Size of motor provided, KW

xv) Power Consumption, KW
a) At 100% Boiler MCR
b) At 80% Boiler MCR
c) At 60% Boiler MCR
d) Shaft HP at 100% Boiler MCR

xvi) Moment of Inertia of
Fan, kg/m2
Motor, kg/m2
Total, kg/m2

xvii) Type of coupling (Furnish details separately)

xviii) Lubrication system (forced/ring-lubrication)

Sump oil Lubrication
a) For fans
b) For motors

xix) Features of construction

a) Blades provided with renewable wearing noses?

b) Mode of adjustment of gas/air flow control

c) Range of above flow control

xx) Material of construction and thickness

a) Casing
b) Casing liner
c) Impeller blade

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xxi) Bearings

a) No. and make
b) Type of bearings
c) Bearing liner Material
d) Method of lubrication
e) Grade of lube oil
f) Thermometers provided ?
g) RTD provided ?
h) method of cooling the bearing(If not forced lubrication)

xxii) Lube oil system

a) No. of pumps/fan
b) No. of pumps in standby service
c) Type of pumps
d) No.of oil cooler/fan
e) No. of oil coolers in standby service
f) Relief Valves Provided?
g) Pressure switches provided?
h) Thermometers provided?
j) Electric heater with oil tank provided?

xxiii) Accessories

a) Coupling guards provided?
b) Base plate and foundation bolts provided ?
c) Forced lubrication unit with pumps, filters, coolers connected piping etc. provided ?
d) hydraulic control unit with pumps filters, coolers, connected piping etc. provided ?
e) Local instruments provided ?
f) RTDs for fan and motor bearings provided?

18.0 Blow down vessels

i) Whether separate vessels offered for continuous & intermittent blow down ?

ii) Number per Boiler

iii) Design code followed

iv) Operating conditions

a) Pressure, kg/cm^2a

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b) Temperature, ^{0}C.

v) Design conditions

a) Pressure, kgcm^{2}a
b) Temperature, ^{0}C.

vi) Shell thickness, mm

vii) Corrosion allowance, mm

viii) Shell diameter, m

ix) Shell height, m

x) Capacity adequate to receive drains from Deaerator, main steam lines ?

xi) Drain & overflow arrangement

19.0 Gas burners

i) Manufacture

ii) Type

iii) Design data

iv) Number per boiler

v) Number per elevation

vi) Number of elevation

vii) Turndown ration

viii) Capacity of burner

ix) Construction features

x) Material of construction

xi) Codes and standards applicable

20.0 Ignition System

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a) Manufacturer

b) Type (high energy arc ignition system)

c) Number of spare ignitors per boiler

d) Number of spare ignitors

e) Heat input per ignitor kcal/h

f) Retractable or stationary ?

g) If high energy arc ignitors are offered, then following data shall be furnished

i) Electrode material

ii) Expected life of electrodes

21.0 Thermal Insulation & Refractory work (For Boiler & Internal Piping)

a) Insulating material

i) Type of insulating materials(s)
ii) Manufacturer's name
iii) Maximum temp. (^{0}C) the insulating material can withstand
iv) Insulating material standard
v) Density of insulating material (kg/m^3)

b) Castable Refractory material

i) Type of Refractory materials(s)
ii) Manufacturer's name
iii) Maximum temp. (^{0}C) the insulating material can withstand
iv) Insulating material standard
v) Density of insulating material (kg/m^3)

c) Resistance to micro-organism

d) Incombustibility

e) Steam Generating Plant & Auxiliaries Insulation & Casing (Furnish separately)

22.0 Equipment Dimensions and Weights

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		Dimension	Weight (tonnes)
		---	---
a)	Supporting structure		
b)	Galleries and stairways		
c)	Interconnecting platforms		
d)	Steam drum		
e)	Manholes/inspection windows etc.		
f)	Waterwalls		
g)	Superheater		
h)	Desuperheaters		
i)	Economiser		
j)	Valves & fittings		
k)	Air preheaters		
l)	Fabricated components for main Boiler under sheet casing		
m)	Total Insulation/ Refractory material for Boiler & other equipment		
n)	Boiler casing		
o)	Fabricated components for insulation of Boiler equipment		
p)	Skin casing		
q)	Gas piping		
r)	Cold air ducts		
s)	Hot air ducts		
t)	Flue ducts		

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u) Other ducting

v) FD fan with drive

w) ID fan with drive

x) Other fans with drives

y) Fan duct

z) Platforms and rails

aa) Supporting structure for flue gas system

bb) dampers/vanes with actuators

cc) Fabricated components for insulation of flue gas system

dd) Other (List down items)

ee) Total weight of the package

dd) Boiler feed pump & drives with break up

23. Boiler Feed Pumps & drive

23.01 Pump

i) Number offered and capacity of each set of BFP

ii) Type & manufacturer

iii) Model No.

iv) Pump Performance for each set of above BFP	100% BMCR	80%BMCR	60% BMCR
a) Design capacity ,t/h			
b) Discharge pressure kg/cm^2			
c) Suction pressure kg/cm^2			
d) Total head developed by the pump			

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e) Operating speed and number of stages, rpm

f) NPSH requirement at full capacity

g) Shut off head

i) Power consumption KW
and efficiency at design capacity

j) Power consumption KW and
efficiency at design capacity
with cold water at room temperature

k) Motor rating provided ,KW

23.02 General Technical Particulars for Material of construction

a) Casing
b) Impeller
c) Shaft
d) Shaft sleeve
e) Wearing ring
f) Diffuser
g) Base plate
h) Radial bearing
i) Thrust bearing

24.0	Chemical Feed System	HP Dosing System	LP dosing System
		---	---
i)	Tank		
a)	No. offered per boiler		
b)	Capacity each, litres		
c)	Size (Dia x Ht), mm		
d)	Material & Plate thickness		
e)	External painting type & thickness		
f)	All tank accessories & connections provided as specified ?		
ii)	Agitators		

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a) Manufacturer

b) No. provided per tank

c) Speed, rpm

d) Material of shaft & propeller

e) Drive Motor, KW

iii) Pumps

a) Manufacturer & Model No.

b) No. offered per boiler

c) Maximum capacity of each pump, litres/h

d) Rated Head, mWC

e) Type of capacity adjustment provided

f) Materials of construction

i) Cylinder

ii) Displacement plunger

iii) Stuffing box

iv) Crank rod

iv) Instruments

- Electric hooters, level switch and other instruments provided as specified

v) Piping & valves

a) Material

b) Sizes used

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c) Manufacturer

d) Materials of construction

e) Type of ends

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B. Steam Turbine and Auxiliaries

1. Make type & model No.

2. Delivery schedule

3. Catalogue / brochure / leaflet etc.

4. General arrangement & layout of all equipment

5. P & I diagrams system scheme & process flow diagram of steam condensate, cooling water and oil system.

6. a. Regulation & control system
   b. Safety & protection system
   c. Supervisory instruments

7. Predicted performance curve

   i. Turbine performance curve with Steam consumption Vs. Load
   ii. Turbine performance curve with heat rate Vs. load
   iii. Turbine BHP at different loads
   iv. Starting rate curve from cold as well as hot conditions
   v. Cycle heat balance diagram

8. a/ Steam consumption in Kg/h, heat rate of turbine in Kcal / kWh under condenser cooling water inlet temperature 34^0C at condenser inlet at TMCR
   Extraction condition
   Straight condition

9.0 a. Main Steam pressure at turbine inlet, Kg/cm^2 g
   Main Steam temperature at turbine inlet, ^{0}C

   i. At maximum duty parameters
   ii. At minimum duty parameters i.e.

   b. Steam pressure at turbine exhaust, Kg/cm^2 g

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c. Steam temp. at turbine exhaust, deg. C

d. Pressure drop between the cooling water inlet and outlet terminal flanges across condenser with 10% tubes plugged. Kg/cm^2 (g)

e. Total cooling water requirement in m^3/h and temperature rise in ^{0}C at cooling water inlet temperature of 34^{0}C

f. Total auxiliary power consumption of all continuously running auxiliary equipment (with break-up), KW

g. i. Steam requirement for each main ejector, Kg/h
ii. Steam requirement for starting ejector, Kg/h

h. Maximum noise level at source, db (A)

i. i. Rated Speed, rpm
ii. Speed range, rpm

j. Condenser vacuum at normal flow rate of turbine and inlet cooling water at 34^0 C, kg/cm^2(a)

k. Maximum flow passing valve wide open condition(5%), t/h.

l. Maximum continuous capacity of turbine, MW

10. **Layout data**

a) Total turbine block length,mm

b) Total turbo-Generator block width.mm

c) Total weight -

i) Turbine-Generator ,tonnes

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ii) Turbine, tonnes

d) Weight of heaviest piece during erection(Generator & turbine).

i) Turbine rotor

e) Moment of Inertia in kg Sq.m for

i) Turbine rotor

ii) Combined rotor assembly

11. **Turbine Design Data**

a) General

i) Last stages annulus area(total), sq.m

b) Last stage blade length and pitch dia., mm

c) Critical speed, rpm of}

i) Turbine rotor

d) Rotor details

i) No. of stages
ii) Method of construction
iii) Diameter of the tips of the first row of blades
iv) Special protection against erosion due to moisture impingement

e) Material of construction

i) Turbine inner casing
ii) Turbine outer casing
iii) Turbine rotor
iv) Control valve chest
v) Blades
- Moving blades

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- Fixed blades

vi) Shaft

vii) Bearing

		Nos. off	Size (mm)	Material
f)	External connections			
	i) Main steam			
	ii) Extraction point			
	iii) Inter-stage drains			
	iv) Outlet connection			

g) Permissible forces & moment at turbine connection flange (Furnish the following data for each connection separately)

i) Forces in kgs.
-Fx-(Axis of turbine rotor)+/-
-Fy-(Vertical) +/-
-Fz-(Lateral) +/-

ii) Moment in kg-m
-Mx +/-
-My +/-
-Mz +/-

h) Turbine Movements

i) Location of turbine anchor point

ii) Movement of the connection flanges for main steam and extraction flanges during heating up of the turbine, mm

Indicate direction
DEL X :
Furnish for each
DEL Y :
Joint separately
DEL Z :

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i) Design pressure and Temperature

i) Valve chest
ii) Casing

j) Maximum noise level, db(A)

k) Bearing

i) Journal bearings-

- Number
- Size
- Type
- Optimum operating temperature
- Lining material

ii) Thrust Bearings

- Number
- Size
- Type
- Optimum operating temp.
- Lining material
- High wear or failure detector

l) Couplings

i) Number
ii) Location
iii) Type
iv) Size
v) No. & size of bolts

m) Exhaust hood relief diaphragm on Condenser

i) Type
ii) Number
iii) Bursting pressure, $kg/cm^2(a)$
iv) Material of construction

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12. **Turbine Controls & Protection**

a) Governor

i) Type
ii) Steady state speed regulation
iii) Speed regulator dead band
vi) Governing range

b) Emergency overspeed governor

i) Type
ii) No. of independent devices
iii) Set operating speed
iv) Range of adjustment
v) Actuation signaling contacts provided ?
vi) Arrangement for testing with unit in operation (on-load test).

c) Control valves for Governor

i) Type
ii) Number & size
iii) Materials
-Valves internals
-Wear surface protection
-Valve seat
iv) Type of sealing

d) Main stop & throttle valve

i) Number
ii) Size
iii) Type & method of actuation
iv) No. of limit switches
v) Provision for on-load testing
vi) Permanent strainer type
vii) Material
- Valve body/ bonnet

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- Valve trim

viii) Type of sealing

13. **Oil System**

a) Main oil tank

i) Capacity, litres
ii) Size
iii) Level indicator with alarm
iv) Internal strainers
v) Relief and access doors
vi) Operating pressure, $kgf/cm^2(a)$
vii) Mountings

b) Main oil tank vapour extractor

i) Number
ii) Type
iii) Capacity
iv) Drive motor, kW
v) Mounting
vi) Lube oil moisture eliminator provided?

c) Overhead lube oil tank

i) Capacity, litres
ii) size
iii) height above turbine / blower shaft
iv) Mountings

d) Overflow type sight flow indicator

i) Type
ii) Number

e) Shaft driven main oil pump

i) Type & Number
ii) Capacity, litres/min.
iii) Suction head, $kg/cm^2(g)$
iv) Discharge pressure, $kg/cm^2(g)$

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f) A.C. Motor driven auxiliary oil pump

i) Type & Number
ii) Capacity, liters/min.
iii) Suction pressure,
iv) Discharge pressure, $kg/cm^2(g)$
v) Drive motor, kW

g) A.C. Motor driven jacking oil pump

i) Type & Number
ii) Capacity, liters/min.
iii) DC motor driven emergency oil pump
- Type
- Details
iv) Suction pressure, $kg/cm^2(g)$
v) Discharge pressure, $kg/cm^2(g)$
vi) Drive motor, kW

h) Oil Cooler

i) Number, working/standby
ii) Type
iii) Capacity of oil, Lit/min.

iv) Cooling water requirement
- Quantity, liters/min.
- Pressure, kg/cm^2 g

v) Pressure drop across cooler, kg/cm^2 g
- Water side
- Oil side
vi) Maximum permissible cooling water temperature at inlet, Deg.C
vii) Water temperature rise, Deg.C
viii) Oil inlet temperature, Deg.C
ix) Oil outlet temperature, Deg.C
x) Tube size and material

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xi) Mountings

i) Oil Strainer (Oil Filter)

i) Number
ii) Type
iii) Location
iv) Removable during operation

j) Oil sight flow indicators at all bearings provided ?

k) Complete specification of the lubricating oil

l) Total oil in the system, Litres

14. **Gland Sealing System**

a) Type of shaft seals

b) Type of seal rings

c) Automatic Seal Regulator

i) Quantity of sealing steam, kg/hr.
ii) Pressure of sealing steam, kg/cm2
iii) Seal steam pressure regulator
iv) Point of steam tapping

d) Gland Steam Condenser

i) Type
ii) Capacity
iii) Designed for maximum condensate flow, t/h.
iv) Water velocity (maximum) in the tubes, m/sec.
v) Tube side design pressure, kg/cm^2
vi) Condensate pressure drop, kg/cm^2
vii) Heat transfer surface, m^2
viii) Tube size and materials used

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ix) Accessories

e) Exhauster for gland steam condenser

i) Type
ii) Number
iii) Drive motor kW

f) Gland seal system capable of operation with gland steam condenser out of service for maintenance ?

15. **Turning Gear**

a) Type
b) Method of engagement
c) Method of disengagement
d) Drive motor kW
e) Turbine rotor speed on turning gear drive
f) Furnished sensing element and other devices as required for remote indication of turning gear engaging & disengaging ?

16. **Turbine Supervisory Instrument**

a) Bearing vibration (Amplitude & velocity)

i) Type of sensing element
ii) Indicator type
iii) Recorder type

b) Axial shift of rotor

i) Type of sensing element
ii) Indicator type
iii) Recorder type

c) Casing & differential expansion

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i) Type of sensing element
ii) Type of indicator
iii) Type of recorder

d) Shaft Eccentricity

i) Type of sensing element
ii) Type of recorder
iii) Type of indicator

e) Control valve position

i) Type of sensing element
ii) Type of recorder
iii) Type of indicator

f) Turbine speed

i) Type of sensing element
ii) Type of recorder
iii) Type of indicator

g) Turbine Acceleration

i) Type of sensing element
ii) Type of indicator

h) Metal Temperatures

i) Type of sensing element
ii) Location of sensing element
iii) Type of recorder

i) Seal Interference

j) Type of sensing element

k) Foundation displacement

l) Type of indicator

m) Any other instrument provided

17. **Condenser**

a) Manufacturer

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b) Type

c) Performance data at rated condition

i) Flow in t/h. of
- Exhaust suction steam to condenser
- System make-up
- Drain from air ejector condenser
- Drain from gland steam condenser

ii) Enthalpy in kcal/kg. of
- Steam from turbine
- System make-up
- Drain from air ejector condenser
- Drain from gland steam condenser

iii) Heat rejected to circulating water at design flow, kcal/kg.

iv) Condenser pressure, $kg/cm^2(a)$

v) Inlet circulating water design pressure, kg/cm^2g

vi) Inlet circulating water design temperature, deg.C

vii) Cleanliness factor used

viii) Temperature of the steam air mixture at the outlet of air removal zone, deg.C

ix) Temperature of condensate at hotwell outlet, deg.C

x) Maximum free oxygen

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content in the condensate coming out of the hotwell CC/litre

xi) Specify code followed for performance calculations

xii) Water velocity in tube m/sec.

xiii) Total cooling water flow m^3/hr.

xiv) Total friction loss across condenser (C.W.inletflange to C.W. outlet flange), MLC

d) Design Particulars

i) No. of passes

ii) Arrangement with respect to turbine axis

e) Condensing surface, Sq.m.

f) Shell

i) Design pressure, kg/cm^2g
ii) Design temperature, deg.C
iii) Thickness of plates, mm
iv) Nozzles provided in the shell
v) Expansion joints provided in the shell

g) Water boxes

i) Type of water boxes
ii) Design pressure, $kg/cm^2(g)$
iii) Design temperature, deg.C
iv) Code used for water box design
v) Method of attaching water boxes to shell
vi) Size of C.W. connection

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- Inlet nozzles, mm
- outlet nozzles, mm

vii) Detail & standard for C.W. inlet and outlet flanges

viii) Suitable drain and vent connection complete with necessary no. of valves provided for all water box compartments ?

ix) Access doors in the water boxes provided ?

h) Tubes

i) O.D. and thickness, mm
ii) Total no. of tubes
iii) Effective tube length, m
iv) Actual length, metres
v) Method of tube to tube sheet joint
vi) Tubes self draining on shut-down
vii) Space required for tube removal, m

i) Hotwells

i) Material thickness
ii) Capacity at normal operating level, kgs,
iii) Normal operating level (from the bottom of hotwell), m
iv) No. and size of condensate outlet nozzles
v) Strainers at condensate outlet provided
vi) Necessary no. of nozzle connection provided
vii) Level instruments provided
viii) Access doors for hotwell provided

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j) Condenser supports and neck expansion joints

i) Type of supports
ii) Total no. of supports
iii) Load on each support, kg.
iv) Manufacturer and type of expansion joint
v) Type of connection at the ends of the expansion joint (flanged or welded)
vi) Material Specification
- Condenser shell
- Hotwell
- Water boxes
- Water box covers
- Tube support plates
- Tube sheets
- Tubes
- Impingement baffles
- Stay rods
- Internal bolts
- Shell expansion joint
- Neck expansion joint
- Water box gaskets
- Internal steam dump piping
- Water box lining
- Tubes sheet paint

k) Forces and reactions

i) Operating load on the condenser feet, kgs.
ii) Maximum load on the condenser feet kgs.
iii) Operating load on the condenser feet, kgs.

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l) Weight and Dimensions

i) Weight of shell and waterboxes (empty),tonnes
ii) Total weight of tubes, tones
iii) Weight of heaviest piece to be handled during transportation and erection, tonnes

18. **Air Extraction System**

a) Manufacturer & Model No.

b) Type

18.01 **Performance data**

a) Main Air Ejector

i) Air removing capacity of the air ejector
- Dry air, Nm3/min.
- Air vapour mixture, kg/hr.

ii) Mixture suction temperature, deg.C
iii) Suction pressure, kg/cm2 (abs.)
iv) Pressure & temperature of driving steam of air ejector ,kg / Sq.cm.;deg.C
v) Total flow of driving steam , kg / hr.
vi) Cut off suction pressure for the air ejector(Suction pressure at zero air flow, kg / cm^2 (abs.)

b) Inter condenser drains
- Pressure, kg/cm2(a)
- Flow, kg/hr.
- Enthalpy, kcal/kg.

c) After condenser drains

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- Pressure, kg/cm2(a)
- Flow, kg/hr.
- Enthalpy, kcal/kg.

d) Starting Ejector

i) Air removing capacity, Nm^3/min. of dry air
ii) Suction pressure for the above capacity, kg/hr.
iii) Total flow of driving steam, kg/hr.
iv) Driving steam pressure, kg/cm^2(g) and temperature, deg.C
v) Time required to raise rated vacuum, minutes

18.02 **Design and Construction**

a) Main Air Ejectors

i) No. Provided
ii) No. of stages
iii) Material specification
- Body
- Nozzles
- Diffusers

b) Inter and After Condenser

i) Nos. provided
ii) Condensing surface, sq.m
iii) Tube O.D. and guage
iv) Tube material specification no.
v) Effective tube length, metres
vi) No. of passes
vii) Design pressure and temperature, kg/cm^2,deg.C
- Shell side
- Tube side

viii) Shell material specification

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ix) Tube sheet material specification

x) Hydrostatic test pressure kg/cm^2(g)
- Shell
- Tube
- Water boxes

18.03 **Starting Ejector**

a) Material of nozzles

b) material of body

18.04 **Weight and Dimensions**

a) Air Ejector

b) Total weight of each air ejector, kg.

c) Overall dimension, m

d) Air Ejector Inter condenser

i) Total weight, kg.
ii) Overall length, m
iii) Outside diameter, m

e) Air Ejector After Condenser

i) Total weight, kg.
ii) Overall length, m
iii) Outside diameter, m

f) Starting Ejector

i) Total weight, kg
ii) Overall dimension, m

19. **Condensate Extraction Pumps**

a) Manufacturer
b) Model No.

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c) Nos. provided

d) Performance data under rated condition

i) Capacity, t/h

ii) Discharge pressure, $kg/cm^2(g)$

iii) Suction pressure, $kg,cm^2(a)$

iv) Temperature at pump suction, deg.C

v) Total pump head, MLC

vi) Required NPSH
Static head at pump suction considering minimum hotwell level, MLC

Total head loss in the suction line, MLC

vii) Speed, rpm

viii) Efficiency, %

ix) Drive power required under design condition, kW

x) Motor rating, kW

xi) Specific speed
- First stage
- Other stages

xii) Shut-off discharge pressure, $kg/cm^2(g)$

xiii) Minimum permissible flow for continuous operation $M^3/hr.$

xiv) Maximum temperature rise under minimum flow operation, deg.C

e) Design and Construction

i) Basic type

ii) No. of stages

iii) Pump rotating assembly
- Moment of inertia of assembly, $kg\text{-}cm^2$

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f) Suction connection

i) Size, mm
ii) Rating of flangs (lb class)

g) Discharge connection

i) Size, mm
ii) Rating of flanges (lb class)

h) Maximum reverse runway speed, rpm

i) Critical speeds, rpm

j) Pump Bearing

i) Manufacturer
ii) Type
iii) Thrust bearing
iv) Manufacturer
v) Type
vi) Provided on the pump or the drive motor

k) Materials

i) Casing
ii) Impeller
iii) Shaft
iv) Shaft sleeves
v) Wearing rings
vi) Shaft seals
vii) Pump can
viii) Coupling
ix) Bolts & nuts
x) Gaskets

l) Weight and Dimensions

i) Completely assembled pump, kg
ii) Rotating assembly, kg.
iii) Motor, kg
iv) Total shipping weight, kg.

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m) Dimensions

i) Overall length, mm
ii) Overall width, mm
iii) Overall height, mm

20. **Pressure Reducing and De-superheating Station (PRDS)**

a. Manufacturer and Model No.

b. Capacity, Pressure, Temp.

c. Inlet steam flow, Press. Temp

d. Inlet feed water flow, press. Temp.

e. Control valve details
i. Steam line
ii. Feed water line

f. Safety valve details

g. Pressure & Temp. gauges

21. **Oil Purification System (Turbine)**

21.01 **Performance Data**

a) Rated capacity, litres/hr.

b) Guaranteed size of solids in the purified oil at the effluent of the polishing filter at rated capacity, microns, (specify also the maximum water content in %)

c) Guaranteed size of solids in the oil at the outlet of the dia of 5µ & above will be removed. (Testing by centrifuge but head of the polishing filter at rated capacity, microns

(Specify also the maximum

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water content in %)

d) Guaranteed percentage of oil drained through heavy phase drain

e) Centrifuging temperature, deg.C

21.02 **Design & Construction**

		Clean Oil Pump	Dirty Oil Pump
a)	Oil Pumps	--------	--------

i) Type
ii) Manufacturer
iii) Capacity, liters/hr.
iv) Total head, m
v) Maximum permissible suction lift at rated capacity, MLC
vi) Pump speed. rpm
vii) Power required at the rated operating conditions, kW
viii) Efficiency of the pump at the operating conditions
ix) Drive details
x) Relief valve
- Capacity, litres/min
- Setting pressure range

xi) Materials of construction
- Casing
- Shaft
- Relief valve

xii) Bearings
- Number
- Type & Make

b) Centrifuge

i) Manufacturer
ii) Type & Model no.

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iii) Bowl capacity, litres
iv) Bowl diameter, mm
v) Speed of the centrifuge rpm
vi) Motor kW
vii) Drive details
viii) Belt guard provided ?
ix) Bearings
- Type and number
- Type of lubrication needed
- Make & Model no.

x) Method of balancing
- Static
- Dynamic

xi) Heavy phase drain through anti-flood tanks ?
xii) Method of signalling loss of water seal in centrifuge and/or excessive water in oil and/or choking of heavy phase drain pipe
xiii) Materials of construction
- Casing
- Bowl and internals
- Shaft

c) Oil Heater

i) Manufacturer
ii) Type & Model no.
iii) Rated capacity, litres/hr.
iv) Design oil inlet temperature, deg.C
v) Design oil outlet temp. deg.C.
vi) Water bath
- Dimension, mm
- Water content, litres
- Gauge glass provided
- Type of insulation

vii) Heating Elements
- No. and ratings, kW
- Material and type of

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construction of heating elements
- Power supply
- No. of thermostats and cut 'in' and cut 'out' temp. of each thermostat

viii) Materials of construction
- Shell
- Tubes
- Heater elements
- Sheathing material

22. **Pipeline material, size and thickness**
- Main steam line
- Auxiliary steam line
- Condensate line
- Feed water line
- DM Water Line
- Oil line
- Cooling water line
- Service & instrument air line
- Fire fighting water line

23. **Requirement of service air instrument air**

i) Normal Nm3/min
ii) Maximum Nm3/min

24. **General Technical Particulars for Feed water transfer pumps**

a) Manufacturer:

b) Model No.

c) Nos. provided(working & standby)

d) Performance data under rated condition

i) Capacity, t/h
ii) Discharge pressure, $Kg/cm^2(g)$
iii) Suction pressure, $kg/cm^2(g)$
iv) Temperature at pump

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suction, deg.C

v) Total pump head, MLC

vi) Required NPSH
Static head at pump suction considering minimum hot well level, MLC
Total head loss in the suction line, MLC

vii) Speed, rpm

viii) Efficiency, %

ix) Drive power required under design condition, kW

x) Motor rating, kW

xi) Specific speed
- First stage

xii) Shut-off discharge pressure, $kg/cm^2(g)$

xiii) Minimum permissible flow for continuous operation $M^3/hr.$

xiv) Maximum temperature rise under minimum flow operation, deg.C

e) Design and Construction

i) Basic type

ii) No. of stages

iii) Pump rotating assembly
- Moment of inertia of assembly, $kg\text{-}cm^2$

f) Suction connection

i) Size, mm

ii) Rating of flangs (lb class)

g) Discharge connection

i) Size, mm

ii) Rating of flanges (lb class)

h) Maximum reverse runway speed, rpm

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i) Critical speeds, rpm

j) Pump Bearing

i) Manufacturer
ii) Type
iii) Thrust bearing
iv) Manufacturer
v) Type
vi) Provided on the pump or the drive motor

k) Materials

i) Casing
ii) Impeller
iii) Shaft
iv) Shaft sleeves
v) Wearing rings
vi) Shaft seals
vii) Pump can
viii) Coupling
ix) Bolts & nuts
x) Gaskets

l) Weight and Dimensions

i) Completely assembled pump, kg
ii) Rotating assembly, kg.
iii) Motor, kg
iv) Total shipping weight, kg.

m) Dimensions

i) Overall length, mm
ii) Overall width, mm
iii) Overall height, mm

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C. Turbo Blowers & Auxiliaries

1. General

Number of Blowers
Design code *I* standard
Make of blower
Type of blower (Axial! Centrifugal)
Type of capacity control of blower
No. of casing and type
ND. of stages
Design capacity, Nm3/h
Design discharge pressure, kg/cm2g
Design operating speed, rpm
Design shaft power, MW
Max. shaft power requirement of Blower, kW
Power "rating of the Steam Turbine, MW
Journal bearing locations
Shaft seal type
Maximum. operating pressure kg/cm2 g
Type of control system
Thrust bearing type & location
Number of journal bearings & type
1st critical speed - rpm
2nd critical speed - rpm
Combined critical speed
Blower and Turbine - rpm
Type of coupling

(a) Between 'turbine & gear box
(b) Between gear box and Blower

2. **Supervisory instruments**

List to be furnished

3. **Control & relay oil system and lube oil system (Common for turbine & Blower)**

Location of main oil tank :
Grade of oil :
Initial fill quantity m3/hr :
Main oil tank capacity, m^3 :
Overhead tank capacity, m^3 :
Change of lube oil period, hrs :
Grade :

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	Quantity	:
	Total oil in circulation, m^3	:
	Lube oil consumption, litres/1000 hrs	:
	Total weight of oil skid	
	Empty	:
	Flooded	:
	Total weight of overhead oil tank	
	Empty	:
	Flooded	:

4. **Material**

a)	Shaft	:
b)	Blades/impellers	:
c)	Casing	:
d)	Guide vanes	:
e)	Bolts & Nuts	:
f)	Labyrinths	:
g)	Diaphragm	:

5. Bearing Gear

	Type	:
	Location	:
	Drive, kW rating	

6. Jacking oil Pump :

	Type	:
	Location	:
	Drive, kW rating	:

7. Weight

	Blower – kg	:
	Gear Box – kg	:
	Steam turbine – kg	:
	Base Plate – Kg	:
	Heaviest single part for erection & Maintenance (Blower) kg	:
	Heaviest single part for erection & Maintenance (Turbine) kg	:

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8. **Protections**

i)	Thrust failure	:
ii)	Loss of bearing oil pressure	:
iii)	Excessive axial rotor displacement	:
iv)	Reverse flow protection	:
v)	Starting with adjustable stator blade fully open and anti-surge valve closed	:
vi)	Excessive air discharge temperature	:
vii)	Surging of machine	:
viii)	Low cooling water pressure	:
ix)	Bearing temperature high	
x)	Others as required	

9. Coast-down time in seconds

10. Cooling water requirement

i)	Cooling water requirement for oil cooler, m^3/hr	:
ii)	Supply water pressure, kg/cm^2g	:
iii)	Return water pressure, kg/cm^2g	:
iv)	Temp. rise in cooling water, deg. C	

11. Suction Air Filter

Location	:
Type of filters	:
No. of filter elements for each blower	:
Capacity of each filter element, m^3/ht	
Filtering efficiency	
Partial 2 micron & larger %	:
Partial 5 micron & larger %	:
Partial 10 micron & larger %	:
Spare capacity %	:

12. Suction Air Stack

Location	:
Size	:
Weight	:

13. Suction Air Silencer

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	Type	:
	Location	:
	Size	:
	Weight	:
14.	Suction Air Damper	
	Type	:
	Location	:
	Size	:
	Weight	:
15.	Discharge Air Silencer	
	Type	:
	Location	:
	Size	:
	Weight	:
16.	Blow off Silencer	
	Type	:
	Location	:
	Size	:
	Weight	:
17.	Blow off Valve	
	Type	:
	Location	:
	Size	:
	Weight	:
18.	Discharge Air Valve (Isolating)	
	Type	:
	Location	:
	Size	:
	Actuator type & power rating in kW	:
	Weight	:
19.	Discharge air non-return Valve	
	Type	:
	Location	:

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	Size	:
	Weight	:

20. Delivery Air Valve (Isolating)

	Type	:
	Location	:
	Size	:
	Actuator type & power rating in kW	:
	Weight	:

E. **Technical Particulars for Steam Turbine & Auxiliaries**

1. **Steam Turbine – "Performance Data"**

a)	Number of Turbines		:
b)	Manufacturer's Name		:
c)	i)	Type (Reaction/impulse)	:
	ii)	Design Standard/ code	:
d)	Main steam pressure before stop Valve kg/cm^2 (g)		:
e)	Main steam temperature before stop Valve kg/cm^2 (g)		:
f)	i)	Rated speed, rpm	:
	ii)	Speed range, rpm	:
g)	Seam flow rate at normal flow rate of Blower, t/h		:
h)	Condenser vacuum at normal flow rate of blower and inlet cooling water at 33^{0}C, kg/cm^2 (a)		:
i)	Rated output, MW at different inlet flow Conditions, t/h		:
j)	Minimum continuous steam flow through Turbine at rated speed, t/h		:
k)	Power generated during minimum steam Flow MW		:
l)	Maximum flow passing ability of turbine With vale wide open condition (5%), t/h		:
m)	Maximum continuous capacity of Turbine, MW		:
n)	Maximum allowable sustained pressure before Turbine stop valve without affecting performance Of blower kg/cm^2 (a)		:
o)	Minimum allowable sustained pressure before		:

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Turbine stop valve without affecting performance
Of blower kg/cm^2 (a)

p) Maximum momentary pressure before turbine stop Valve, kg/cm^2(g) :

q) Maximum allowable temperature before turbine stop Valve, deg. C :

r) Minimum allowable steam temperature without affecting Performance of blower :

2. **Layout data**

a) Total turbine-blower block length, mm :

b) Total turbine-blower block width, mm :

c) Total weight

i) Turbine blower tones :
ii) Turbine tones :
iii) Blower tones :

d) Weight of single heaviest piece during Erection (blower & turbine) :

e) Weight of following, tones

i) Blower rotor :
ii) Upper casing with diaphragms :
iii) Turbine rotor :
iv) Oil skid :
v) Gear Box :

f) Moment of Inertia in kg/m^2 for

i) Turbine rotor (Gr^2) :
ii) Blower rotor (GD^2/4) :
iii) Combined rotor assembly :

3. **Turbine Design Data**

a) Last stages annulus area (total), sq.m :

b) Last stage blade length and pitch dia, mm :

c) Critical speed, rpm of

i) Turbine rotor

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- Upper :
- Lower :

ii) Blower rotor

- Upper :
- Lower :

iii) Combined critical speeds :

d) Rotor details

i) No. of stages :
ii) Method of construction :
iii) Diameter of the tips of the first row of blades :
iv) Special protection against erosion due to moisture impingement :

e) Material of construction

i) Turbine inner casing :
ii) Turbine outer casing :
iii) Turbine rotor :
iv) Control valve chest
v) Blades

- Moving blades :
- Fixed blades :

v) Shaft :
vi) Bearing :
viii) Coupling :
ix) Coupling Guard :

f) External Connections Size (mm) Material

i) Main steam :
ii) Extraction point :
iii) Inter-stage drains :
iv) Outlet connection :

g) Permissible forces & moment at turbine ESV flange (Furnish the following data for Each connection separately)

i) Forces in kgs.

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- Fx-(Axis of turbine rotor)+/- :
- Fx-(vertical) +/- :
- Fy-(vertical) +/- :
- Fz-(Lateral) +/- :

ii) Moment in kg-m
- Mx +/- :
- My +/- :
- MZ +/- :

h) Turbine Movements

i) Location of turbine anchor point :
ii) Movement of the ESV flanges for main steam and extraction flanged during heating up of the turbine, mm

i) Design pressure and temperature

i) Valve chest :
ii) Casting

j) Maximum noise level, db (A) :

k) Bearing

i) Journal bearings

- Number :
- Size :
- Type :
- Optimum operating
  Temperature :
  Lining Material :

ii) Thrust bearings

- Number :
- Size :
- Type :
- Optimum operating
  Temperature :
  Lining Material :
- High wear of failure detector :

m) Couplings

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i) Number :
ii) Location :
iii) Type :
iv) Size :
v) No. & size of bolts :

o) Exhaust hood relief diaphragm (Rupture Disc) on Condenser
i) Type :
ii) Number :
iii) Bursting pressure, kg/cm^2 (a) :
iv) Material of construction :

4. Turbine Controls & Protection

a) Governor
i) Type :
ii) Steady state speed regulation :
iii) Speed regulator dead band :
iv) Governing range :

b) **Emergency overspeed governor**
i) Type :
ii) No. of independent devices :
iii) Set operating speed :
iv) Range of adjustment :
v) Actuation signaling contacts provided? :
vi) Arrangement for testing with unit in operation (on-load test) :

c) Control valves for Governor
i) Type :
ii) Number of size :
iii) Materials :
- Valves internals :
- Wear surface protection :
- Wear surface protection :
- Valve seat :
iv) Type of sealing :

e) Main throttle valve
i) Number :
ii) Size :
iii) Type & method of actuation :
iv) No. of limit switches :
v) Provision for on-load testing :
vi) Permanent strainer type :

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vii) Material :
- Valve body/bonnet :
- Valve trim :
viii) Type of sealing :

5. Oil System (Common with blower)
Refer compressor eng

a) Oil Tank

i) Capacity, litres :
ii) Size :
iii) Level indicator with alarm :
iv) Internal strainers :
v) Relief and access doors :
vi) Operating pressure, kgf/cm^2 (a) :
vii) Mountings :

b) Oil reservoir vapour extractors/oil mist fans

i) Number :
ii) Type :
iii) Capacity :
iv) Drive motor, kW :
v) Mounting :
vi) Lube oil moisture eliminator provided ? :

c) **Overflow type sight flow indicator**

i) Type :
ii) Number :

d) **Shaft driven main oil pump (MOP)**

i) Type & Number :
ii) Capacity, litres/min. :
iii) Suction head, kg/cm^2 (g) :
iv) Discharge pressure, kg/cm^2 (g) :
v) Power rating, kW :
vi) Location :

e) **A.C. Motor driven auxiliary oil pump (AOP)**

i) Type & Number :
ii) Capacity, litres/min. :
iii) Suction pressure, :
iv) Discharge pressure, kg/cm^2 (g) :
v) Driven motor, kW :

f) **A.C. Motor driven jacking (JOP)**

i) Type & Number :
ii) Capacity, litres/min. :
v) Driven motor, kW :

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g) Emergency lube oil Pump (EOP)

i) - Type
- Number :
ii) Suction pressure, kg/cm^2 (g) :
iii) Discharge pressure
v) Driven motor, kW kg/cm^2 (g) :

h) Oil Cooler
i) Number, working/standby :
ii) Type :
iii) Capacity of oil, Lit/min. :
iv) Location :
v) Cooling water requirement :
- Quantity, liters/min. :
- Pressure, kg/cm^2 (g) :
vi) Pressure drop across cooler, kg/cm^2 (g)
- Water side :
- Oil side :
vii) Maximum permissible cooling water temperature at inlet ^{0}C :
viii) Water temperature rise, ^{0}C :
ix) Oil inlet temperature, ^{0}C :
x) Oil outlet temperature, ^{0}C :
xi) Tube size and material :
xii) Shell material :
xiii) Weight :
- Empty :
- Flooded :

j) Mountings :
k) Oil Strainer (Oil Filter)
i) Number :
ii) Type :
iii) Location :
iv) Removable during operation :
v) Weight :
- Empty :
- Flooded :
l) Oil Centrifuge
Type :
Number :
Type :
Make :
Capacity :
Weight :

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Size of solids in the outlet oil at the outlet o purification unit, micron :

m) Oil sight flow indicators at all bearings provided ? :

n) Complete specification of the lubricating oil :

o) Total oil in the system, Litres :

6. Gland Sealing System

6.01 Turbine Gland Sealing

a) Type of shaft seals :
b) Type of seal rings :
c) Automatic Seal Regulator :
i) Quantity of sealing steam, kg/hr :
ii) Pressure of sealing steam, kg/cm^2 :
iii) Seal steam pressure regulator :
iv) Point of steam tapping :

6.02 Gland Steam Condenser

i) Number (working & standby) :
ii) Type :
iii) Capacity :
iv) Designed for maximum condensate flow, t/h :
v) Water velocity (maximum) in he tubes, m/sec :
vi) Tube side design pressure, kg/cm^2 :
vii) Shell side design pressure, kg/cm^2 :
viii) Condensate pressure drop, kg/cm^2 :

ix) Condensate temperature at the outlet of Gland steam Condenser, deg.C :
x) Heat transfer surface, m^2 :
xi) Tube size and materials used :
xii) Accessories :
xiii) Weight
- Empty :
- Flooded :

6.03 Exhauster for gland steam condenser

i) Type :
ii) Number :
iii) Drive motor, kW :

6.04 Gland seal stem capable of operation with gland steam condenser out of service for maintenance ? :

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7. Turning Gear

a) Type :
b) Method of engagement :
c) Method of disengagement :
d) Drive motor kW :
e) Turbine rotor speed on turning gear drive :
f) Furnished sensing element and other devices as required for remote indication of turning gear engaging & disengaging ? :

8. **Turbine Supervisory Instrument**

a) Bearing vibration (Amplitude & velocity) :

i) Type of sensing element :
ii) Indicator type :
iii) Recorded type :

b) Axial shift of rotor) :

i) Type of sensing element :
ii) Indicator type :
iii) Recorded type :

c) Casing & differential expansion :

i) Type of sensing element :
ii) Indicator type :
iii) Recorded type :
d) Shaft Eccentricity :

i) Type of sensing element :
ii) Type of recorder :
iii) Type of indicator :

e) Control valve position :

i) Type of sensing element :
ii) Type of recorder :
iii) Type of indicator :

f) Turbine Speed :

i) Type of sensing element :

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ii) Type of recorder :
iii) Type of indicator :

g) Turbine Acceleration :

i) Type of sensing element :
ii) Type of indicator :

h) Metal Temperatures :

i) Type of sensing element :
ii) Location of sensing element :
iii) Type of recorder :

i) Seal Interference :

j) Type of sensing element :

k) Foundation displacement :

l) Type of indicator :

m) Any other instrument provided :

9. Condenser & Air Extraction Equipment :

9.01 Condenser

a) Manufacturer :
b) Type :
c) Performance data at rated condition

i) Flow t/h of
- Exhaust suction steam to condenser :
- System make-up :
- Drain from air ejector condenser :
- Drain from gland steam condenser :

ii) Enthalpy in Kcal/kg. of
- Steam from turbine :
- System make-up :
- Drain from air ejector condenser :
- Drain from gland steam condenser :

iii) Heat rejected to circulating water at :

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	design flow, kcal/kg	
iv)	Condenser pressure, kg/cm^2(a)	:
v)	Inlet circulating water	:
vi)	Inlet circulating water design temperature deg. C	:
vii)	Cleanliness factor used	:
viii)	Temperature of the steam - air mixture at the outlet of air removal zone, ^{0}C	:
ix)	Temperature of condensate at hotwell outlet, ^{0}C	:
x)	Maximum free oxygen content in the condensate coming out of the hotwell CC/litre	:
xi)	Specify code followed for performance calculations	:
xii)	Water velocity in tube m/sec	:
xiii)	Total cooling water flow m^3/hr	:
xiv)	Total friction loss across condenser (C.W. inlet flange to C.W. outlet flange), MLC	:
d)	Design Particulars	
i)	No. of passes	:
ii)	Arrangement with respect to turbine axis	:
e)	Condensing surface, Sq. m	:
f)	Shell	
i)	Design pressure, kg/cm^{2}g	:
ii)	Design temperature, deg. C	:
iii)	Thickness of plates, mm	:
iv)	Nozzle provided in the shell	:
v)	Expansion joints provided in the shell	:

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g)	Water boxes	
i)	Type of water boxes	:
ii)	Design pressure, kg/cm^2 (g)	:
iii)	Design temperature, deg. C	:
iv)	~~Code used for~~ practice water box design	:
v)	Method of attaching water boxes to shell	:
vi)	Size of C.W. connection	
	- Inlet nozzles, mm	:
	- outlet nozzles, mm	:
vii)	Detail & standard for C.W. inlet and outlet flanges	:
viii)	Suitable drain and vent connection complete with necessary no. of valves provided for all water box compartments	:
ix)	Access doors in the water boxes provided ?	:
k)	Tubes	
i)	O.D. and thickness, mm	:
ii)	Total no. of tubes	:
iii)	Effective tube length, m	:
iv)	Actual length, metres	:
v)	Method of tube to tube sheet joint	:
vi)	Tubes self draining on shut-down	:
vii)	Space required for tube removal, m	:
l)	Hotwells	
i)	Material thickness	:
ii)	Capacity at normal condition	:
iii)	Normal operating level, m^3 (from the bottom of hotwell), m	:
iv)	No. and size of condensate outlet nozzles	:
v)	Strainers at condensate outlet provided	:
vi)	Necessary no. of nozzle connection provided	:
vii)	Level instruments provided	:
viii)	Access doors for hotwell provided	:
m)	Condenser supports and neck expansion joints	
i)	Type of supports	:
ii)	Total no. of supports	:
iii)	Load on each support, kg.	:
iv)	Manufacturer and type of expansion joint	:

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v)	Type of connection at the ends of the expansion joint (flanged or welded)	:
vi)	Material Specification	
	- Condenser shell	:
	- Hotwell	:
	- Water boxes	:
	- Water box covers	:
	- Tube support plates	:
	- Tube sheets	:
	- Tubes	:
	- Impingement baffles	:
	- Stay rods	:
	- Internal bolts	:
	- Shell expansion joint	:
	- Water box gaskets	:
	- Internal steam dump piping	:
	- Water box lining	:
	- Tubes sheet paint	:
n)	Forces and reactions	:
o)	Operating load on the nozzles condenser feet, kgs.	
i)	Maximum load on the condenser feet, kgs.	:
ii)	Operating load on the condenser feet, kgs.	:
p)	Weight and Dimensions	
i)	Weight of shell and water boxes (empty), tonnes	:
ii)	Total weight of tubes, tonnes	:
iii)	Weight of heaviest piece to be handed during transportation and erection, tonnes	:

9.02.01 **Air Removal System**

a)	Manufacturer & Model No.	:
b)	Type	:

9.02.02 **Performance data**

a)	Air Ejector	
i)	Air removing capacity of the air ejector	:
	- Dry air, Nm^3/min.	:
	- Air vapour mixture, kg/hr	:

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ii)	Mixture suction temperature, deg. C	:
iii)	Suction pressure, kg/cm^2 (abs)	:
iv)	Pressure & temperature of driving steam of air ejector, kg/sq. cm, deg.C	:
v)	Total flow of driving steam, kg/hr	:
vi)	Cut off suction pressure for the air ejector (suction pressure at zero air flow, kg/cm^2 (abs)	:

b)	Inter condenser drains	
	- Pressure, kg/cm^2 (a)	:
	- Flow, kg/hr	:
	- Enthalpy, kcal/kg.	:

c)	After condenser drains	
	- Pressure, kg/cm^2 (a)	:
	- Flow, kg/hr	:
	- Enthalpy, kcal/kg.	:

d) Starting Ejector

i)	Air removing capacity, Nm^3/min. of dry air	:
ii)	Suction pressure for the above capacity, kg/hr	:
iii)	Total flow of driving steam, kg/hr	:
iv)	Driving steam pressure, kg/cm^2 (g) and temperature, deg. C	:
v)	Time required to raise rated vacuum, minutes	:

9.02.03 **Design and Construction**

a) Air Ejectors

i)	No. provided (Working & Standby)	:
ii)	No. of stages	:
iii)	Material Specification	
	- Body	:
	- Nozzles	:
	- Diffusers	:

b) Inter and After Condenser

i)	Nos. provided	:
ii)	Condensing surface, sq.m	:
iii)	Tube O.D. and gauge	:
iv)	Tube material specification no.	:
v)	Effective tube length, meters	:

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vi)	No. of passes	:
vii)	Design pressure and temperature, kg/cm^2, deg. C	:
	- Shell side	:
	- Tube side	:
viii)	Shell material specification	:
ix)	Tube sheet material specification	:
x)	Hydrostatic test pressure kg/cm^2 (g)	:
	- Shell	:
	- Tube	:
	- Water boxes	:

9.02.04 **Starting Ejector**

a)	Material of nozzles	:
b)	Material of body	:

9.02.05 **Weight and Dimensions**

a)	Air Ejectors	
b)	Total weight of each air ejector	
	- Empty	:
	- Flooded	:
c)	Overall dimension, m	:
d)	Air Ejector inter condenser	
i)	Total weight, kg	:
ii)	Overall length, m	:
iii)	Outside diameter, m	:
e)	Air ejector after condenser	
i)	Total weight, kg	:
	- Empty	:
	- Flooded	:
ii)	Overall length, m	:
iii)	Outside diameter, m	:
f)	Starting Ejector	
i)	Total weight, kg	:
ii)	Overall dimension, m	:

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g)	Ejector skid (Total system)	
h)	Overall dimension (Lx W x H)	:
i)	Weight	
	- Empty	:
	- Flooded	:

10. **Condensate Extraction Pumps**

a)	Manufacturer	:
b)	Model No.	:
c)	Nos. provided (Working & Standby)	:
d)	Performance data under rated condition	
i)	Capacity, t/h	:
ii)	Discharge pressure, kg/cm^2 (g)	:
iii)	Suction pressure, kg/cm^2 (a)	:
iv)	Temperature at pump suction, deg. C	:
v)	Total pump head, MLC	:
vi)	Required NPSH Static head at pump suction considering minimum hotwell level, MLC	:
	Total head loss in the suction line, MLC	:
vii)	Speed, rpm	:
viii)	Efficiency, %	:
ix)	Drive power required under design condition, kw	:
x)	Motor rating, kW	:
xi)	Specific speed	
	- First stage	:
	- Other stage	:
xii)	Shut-off discharge pressure, kg/cm^2 (g)	:
xiii)	Minimum permissible flow for continuous operation, M^3/hr	:
xiv)	Maximum temperature rise under minimum flow operation deg. C	:
e)	Design and Construction	
i)	Basic type	:
ii)	No. of stages	:
iii)	Pump rotating assembly	
	- Moment of inertia of assembly, kg-cm^2	:
f)	Suction connection	

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i)	Size, mm	:
ii)	Rating of flanges (lb class)	:
g)	Discharge connection	
i)	Size, mm	:
ii)	Rating of flanges (lb class)	:
h)	Maximum reverse runway, speed, rpm	:
i)	Critical speeds, rpm	:
j)	Pump bearing	
i)	Manufacturer	:
ii)	Type	:
iii)	Thrust bearing	:
iv)	Manufacturer	:
v)	Type	:
vi)	Provided on the pump or the drive motor	:
k)	Materials	
i)	Casing	:
ii)	Impeller	:
iii)	Shaft	:
iv)	Shaft sleeves	:
v)	Wearing rings	:
vi)	Shaft seals	:
vii)	Pump can	:
viii)	Coupling	:
ix)	Bolts & nuts	:
x)	Gaskets	
l)	Weight and Dimensions	
i)	Completely assembled pump, kg	:
ii)	Rotating assembly, kg	:
iii)	Motor, kg	:
iv)	Total shipping weight, kg	:
m)	Dimensions	
i)	Overall length, mm	:
ii)	Overall width, mm	:
iii)	Overall height, mm	:

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11. Lube Oil Purification System (Common for Turbine & Blower)

11.01 Performance Data

a) Rated capacity, litres/ hr :

b) Guaranteed size of Solids in the purified oil at the effluent of the polishing filter at rated capacity, microns, (specify also the maximum water content in %) :

c) Guaranteed size of solids in the oil at the outlet of the centrifuge but head of the polishing filter at rated capacity, microns (specify also the maximum water content in %) :

d) Guaranteed percentage of oil drained through Heavy phase drain :

e) Centrifuge temperature, deg. C :

11.02 Design & Construction

a) Oil Pumps		Clean oil Pump	Dirty oil Pump
i) Type	:		
ii) Manufacturer	:		
iii) Capacity, litres/ min	:		
iv) Total head, kg/cm^2	:		
v) Maximum permissible suction lift at rated capacity, MLC	:		
vi) Pump speed, rpm	:		
vii) Power required at the rated operating conditions, kW	:		
viii) Efficiency of the pump at the operating conditions	:		
ix) Drive details	:		
x) Relief valve			
- Capacity, litres/min	:		
- Setting pressure range	:		
xi) Materials of construction			
- Casing	:		

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	- Shaft	:
	- Relief valve	:
xii)	Bearings	
	- Number	:
	- Type & Make	:

b) Centrifuge

i)	Manufacturer	:
ii)	Type & Model No.	:
iii)	Bowl capacity, litres	:
iv)	Bowl diameter, mm	:
v)	Speed of the centrifuge, rpm	:
vi)	Motor, kW	:
vii)	Drive details	:
viii)	Belt guard provided ?	:
ix)	Bearings	
	- Type and number	:
	- Type of lubrication needed	:
	- Make & Model No.	:
x)	Method of balancing	
	- Static	:
	- Dynamic	:
xi)	Heavy phase drain through anti-flooded tanks ?	:
xii)	Method of signaling loss of water seal in Centrifuge and/or excessive water in oil and/or Choking of heavy phase drain pipe	:
xiii)	Materials of Construction	
	- Casing	:
	- Bowl and internals	:
	- Shaft	:

c) Oil Heater

i)	Manufacturer	:
ii)	Type & Model No.	:
iii)	Rated capacity, litres/hr	:
iv)	Design oil inlet temperature, deg. C	:
v)	Design oil outlet temperature, deg. C	:
vi)	Water bath	
	- Dimension, mm	:
	- Water content, litres	:
	- Gauge glass provided	:
	- Type of insulation	:
vii)	Heating Elements	

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	- No. and ratings, kW	:
	- Material and type of construction of Heating elements	:
	- Power supply	:
	- No. of thermostats and cut 'in' and cut 'out' Temperature of each thermostat.	:
viii)	Material of construction	
	- Shell	:
	- Tubes	:
	- Heater elements	:
	- Sheating material	:
d)	Polishing Filter	
i)	Manufacturer	:
ii)	Type & Model No.	:
iii)	Rated capacity, litres/hr	:
iv)	Pressure drop at rated capacity, kg/cm^2	:
	- Normal	:
	- Maximum	:
v)	Filtering surface, m^2	:
vi)	Filtering elements	
	- Type	:
	- Material	:
	- Reusable after cleaning	:
vii)	Filter Vessel	
	- O.D., mm	:
	- Height, mm	:
	- Plate thickness, mm	:
	- Relief valve capacity	:
	- Design pressure, kg/cm^2g	:
	- Material of Construction	:
e)	Central Oil Storage Tank	
i)	Capacity, Litres	:
ii)	No. of compartment	:
iii)	Overall dimension	:
iv)	Floating suction details	:
v)	Level gauge details	:
f)	Weight Data, Kgs	
i)	Pumps with drives	
	- Clean oil pump	:
	- Dirty oil pump	:
ii)	Centrifuge unit	:

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iii) Oil heater :
iv) Polishing filter :

g) Gear Box

1. Type :
2. Make/country :
3. Type of Gear :
4. Gear ratio :
5. Direction of Rotation
   a) Driving end :
   b) Driven end :
6. Lubrication System
7. Bearing
   Type :
   No. of each Type :
8. Coupling
   a) Driving end
      i) Type :
      ii) Coupling guard provided ? :

   b) Driver end
      i) Type :
      ii) Coupling guard provided ? :

9. Mounting of Gear box :
   (Mounted on Turbine frame/Blower frame/
   Independent ?)
10. Material
    a) Gear Box housing :
    b) Gear :
    c) Bearing
       i) Journal :
       ii) Thrust :
    d) Thrust Collar :
    e) Shaft :
    f) Bearing housing :

11.03 General Technical Particulars for Feed Water Transfer Pump

a) Manufacturer :
b) Model No. :
c) Nos. provided (Working & standby) :
d) Performance data under rated condition
i) Capacity, t/h :

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ii)	Discharge pressure, kg/cm^2(g)	:
iii)	Suction pressure, kg/cm^2(g)	:
iv)	Temperature at pump suction, deg. C	:
v)	Total pump head, MLC	:
vi)	Required NPSH Static head at pump suction considering minimum hotwell level, MLC	:
	Total head loss in the suction line, MLC	:
vii)	Speed, rpm	:
viii)	Efficiency, %	:
ix)	Drive power required under design condition, kw	:
x)	Motor rating, kW	:
xi)	Specific speed	
	- First stage	:
xii)	Shut-off discharge, kg/cm^2(g)	:
xiii)	Minimum permissible flow for continuous operation M^3/hr	:
xiv)	Maximum temperature rise under minimum flow operation, deg. C	:
e)	Design and Construction	
i)	Basic type	:
ii)	No. of stages	:
iii)	Pump rotating assembly	
	- Moment of inertia of assembly, kg-cm^2	:
f)	Suction connection	
i)	Size, mm	:
ii)	Rating of flanges (lb class)	:
g)	Discharge connection	
i)	Size, mm	:
ii)	Rating of flanges (lb class)	:
h)	Maximum reverse runway, speed, rpm	:
i)	Critical speeds, rpm	:
j)	Pump bearing	

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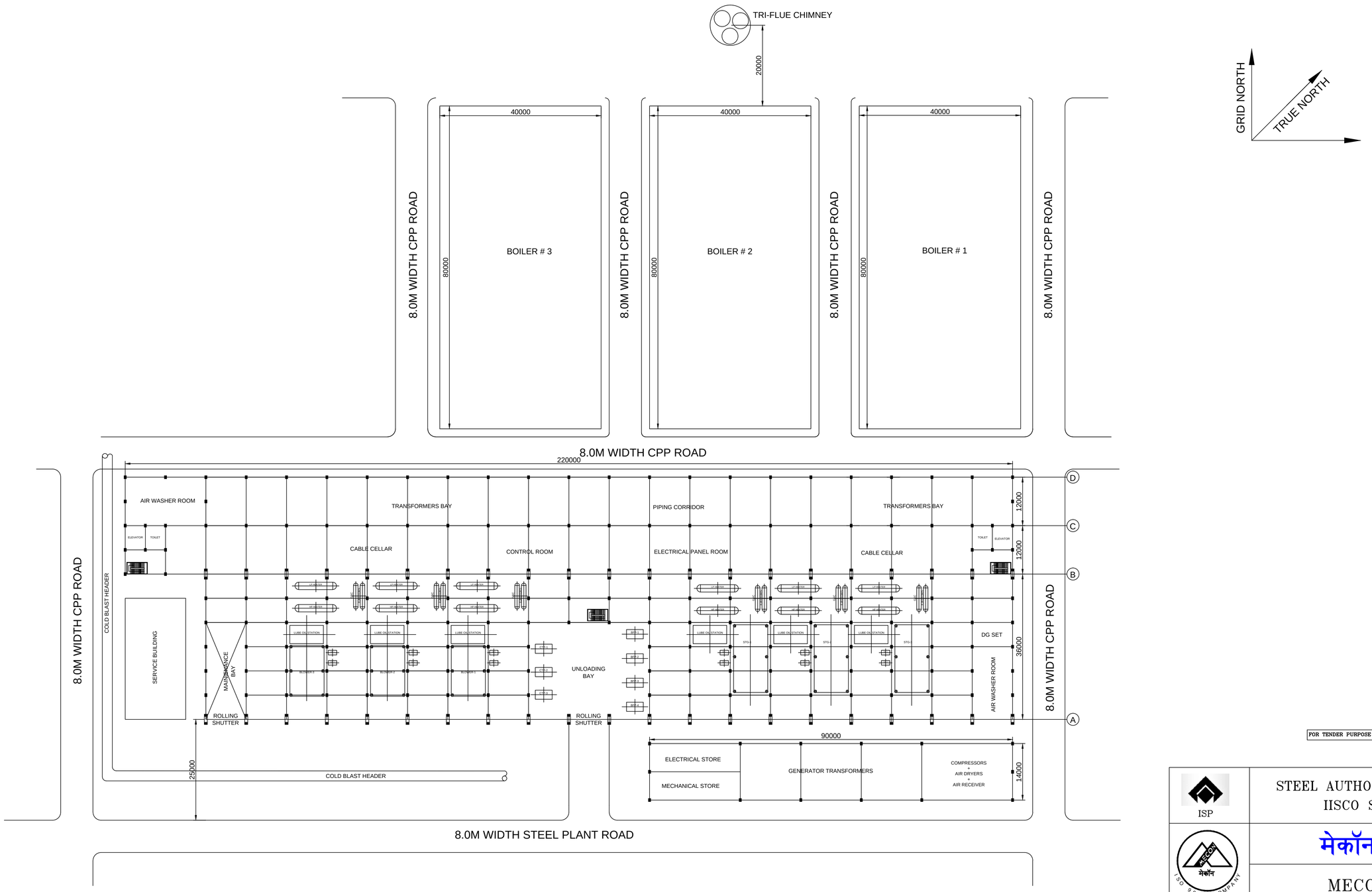
i)	Manufacturer	:
ii)	Type	:
iii)	Thrust bearing	:
iv)	Manufacturer	:
v)	Type	:
vi)	Provided on the pump or the drive motor	:
k)	Materials	
i)	Casing	:
ii)	Impeller	:
iii)	Shaft	:
iv)	Shaft sleeves	:
v)	Wearing rings	:
vi)	Shaft seals	:
vii)	Pump can	:
viii)	Coupling	:
ix)	Bolts & nuts	:
x)	Gaskets	
l)	Weight and Dimensions	
i)	Completely assembled pump, kg	:
ii)	Rotating assembly, kg	:
iii)	Motor, kg	:
iv)	Total shipping weight, kg	:
m)	Dimensions	
i)	Overall length, mm	:
ii)	Overall width, mm	:
iii)	Overall height, mm	:

Note : Data in all corresponding blank spaces shall be fill up by Tenderer.

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IISCO STEEL PLANT

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MECON LIMITED

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APPROVED	SIG A.K.BAIRAGI
	DATE:- 22.10.2024

4.08 MTPA EXPANSION

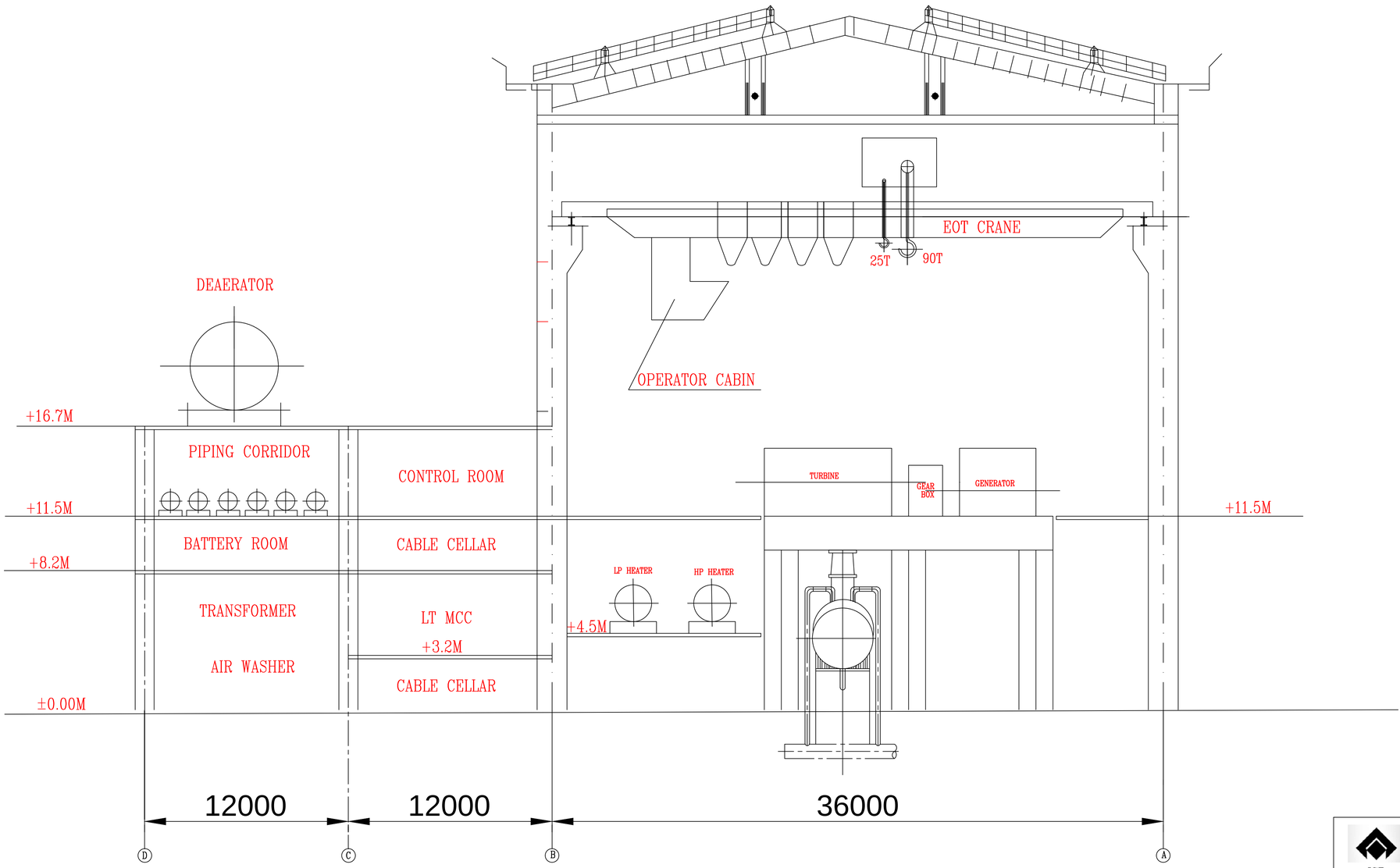
CAPTIVE POWER PLANT
MAIN PLANT LAYOUT

SCALE : N.T.S

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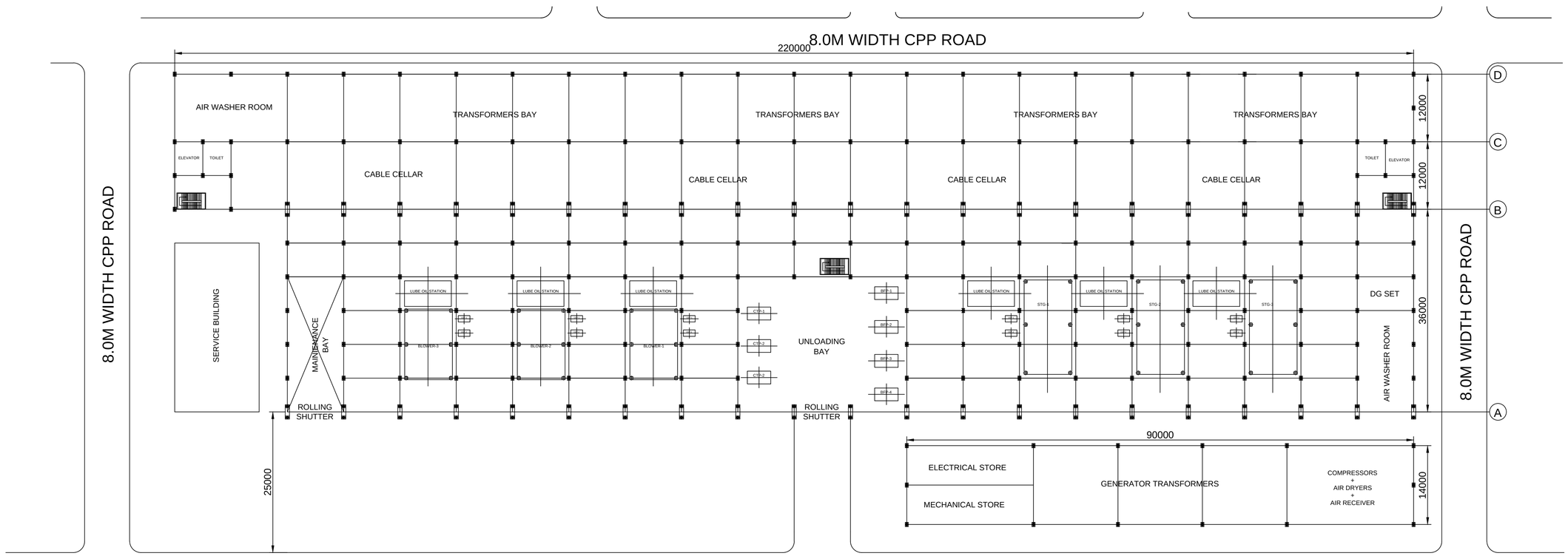
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POWER HOUSE BUILDING
(ELEVATION)

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POWER HOUSE BUILDING
(EL ±0.00M)

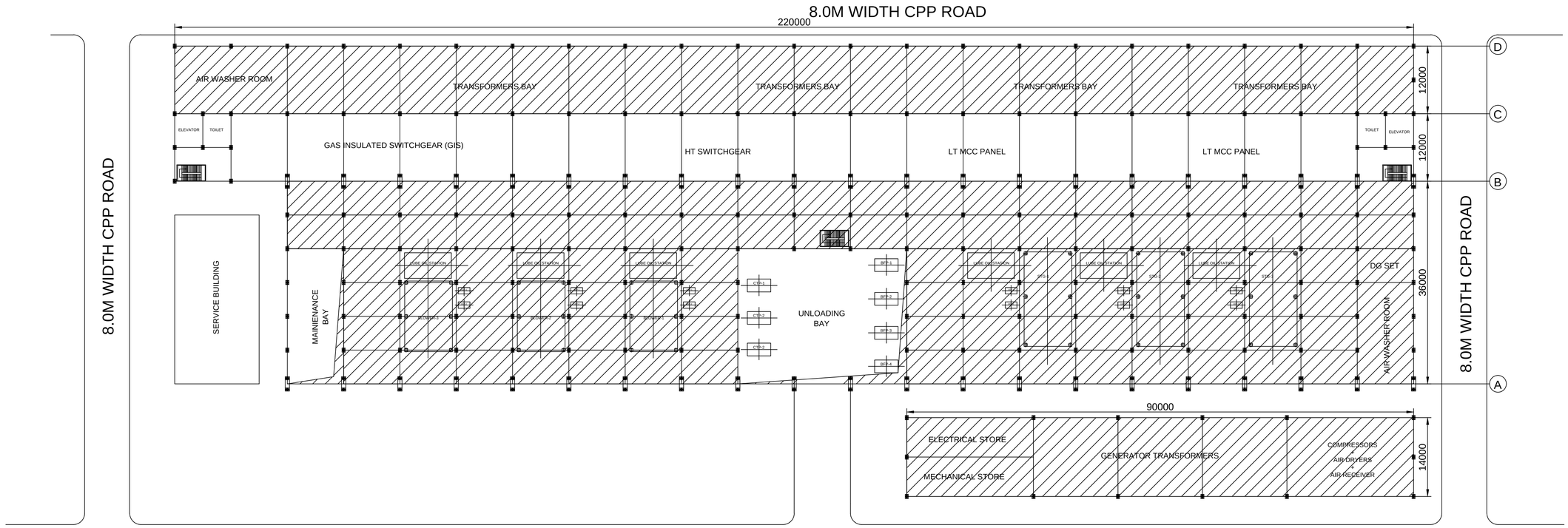
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(EL.+3.20M)

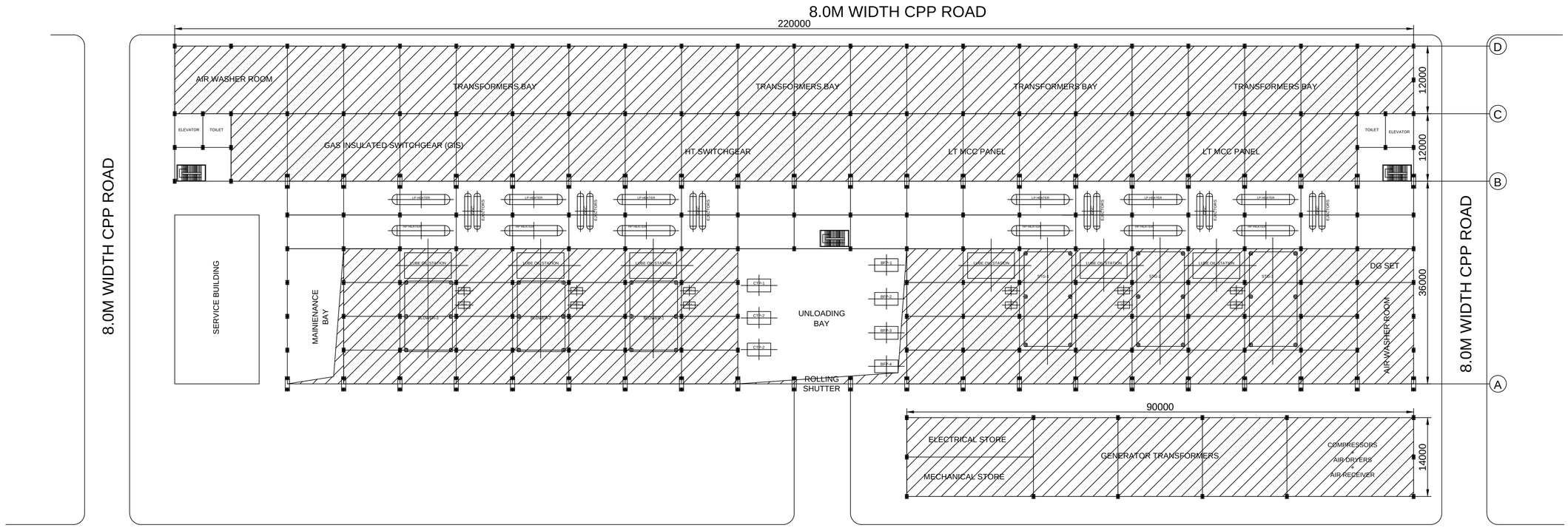
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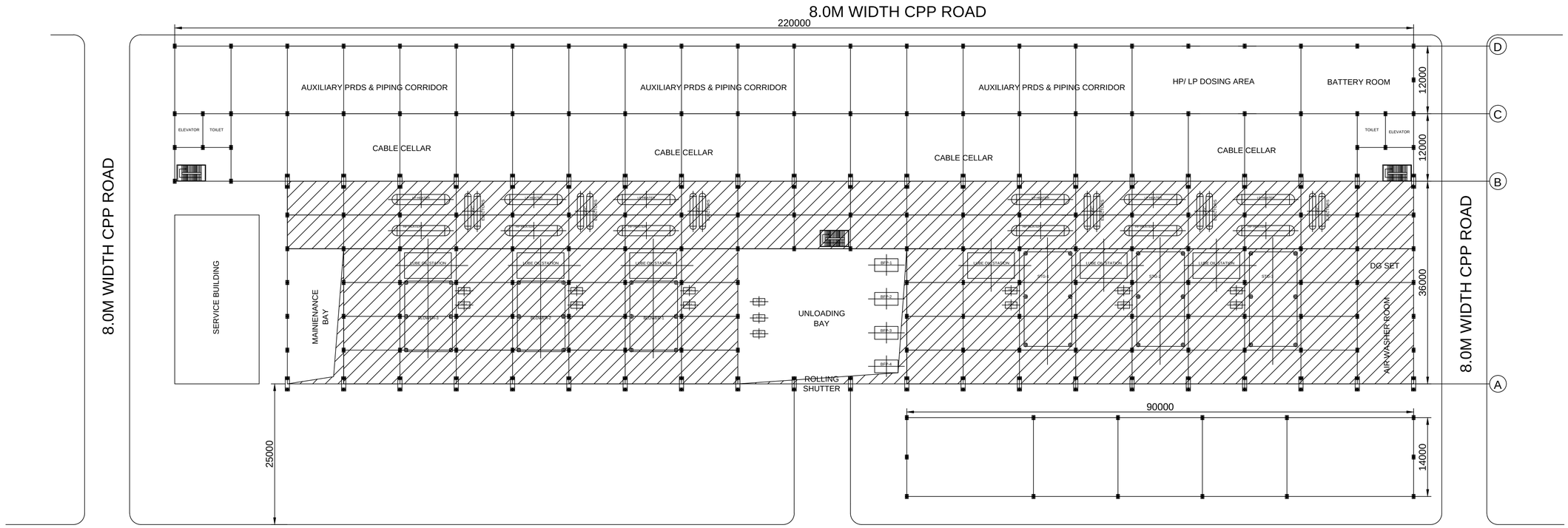
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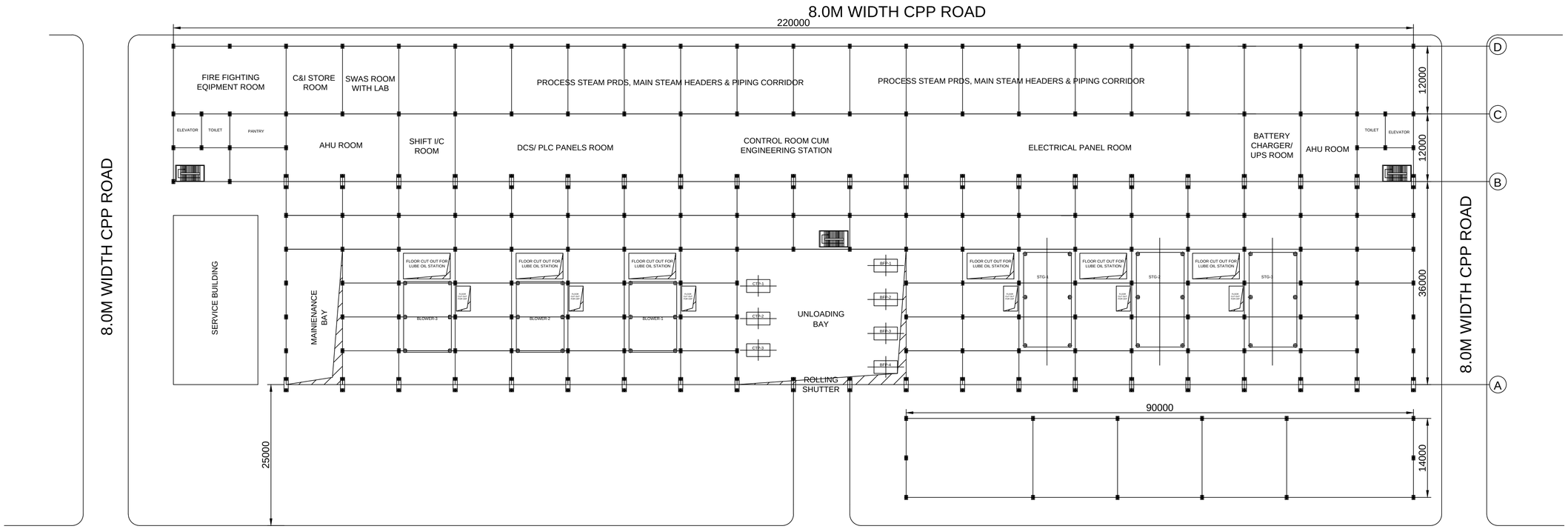
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POWER HOUSE BUILDING
(EL.±11.50M)

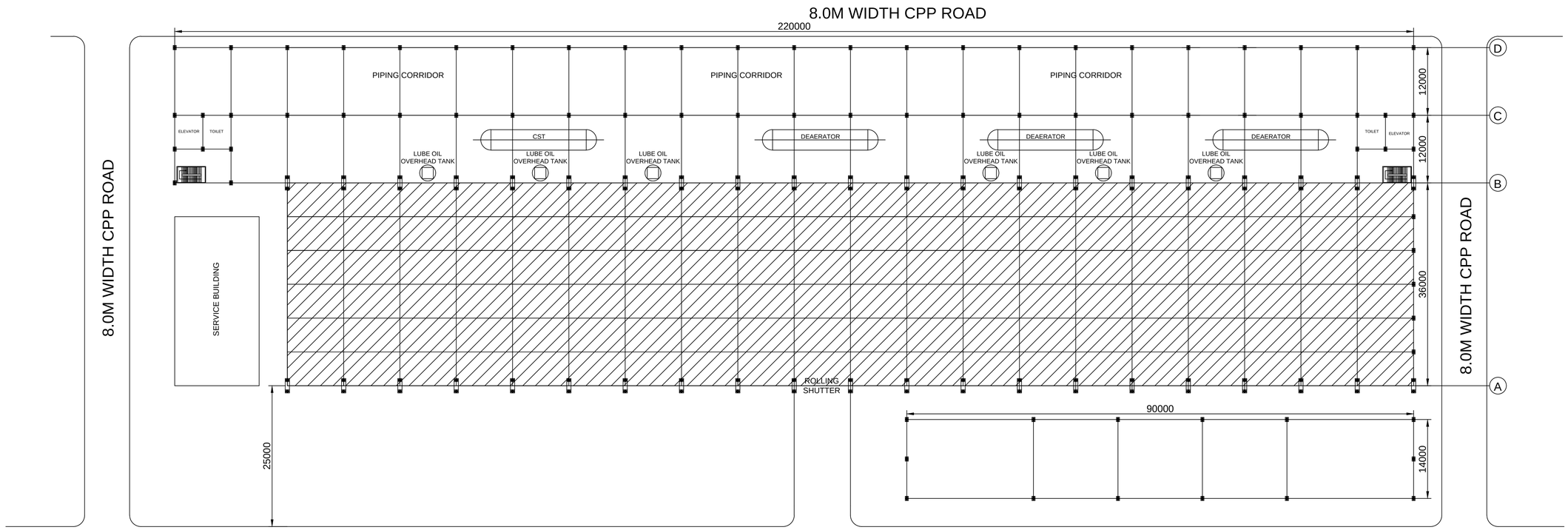
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4.08 MTPA EXPANSION

POWER HOUSE BUILDING
(EL.±16.70M)

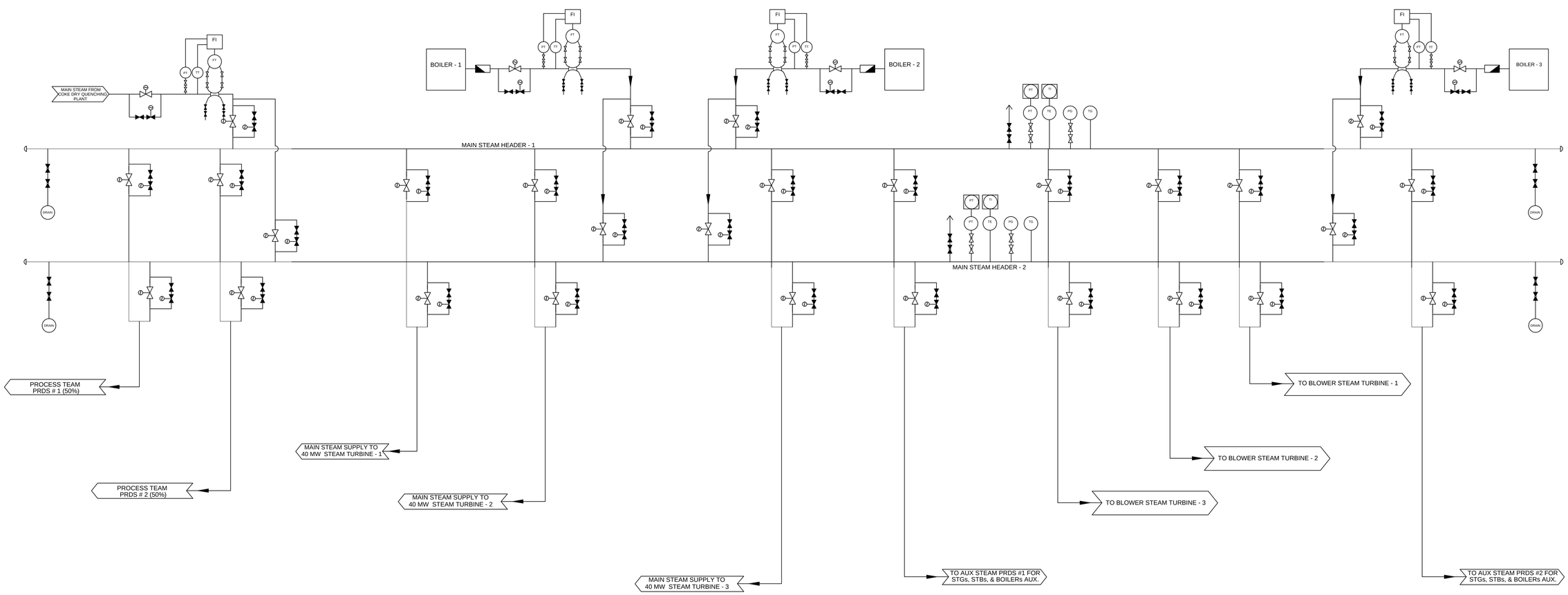
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APPROVED	SIG A.K.BAIRAGI
	DATE:– 22.10.2024

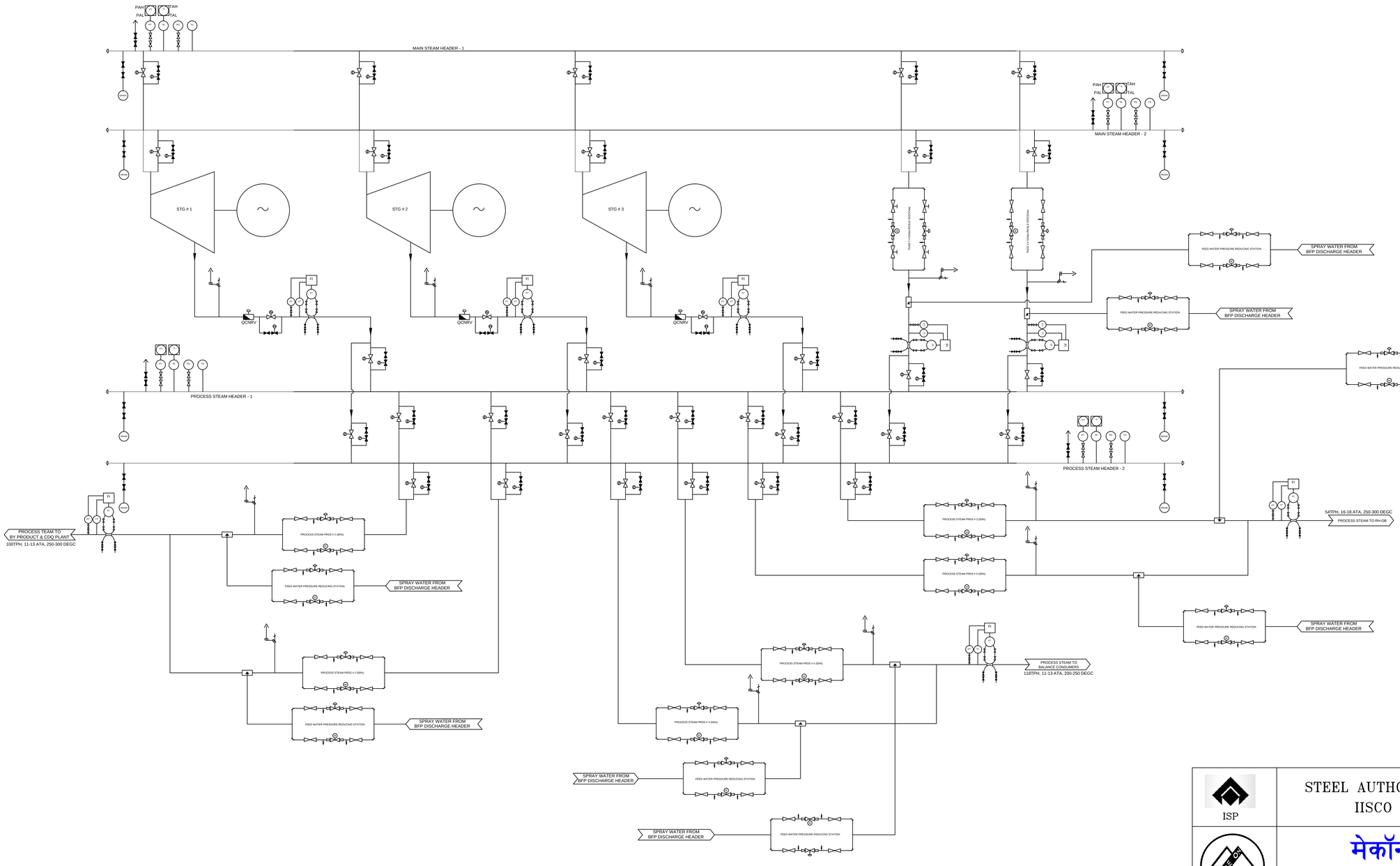
4.08 MTPA EXPANSION

CAPTIVE POWER PLANT
MAIN STEAM DISTRIBUTION SCHEME

SCALE : N.T.S | REV

DRG. NO. MEC/11/S3/M/0033/CPP1/09 | 01

DRG. NO. MEC/11/S3/M/0033/CPP1/10



FOR TENDER PURPOSE ONLY

ISP

STEEL AUTHORITY OF INDIA LTD
IISCO STEEL PLANT

मेकॉन लिमिटेड

MECON LIMITED

REV	DESCRIPTION	BY	VERIFIED
	REVISION		

1. THIS SCHEME IS FOR ESTIMATION PURPOSE ONLY.
2. TENDERER SHALL PREPARE THE FINAL PROCESS STEAM DISTRIBUTION SCHEME AND SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING STAGE.

CONCURRED BY

REFERENCES | DOC NO./DRG. NO.

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SECTION	PP & EE
LOCATION	RANCHI
DESIGNED	S.BANERJEE
DRAWN	S.BANERJEE
CHECKED AND VERIFIED	D.CHATTERJEE
APPROVED	SIG A.K.BAIRAGI
	DATE:- 22.10.2024

4.08 MTPA EXPANSION

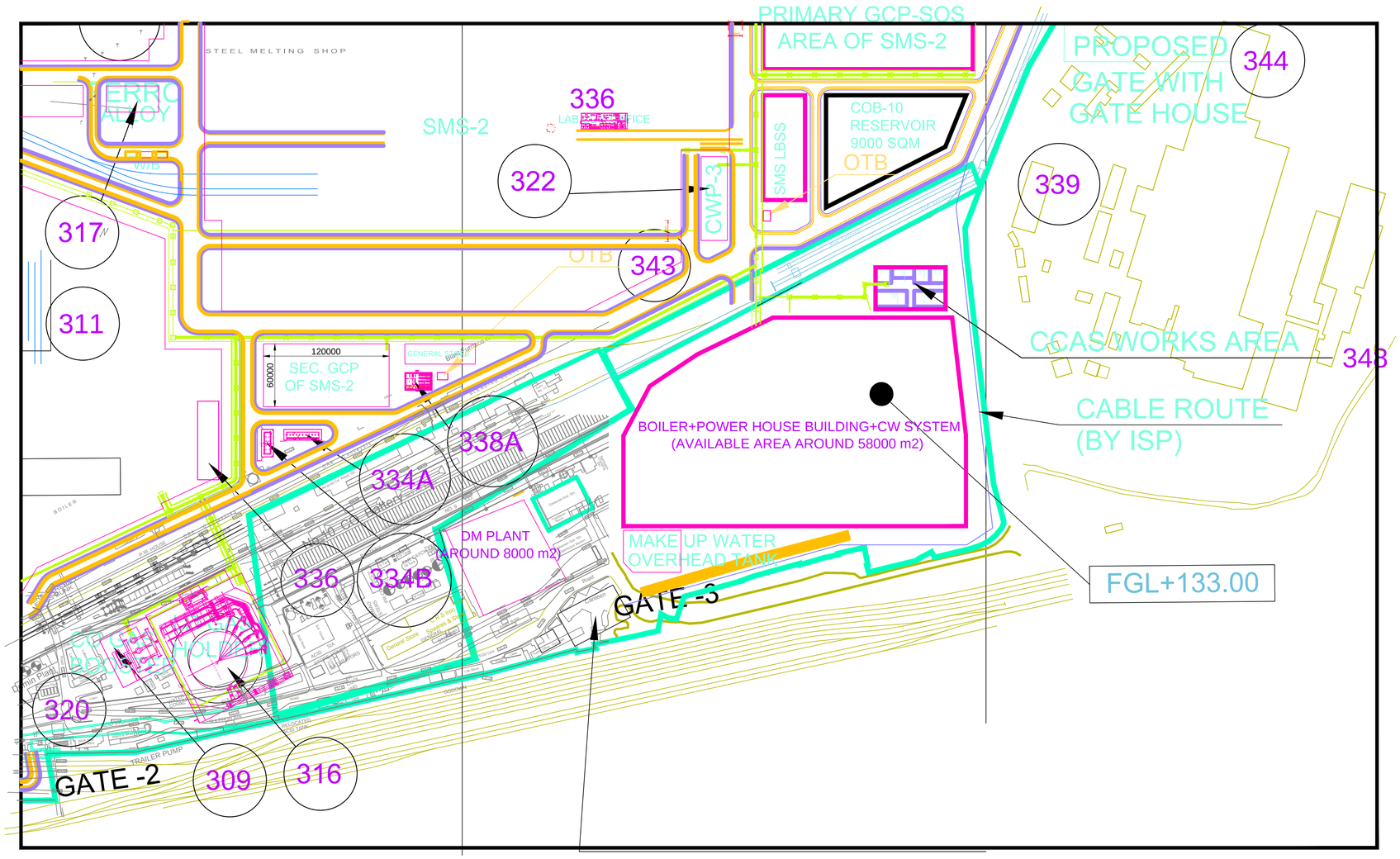
CAPTIVE POWER PLANT
PROCESS STEAM DISTRIBUTION SCHEME

SCALE : N.T.S

DRG. NO. MEC/11/S3/M/0033/CPP1/10

REV 01

DRG. NO. MEC/11/S3/M/0033/CPP1/11



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	12	11	10	10	7		6	5			4		3			2		1					

REV. NO.	DATE	DESCRIPTION	BY	VERIFIED
		REVISION		

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REFERENCES	DOC NO./DRG. NO.		
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APPROVED	SIG A.K.BAIRAGI	SCALE : N.T.S	REV
	DATE:– 22.10.2024	DRG. NO. MEC/11/S3/M/0033/CPP1/11	01

ISP

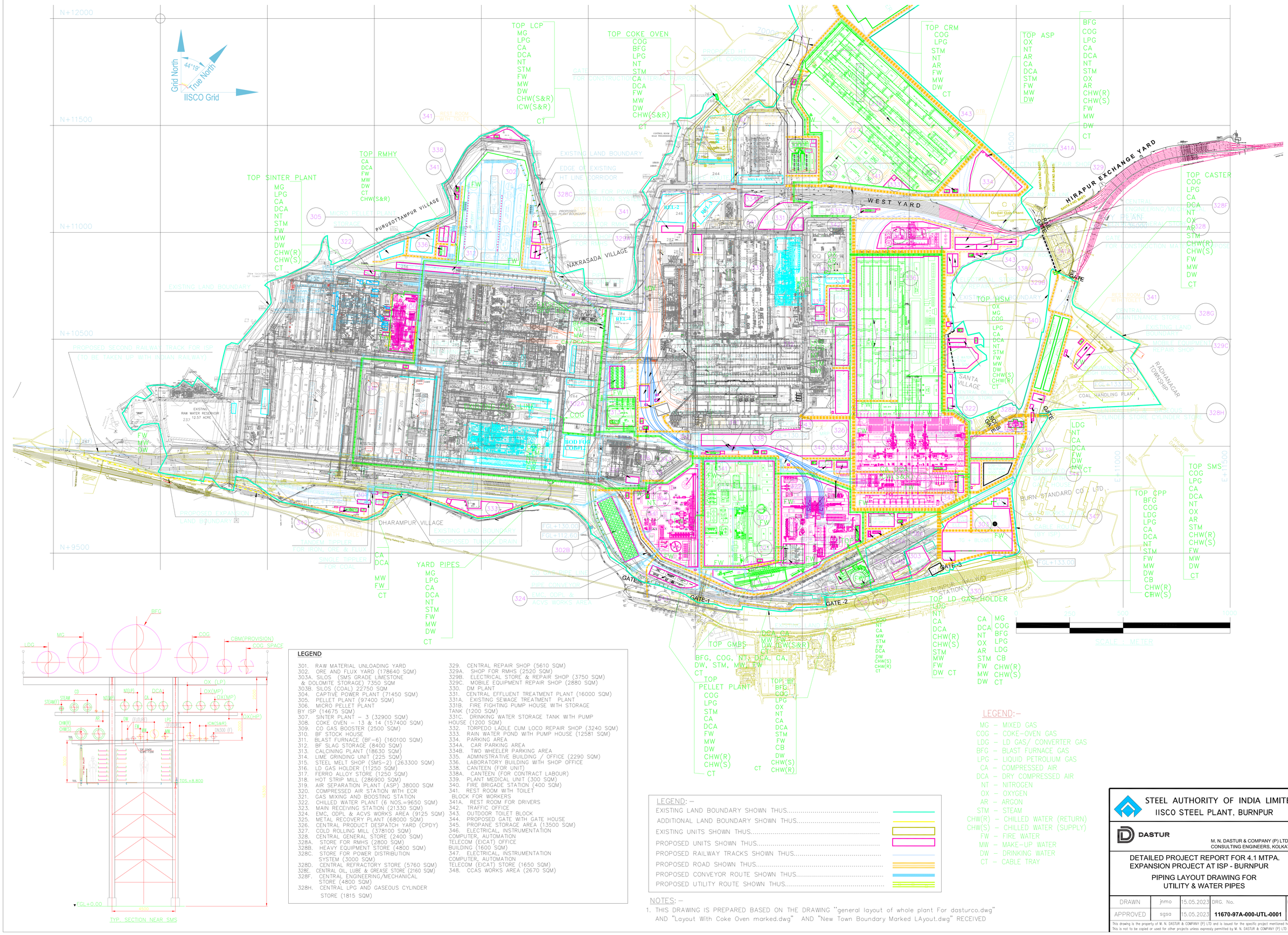
STEEL AUTHORITY OF INDIA LTD
IISCO STEEL PLANT

मेकॉन लिमिटेड

MECON LIMITED

4.08 MTPA EXPANSION

CAPTIVE POWER PLANT
GENERAL LAYOUT



LEGEND

301. RAW MATERIAL UNLOADING YARD
302. ORE AND FLUX YARD (178640 SQM)
303A. SILOS (SMS GRADE LIMESTONE & DOLOMITE STORAGE) 7350 SQM
303B. SILOS (COAL) 22750 SQM
304. CAPTIVE POWER PLANT (71450 SQM)
305. PELLET PLANT (97400 SQM)
306. MICRO PELLET PLANT
BY ISP (14675 SQM)
307. SINTER PLANT – 3 (32900 SQM)
308. COKE OVEN – 13 & 14 (157400 SQM)
309. CO GAS BOOSTER (2500 SQM)
310. BF STOCK HOUSE
311. BLAST FURNACE (BF–6) (160100 SQM)
312. BF SLAG STORAGE (8400 SQM)
313. CALCINING PLANT (18630 SQM)
314. LIME GRINDING UNIT (225 SQM)
315. STEEL MELT SHOP (SMS–2) (263300 SQM)
316. LD GAS HOLDER (11250 SQM)
317. FERRO ALLOY STORE (1250 SQM)
318. HOT STRIP MILL (286900 SQM)
319. AIR SEPARATION PLANT (ASP) 38000 SQM
320. COMPRESSED AIR STATION WITH ECR
321. GAS MIXING AND BOOSTING STATION
322. CHILLED WATER PLANT (6 NOS.+9650 SQM)
323. MAIN RECEIVING STATION (21330 SQM)
324. EMC, ODPL & ACVS WORKS AREA (9125 SQM)
325. METAL RECOVERY PLANT (68000 SQM)
326. CENTRAL PRODUCT DISPATCH YARD (CPDY)
327. COLD ROLLING MILL (378100 SQM)
328. CENTRAL GENERAL STORE (2400 SQM)
328A. STORE FOR RMHS (2800 SQM)
328B. HEAVY EQUIPMENT STORE (4800 SQM)
328C. STORE FOR POWER DISTRIBUTION SYSTEM (3000 SQM)
328D. CENTRAL REFRACTORY STORE (5760 SQM)
328E. CENTRAL OIL,LUBE & GREASE STORE (2160 SQM)
328F. CENTRAL ENGINEERING/MECHANICAL STORE (4800 SQM)
328H. CENTRAL LPG AND GASEOUS CYLINDER STORE (1815 SQM)
329. CENTRAL REPAIR SHOP (5610 SQM)
329A. SHOP FOR RMHS (2520 SQM)
329B. ELECTRICAL STORE & REPAIR SHOP (3750 SQM)
329C. MOBILE EQUIPMENT REPAIR SHOP (2880 SQM)
330. DM PLANT
331. CENTRAL EFFLUENT TREATMENT PLANT (16000 SQM)
331A. EXISTING SEWAGE TREATMENT PLANT
331B. FIRE FIGHTING PUMP HOUSE WITH STORAGE TANK (1200 SQM)
331C. DRINKING WATER STORAGE TANK WITH PUMP HOUSE (1200 SQM)
332. TORPEDO LADLE CUM LOCO REPAIR SHOP (3240 SQM)
333. RAIN WATER POND WITH PUMP HOUSE (12581 SQM)
334. PARKING AREA
334A. CAR PARKING AREA
334B. TWO WHEELER PARKING AREA
335. ADMINISTRATIVE BUILDING / OFFICE (2290 SQM)
336. LABORATORY BUILDING WITH SHOP OFFICE
338. CANTEEN (FOR UNIT)
338A. CANTEEN (FOR CONTRACT LABOUR)
339. PLANT MEDICAL UNIT (300 SQM)
340. FIRE BRIGADE STATION (400 SQM)
341. REST ROOM WITH TOILET BLOCK FOR WORKERS
341A. REST ROOM FOR DRIVERS
342. TRAFFIC OFFICE
343. OUTDOOR TOILET BLOCK
344. PROPOSED GATE WITH GATE HOUSE
345. PROPANE STORAGE AREA (13500 SQM)
346. ELECTRICAL, INSTRUMENTATION COMPUTER, AUTOMATION TELECOM (EICAT) OFFICE BUILDING (1600 SQM)
347. ELECTRICAL, INSTRUMENTATION COMPUTER, AUTOMATION TELECOM (EICAT) STORE (1650 SQM)
348. CCAS WORKS AREA (2670 SQM)

LEGEND:–
MG – MIXED GAS
COG – COKE–OVEN GAS
LDG – LD GAS/ CONVERTER GAS
BFG – BLAST FURNACE GAS
LPG – LIQUID PETROLIUM GAS
CA – COMPRESSED AIR
DCA – DRY COMPRESSED AIR
NT – NITROGEN
OX – OXYGEN
AR – ARGON
STM – STEAM
CHW(R) – CHILLED WATER (RETURN)
CHW(S) – CHILLED WATER (SUPPLY)
FW – FIRE WATER
MW – MAKE–UP WATER
DW – DRINKING WATER
CT – CABLE TRAY

LEGEND:–
EXISTING LAND BOUNDARY SHOWN THUS.....
ADDITIONAL LAND BOUNDARY SHOWN THUS.....
EXISTING UNITS SHOWN THUS.....
PROPOSED UNITS SHOWN THUS.....
PROPOSED RAILWAY TRACKS SHOWN THUS.....
PROPOSED ROAD SHOWN THUS.....
PROPOSED CONVEYOR ROUTE SHOWN THUS.....
PROPOSED UTILITY ROUTE SHOWN THUS.....

NOTES:–
1. THIS DRAWING IS PREPARED BASED ON THE DRAWING "general layout of whole plant For dasturco.dwg" AND "Layout With Coke Oven marked.dwg" AND "New Town Boundary Marked LAyout.dwg" RECEIVED

STEEL AUTHORITY OF INDIA LIMITED
IISCO STEEL PLANT, BURNPUR

DASTUR
M. N. DASTUR & COMPANY (P) LTD
CONSULTING ENGINEERS, KOLKATA

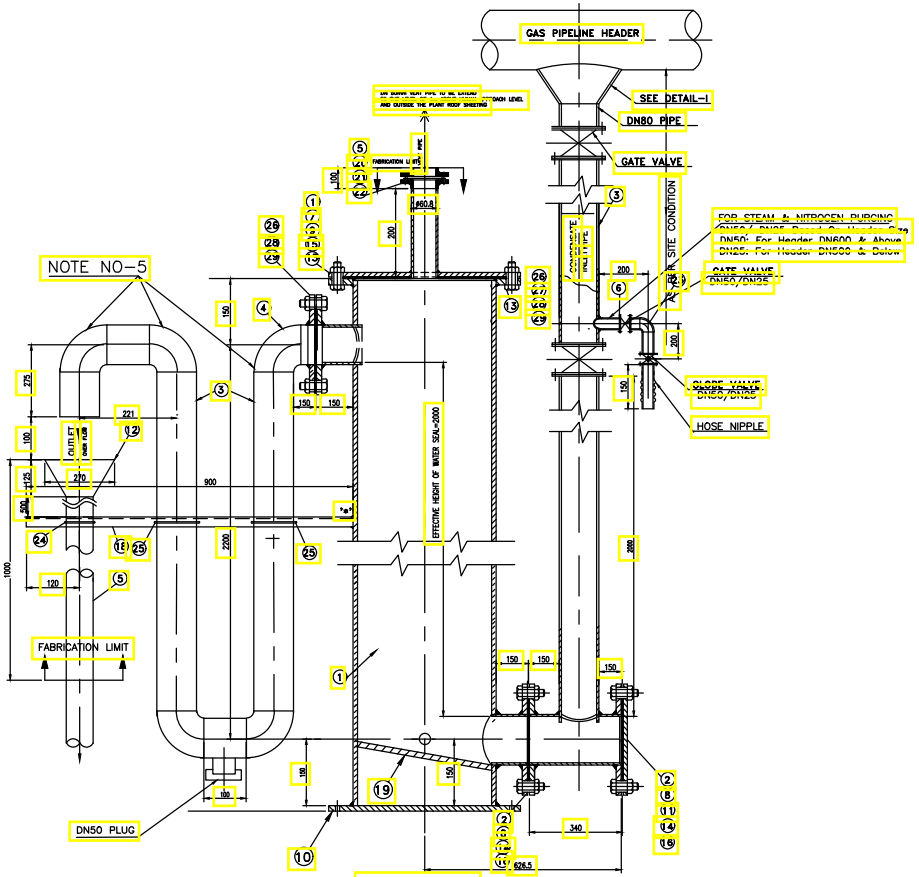
DETAILED PROJECT REPORT FOR 4.1 MTPA. EXPANSION PROJECT AT ISP - BURNPUR

PIPING LAYOUT DRAWING FOR UTILITY & WATER PIPES

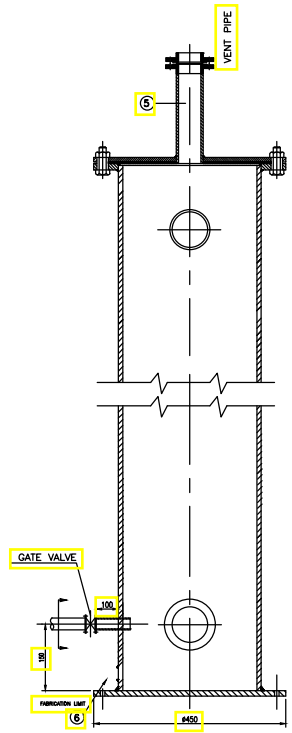
DRAWN	jnmo	15.05.2023	DRG. No.	REV.
APPROVED	sgsa	15.05.2023	11670-97A-000-UTL-0001	0

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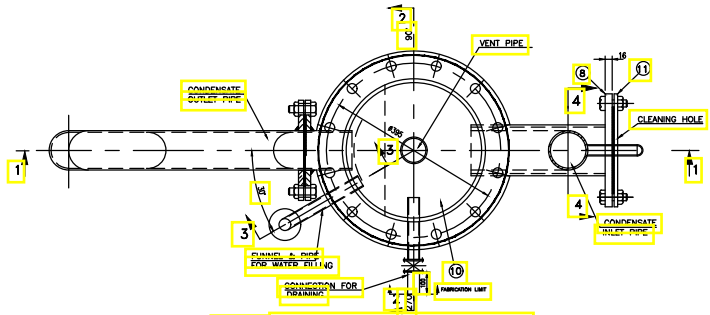
DRG. NO. MEC-GTS-09-11-40-001



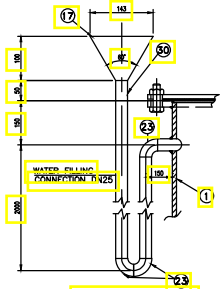
SECTION 1-1



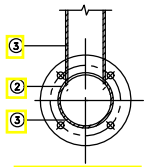
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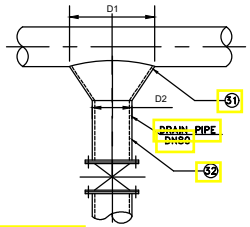
PLAN (WITH NOZZLES ORIENTATION)



SECTION 3-3



SECTION 4-4



DETAIL-I

SL NO.	PIPE DIA(mm)	D1(DN)	D2(DN)	Material Spec.
1.	DN2000 and Above	400	80	FABRICATED FROM PARENT PIPE/PLATE
3.	DN500 to below DN2000	300	80	ASTM A234 WPB TO B16.9 (DN150X80 & DN150X80) OR FABRICATED FROM PARENT PIPE/PLATE
3.	UPTO DN500	150	80	ASTM A234 WPB TO B16.9 (DN150X80)

BILL OF MATERIALS

SL NO.	DESCRIPTION	STANDARD	QTY.	UNIT	MATL.	WT. IN KG. UNIT	WT. IN KG. TOTAL	REMARKS
1.	WELDED PIPE DN300	ANSI B36.10	1	No.	ASTM A53 GR-B			
2.	[illegible]	ANSI B36.10	1	No.	ASTM A53 GR-B			
3.	ERW PIPE DN80	ANSI B36.10	1	No.	ASTM A53 GR-B			
4.	LR ELBOW DN 80	B16.9	5	No.	ASTM A234 WPB			
5.	ERW PIPE DN50	ANSI B36.10	1	No.	ASTM A53 GR-B			
6.	PIPE/ PLATE [illegible]	ANSI B36.10	1	No.	ASTM A53 GR-B			IBR QUALITY
7.	PLATE FLANGE DN600	IS:6392	1	No.	IS 2062 GR-B			TABLE-5 FOR DRILLING
8.	PLATE FLANGE DN100	ANSI B16.5	4	No.	ASTM A105			
9.	SPIGOT PLATE FLANGE	IS:6392	1	No.	IS 2062 GR-B			TABLE-5 FOR DRILLING
10.	SPIGOT PLATE, t=10mm DN300	IS:6392	1	No.	IS 2062 GR-B			TABLE-5 OR DRILLING
11.	BLANK FLANGE	ANSI B16.5	2	No.	ASTM A105			
12	FUNNEL,t=6	IS:2062	1	No.	IS 2062 GR-B			
13	BOLT WITH NUT M16X80	B18.2	12	No.	Gr. B7&2H			
14.	BOLT WITH NUT M16X80	B18.2	12	No.	IS 2062 GR-B			
15.	GASKET, t=4 DN300	–	1	No.	ASBES OS			
16.	GASKET, t=3 DN100	–	3	No.	ASBES OS			
17.	FUNNEL,t=6	–	1	No.	IS 2062 GR-B			
18.	ISA 50x50x6, L=900	–	1	No.	IS-808			
19.	PLATE, t=20mm	IS:6392	1	No.	IS 2062 GR-B			
20	FLANGE DN50, #150	ANSI B16.5	2	No.	ASTM A105			
21	GASKET, DN50 t=3	–	1	No.	ASBES OS			
22	BOLT WITH NUT M16X80	B18.2	4	–	Gr. B7&2H			
23	LR ELBOW DN25	B16.9	4	No.	ASTM A334 WPB			
24	U-CLAMP DN50	–	1	No.	IS-808			
25	U-CLAMP DN80	–	2	No.	IS-808			
26	FLANGE DN80	ANSI B16.5	3	No.	ASTM A105			
27	BLANK FLANGE DN80	ANSI B16.5	1	No.	ASTM A105			
28	BOLT WITH NUT M16X80	B18.2	8	–	Gr. B7&2H			
29	GASKET, DN80 t=3	–	2	No.	ASBES OS			
30	ERW PIPE DN80 [illegible]	ANSI B36.10	1	No.	ASTM A53 GR-B			
31	CONNECTING REDUCER	FOR DETAIL-I	1	No.				
32	ERW PIPE DN80 [illegible]	ANSI B36.10	1	No.	ASTM A53 GR-B			

NOTES:-

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. THIS IS FOR LOW PRESSURE FUEL GAS ONLY (MAX WORKING PR. 1500MMWC)
3. THE HEIGHT OF THE WELD SHALL BE EQUAL TO THE MINIMUM THICKNESS OF PARTS UNDER WELDING.
4. AFTER FABRICATION/ASSEMBLY INDIVIDUAL SEAL POT SHALL BE TESTED FOR ANY LEAKAGE FROM ALL JOINTS, FOR NOT LESS THAN ONE HOUR, AT A PRESSURE OF 2000 MM [illegible]
5. CONDENSATE DRAIN POT SHALL BE PAINTED
6. THE DRAIN PIPE LINE FROM GAS PIPE SHALL BE ROUTED AS PER SITE HOWEVER, THE SAME SHALL BE AS STRAIGHT AS POSSIBLE.

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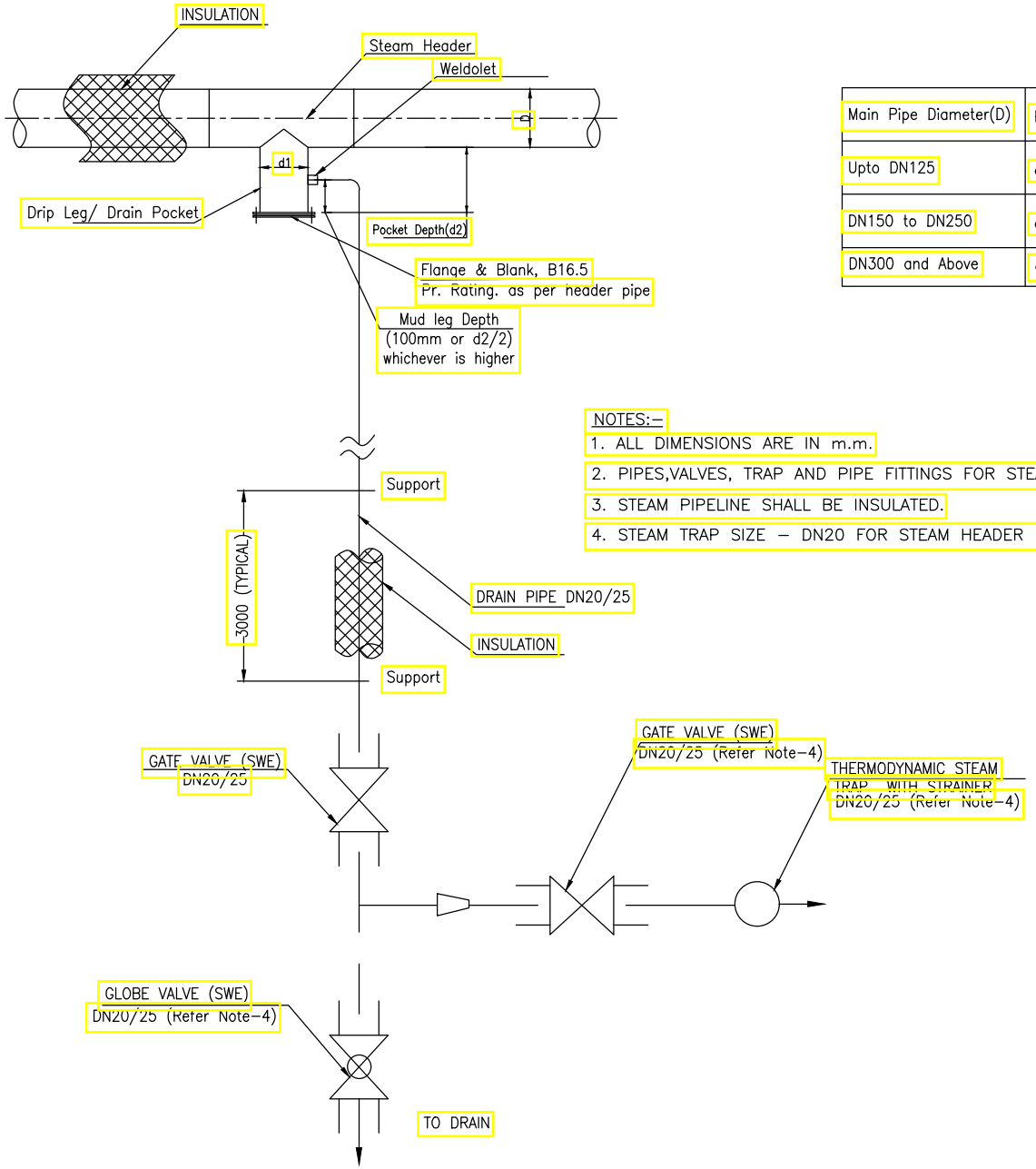
MECON LIMITED

SECTION	FS & PD
LOCATION	RANCHI
DESIGNED & DRAWN	TAPAS KUMAR DAS
CHECKED	MC MANDAL
APPROVED	S MALIK
DATE	

TYPICAL DRG OF CONDENSATE SEAL POT (FOR LOW PR. GAS PIPELINE) (B' Gas, CO Gas, BOF Gas, Mixed Gas)

SCALE- N.T.S	SHEET	REV.
DRG. NO. MEC-GTS-09-11-40-001	1 OF 1	0

DRG. NO. MEC-GTS-11-11-40-002



Main Pipe Diameter(D)	Pocket Diameter(d1)	Pocket Depth(d2)
Upto DN125	d1=D	d2=200mm
DN150 to DN250	d1= 150mm	d2=300mm
DN300 and Above	d1= D/2	d2=D

NOTES:–

1. ALL DIMENSIONS ARE IN m.m.
2. PIPES,VALVES, TRAP AND PIPE FITTINGS FOR STEAM LINE SHALL BE IBR APPROVED
3. STEAM PIPELINE SHALL BE INSULATED.
4. STEAM TRAP SIZE – DN20 FOR STEAM HEADER UPTO DN100 AND DN25 FOR ABOVE DN100/ AS PER CALCULATION OF CONDENSATE LOAD

TYPICAL DETAIL OF STEAM CONDENSATE DRAIN ARRANGEMENT

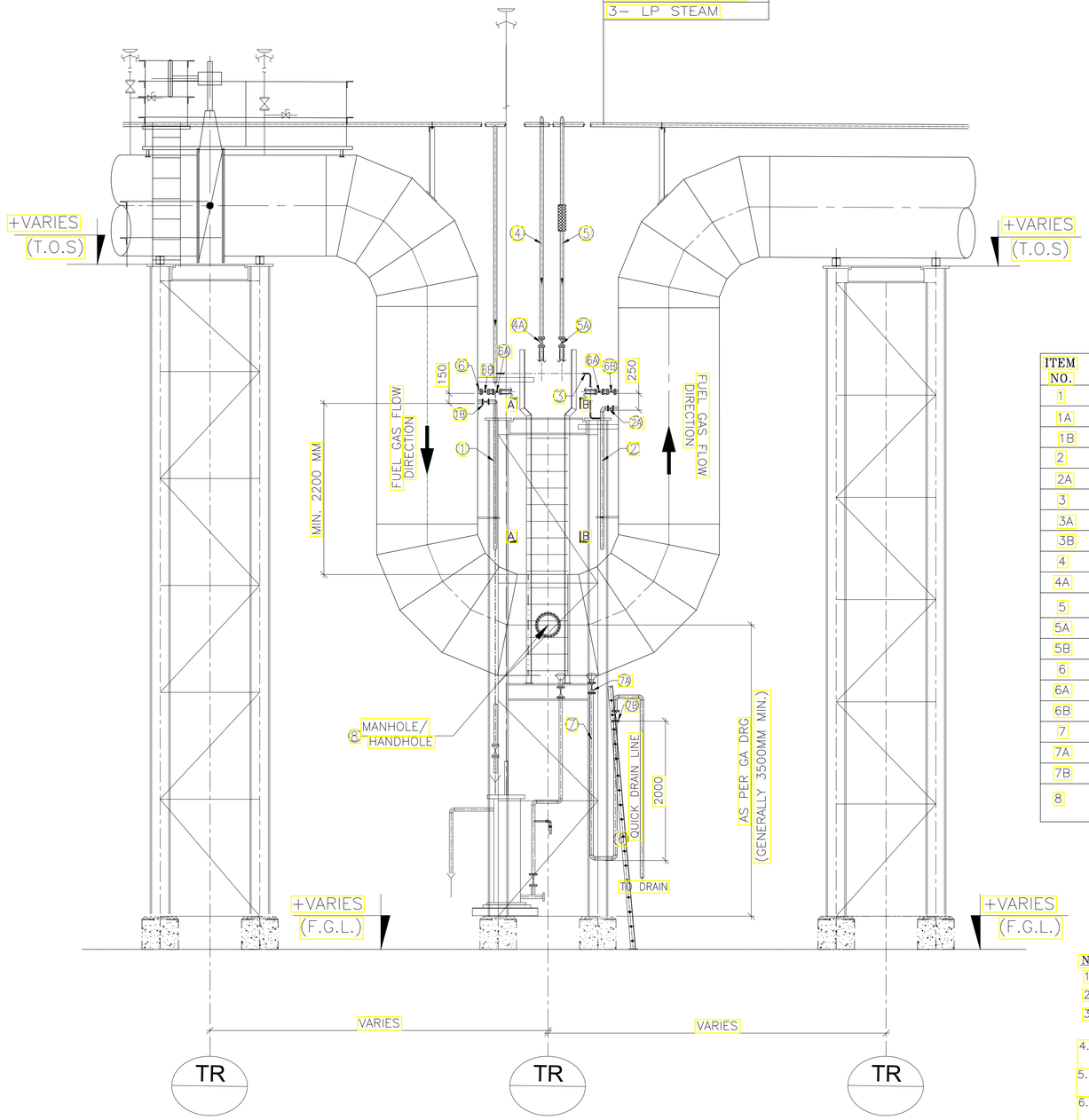
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MECON LIMITED

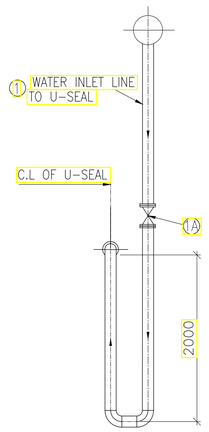
SECTION	FS & PD	TYPICAL SCHEME FOR STEAM CONDENSATE DRAIN ARRANGEMENT	
LOCATION	RANCHI		
DESIGNED & DRAWN	TAPAS KUMAR DAS		
CHECKED	MC MANDAL		
APPROVED	S MALIK	SCALE– N.T.S	SHEET 1 OF 1 / REV. 0
DATE		DRG. NO. MEC–GTS–11–11–40–002	

DRG. NO. MEC-GTS-11-11-40-003

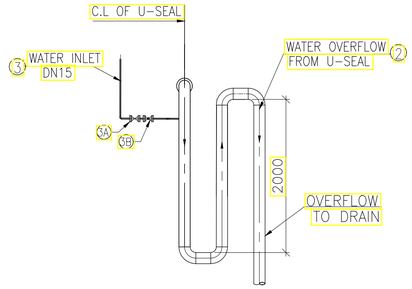
1- WATER DN 150
2- LP NITROGEN
3- LP STEAM



TYP. DETAIL OF U-TYPE WATER SEAL



SECTION A-A
(WATER INLET PIPE DETAILS ONLY)



SECTION B-B
(OVERFLOW PIPE DETAILS ONLY)

ITEM NO.	DESCRIPTION	GAS HEADER SIZE UPTO DN500	GAS HEADER SIZE DN600-DN950	GAS HEADER SIZE DN1000-DN1500	GAS HEADER SIZE ABOVE DN1500
1	WATER INLET PIPELINE TO U-SEAL	DN 50	DN 80	DN 100	DN 150
1A	GATE VALVE FOR ISOLATION	DN 50	DN 80	DN 100	DN 150
1B	GATE VALVE FOR ISOLATION	DN 50	DN 80	DN 100	DN 150
2	OVERFLOW PIPE LINE FROM U-SEAL	DN 100	DN 150	DN 200	DN 200
2A	GATE VALVE FOR ISOLATION	DN 100	DN 150	DN 200	DN 200
3	WATER INLET PIPELINE TO OVERFLOW U-PART	DN 15	DN 15	DN 15	DN 25
3A	GATE VALVE FOR ISOLATION	DN 15	DN 15	DN 15	DN 25
3B	GLOBE VALVE FOR PR/FLOW REGULATION	DN 15	DN 15	DN 15	DN 25
4	N2 TAPPING LINE FROM N2 HEADER FOR PURGING	DN 25	DN 50	DN 50	DN 50
4A	BALL VALVE FOR N2 TAPPING LINE ISOLATION	DN 25	DN 50	DN 50	DN 50
5	STM TAPPING LINE FROM STM HEADER FOR PURGING	DN 25	DN 50	DN 50	DN 50
5A	GATE VALVE FOR STM TAPPING LINE ISOLATION	DN 25	DN 50	DN 50	DN 50
5B	SELF ACTUATING STM PRV FOR PR. REDUCTION	DN 25	DN 50	DN 50	DN 50
6	PURGING LINE ON GAS HEADER	DN 25	DN 50	DN 50	DN 50
6A	GATE VALVE FOR ISOLATION	DN 25	DN 50	DN 50	DN 50
6B	GLOBE VALVE FOR PR/FLOW REGULATION	DN 25	DN 50	DN 50	DN 50
7	QUICK DRAIN LINE OF U-SEAL	DN 100	DN 150	DN 150	DN 200
7A	GATE VALVE FOR ISOLATION	DN 100	DN 150	DN 150	DN 200
7B	GATE VALVE FOR ISOLATION	DN 100	DN 150	DN 150	DN 200
8	MANHOLE(DN600)/HANDHOLE(EQUALL TO PIPE HEADER SIZE FOR PIPE HEADER BELOW DN600	DN 600/ BELOW	DN 600	DN 600	DN 600

NOTES:-

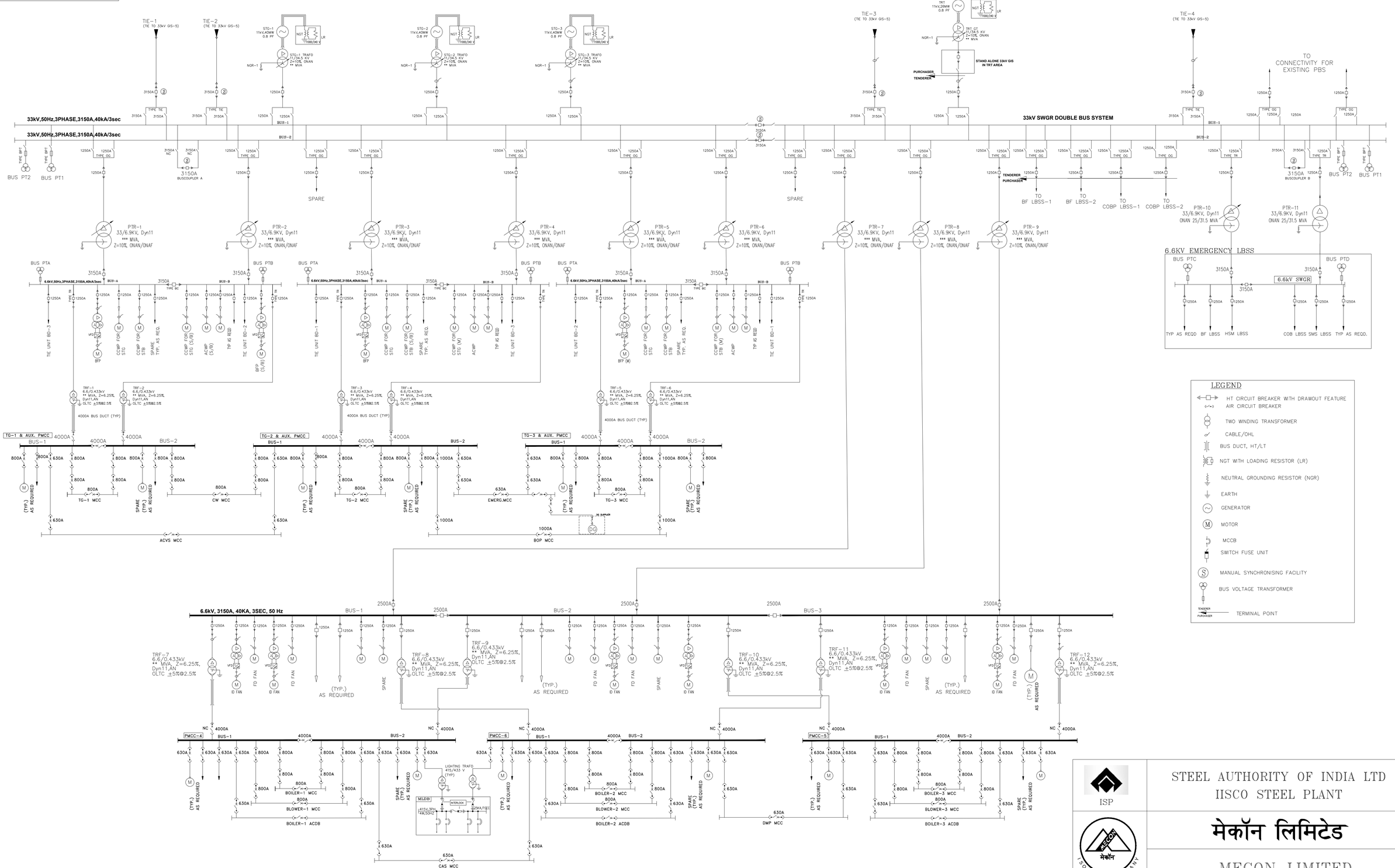
1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. ALL WELDING SHALL BE CARRIED OUT AS PER IS:9595
3. THE HEIGHT OF THE WELD SHALL BE EQUAL TO THE MINIMUM THICKNESS OF PARTS UNDER WELDING.
4. ALL VALVE OF DN50 & ABOVE SHALL BE FLANGED END, RISING SPINDLE, CLASS#150, CS BODY & SS TRIM.
5. ALL VALVE OF DN40 & BELOW SHALL BE SW END, RISING SPINDLE, CLASS#800, CS BODY & SS TRIM.
6. MANHOLE TO BE PROVIDED FOR DN600 AND ABOVE GAS HEADER AND HAND-HOLE TO BE PROVIDED FOR BELOW DN600 GAS HEADER. HAND-HOLE SIZE SHALL BE EQUAL TO GAS HEADER.
7. FOR SEAL POT DETAILS, REFER DRG. NO. MEC-GTS-09-11-40-003
8. SMALL DIAMETER PIPES SHALL BE SUPPORTED PROPERLY SUIT TO SITE

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MECON LIMITED

SECTION	FS & PD	TYPICAL FOR U-TYPE WATER SEAL (FOR LP FUEL GAS i.e. BF Gas, CO Gas, Mixed Gas, BOF Gas)		
LOCATION	RANCHI			
DESIGNED & DRAWN	TAPAS KUMAR DAS			
CHECKED	MC MANDAL			
APPROVED	S MALIK	SCALE- N.T.S	SHEET	REV.
DATE		DRG. NO. MEC-GTS-11-11-40-003	1 OF 1	0

DRG. NO. MEC/11/E4/M/0033/CPP1/01



LEGEND

- HT CIRCUIT BREAKER WITH DRAWOUT FEATURE
- AIR CIRCUIT BREAKER
- TWO WINDING TRANSFORMER
- CABLE/OHL
- BUS DUCT, HT/LT
- NGT WITH LOADING RESISTOR (LR)
- NEUTRAL GROUNDING RESISTOR (NGR)
- EARTH
- GENERATOR
- MOTOR
- MCCB
- SWITCH FUSE UNIT
- MANUAL SYNCHRONISING FACILITY
- BUS VOLTAGE TRANSFORMER
- TERMINAL POINT (TRANSFER PURCHASER)

NOTE:-

1. THE DRAWING FORMS PART OF TECHNICAL SPECIFICATION.
2. NUMBER AND RATING OF FEEDERS IN VARIOUS HT/LT SWITCHBOARD ARE INDICATIVE ONLY. THE SAME SHALL BE FINALISED DURING DETAILED ENGINEERING STAGE.
3. BREAKER MARKED WITH "SYN" SHALL BE PROVIDED WITH SYNCHRONISATION FACILITY. NECESSARY EQUIPMENT & INTERLOCKS SHALL BE PROVIDED AS PART OF SYNCHRONISING FACILITY ON COMMON SYNCHRONISATION PANEL.
4. CAPACITY OF VARIOUS ELECTRICAL EQUIPMENT SHOWN ARE INDICATIVE ONLY.THE SAME SHALL BE FINALISED DURING DETAILED ENGINEERING STAGE.
5. FEEDERS SHOWN IN THIS SLD ARE TENTATIVE ONLY. THE SAME SHALL BE FINALIZED BY BIDDER BASED ON REQUIREMENT OF OFFERED SYSTEM. THIS SHALL BE REVIEWED DURING DETAIL ENGINEERING. MINIMUM 20% SPARE CAPACITY FEEDERS OF EACH RATING SHALL BE PROVIDED.
6. THE TRANSFORMER AND BREAKER RATINGS INDICATED IN THE SLD ARE MINIMUM AND INDICATIVE ONLY. THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.
7. PTR-10 & 11 SHALL CATER TO EMERGENCY LOAD REQUIREMENT OF THE STEEL PLANT.

NOTE: ** QUANTITY & RATING OF GENERATOR TRANSFORMER, POWER TRANSFORMERS & LT DISTRIBUTION TRANSFORMERS SHALL BE SELECTOR BY THE BIDDER BASED ON THE TECHNOLOGICAL REQUIREMENT OF THEIR OFFERED SYSTEM. THIS SHALL BE REVIEWD & FINALIZED DURING DETAIL ENGINEERING.

REV	DATE	DESCRIPTION	BY	VERIFIED
1	06.08.2024			

REV / SEC — CONCURRED BY

REVISION

REFERENCES | DOC NO./DRG. NO.

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ISP

STEEL AUTHORITY OF INDIA LTD
IISCO STEEL PLANT

मेकॉन लिमिटेड

MECON LIMITED

SECTION	ELECTRICAL(P)
LOCATION	RANCHI
DESIGNED	UTTAM
DRAWN	S. AHMAD
CHECKED AND VERIFIED	A.CHAKRABORTY
APPROVED	SIG DK. SINGH
	DATE:- 07.08.2024

4.08 MTPA EXPANSION

CPP SINGLE LINE DIAGRAM

SCALE : N.T.S

REV 1

DRG. NO. MEC/11/E4/M/0033/CPP1/01

DRG. NO. MEC/11/E5/0033/TS/27/101

OWS-1 27" | OWS-2 27" | OWS-3 27" | OWS-4 27" | OWS-5 27" | OWS-6 27" | OWS-7 27" | OWS-8 27"

LVS CONTROLLER | CCTV | FLAME VIEWING SYSTEM

HARDWIRED BACK-UP PANEL | HARDWIRED I/Os

PERFORMANCE 27" | SHIFT I/C PC 27" | ELECTRICAL OS 27" | SOE WS 27" | UNIT I/C ROOM | UNIT I/C 27"

LASERJET | INKTANK | FROM CBMS PANEL

SYSTEM BUS

RIO PANEL CW & ACW PUMPHOUSE | DM PLANT DDCMIS

CBMS A&D 27" | CBMS A&D 27" | FROM CBMS RACK

E□□ 27" | □ER□RMAN□E 27" | EMER□EN□ 27" | □□□RIAN 27" | □ER□ER 27" | HART PC 27" | NETWORK PC 27"

TO OPC SERVER | SW-A201 | SW-A202

AUTO BACK-UP FACILITY | AUTO BACK-UP FACILITY

I/O BUS

TO CBMS PC | TO OPC SERVER | STG TSI SYSTEM | BLOWER TSI SYSTEM | □□M□ □ANE□

ISOLATED 4-20mA ALARM / TRIP CONTACTS | ISOLATED 4-20mA ALARM / TRIP CONTACTS

HARDWIRED SIGNAL EXCHANGE WITH BF AUTOMATION RIO

M A R S H A L L I N G C A B I N E T | T S I C A B I N E T | M A R S H A L L I N G C A B I N E T

LOCAL J.B. | CONTACT INPUTS | ANALOG (4-20 mA) | CJC BOX | T/Cs | RTDs | ELECTRICAL SYSTEM | MOTORISED VALVE/ DAMPER | MOTORS/ PUMPS | BREAKERS | TRANSDUCER J/B | TSI SENSOR

NOTES:

CONCURRED BY

REV / SEC | REV NO | DATE | ZONE | DESCRIPTION | BY | VERIFIED | REVISIONS

REFERENCES | DRG. NO.

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STEEL AUTHORITY OF INDIA LTD.

IISCO STEEL PLANT, BURNPUR

मेकॉन लिमिटेड

MECON LIMITED

SECTION	I&PC
LOCATION	R A N C H I
DESIGNED	RAJESH M
DRAWN	RAJESH M
CHECKED & VERIFIED	A. K. MAITI
APPROVED	SIG. – SKD
DATE	16-08-2024

4.1 MTPA EXPANSION PROJECT

CAPTIVE POWER PLANT

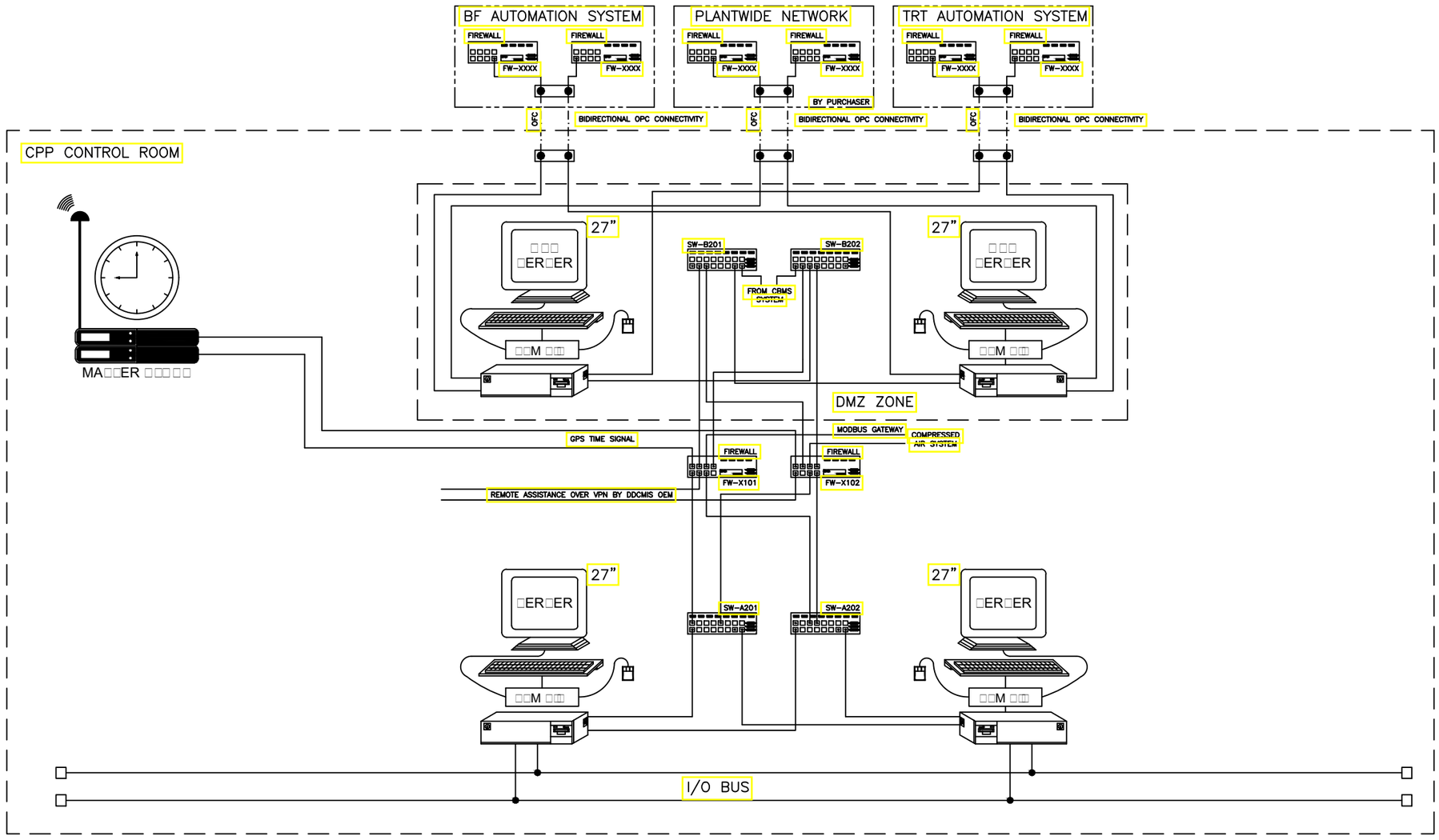
CAPTIVE POWER PLANT DDCMIS

AUTOMATION SYSTEM CONFIGURATION DRAWING

SCALE – NTS | SHEET 1 OF 5 | REV 0

DRG.NO. MEC/11/E5/0033/TS/27/101

DRG. NO. MEC/11/ES/M/0033/TS/27/101



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STEEL AUTHORITY OF INDIA LTD.
IISCO STEEL PLANT, BURNPUR

मेकॉन लिमिटेड
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REV NO	DATE	ZONE	DESCRIPTION	BY	VERIFIED
			REVISIONS		

CONCURRED BY

SECTION	MMPC
LOCATION	RANCHI
DESIGNED	RAJESH M
DRAWN	RAJESH M
CHECKED & VERIFIED	A. K. MAITI
APPROVED	SIG. – SKD
DATE	16-08-2024

4.08 MTPA EXPANSION PROJECT

CAPTIVE POWER PLANT

CAPTIVE POWER PLANT DDCMIS

AUTOMATION SYSTEM CONFIGURATION DRAWING

SCALE – NTS | SHEET 2 OF 5 | REV 0

DRG.NO. MEC/11/ES/M/0033/TS/27/101

DRG. NO. MEC/11/E5/M/0033/TS/27/101

DM PLANT CONTROL ROOM

OWS–9 27”

HCP

OWS–10 27”

LASERJET

HARDWIRED I/Os

OFC

SYSTEM BUS

OFC

SERVER ROOM

27” EMER□EN□□ □□ □

27” □ER□ER

TO OPC SERVER

SW–A201

SW–A202

27” □ER□ER

27” E□ □

LASERJET

□□M □□□

I/O BUS

DDCMIS CONTROLLER RACK

DDCMIS I/O RACK

DDCMIS I/O RACK

DDCMIS I/O RACK

DDCMIS I/O RACK

I/Os FROM/TO BACK–UP PANEL

M A R S H A L L I N G C A B I N E T

LOCAL J.B.

LOCAL J.B.

CJC BOX

LOCAL J.B.

LOCAL J.B.

ELECTRICAL SYSTEM

CONTACT INPUTS

ANALOG (4–20 mA)

T/Cs

RTDs

MOTORISED VALVE/ DAMPER

MOTORS/ PUMPS

BREAKERS

□□R □ENDER □UR□□ □E □N□□

ISP

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STEEL AUTHORITY OF INDIA LTD.

IISCO STEEL PLANT, BURNPUR

मेकॉन लिमिटेड

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NOTES:

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CONCURRED BY

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DATE

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SECTION	M&PC
LOCATION	R A N C H I
DESIGNED	RAJESH M
DRAWN	RAJESH M
CHECKED & VERIFIED	A. K. MAITI
APPROVED	SIG. – SKD
DATE	16–08–2024

4.08 MTPA EXPANSION PROJECT

CAPTIVE POWER PLANT

DM PLANT DDCMIS

AUTOMATION SYSTEM CONFIGURATION DRAWING

SCALE – NTS | SHEET 3 OF 5 | REV 0

DRG.NO. MEC/11/E5/M/0033/TS/27/101

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DRG. NO. MEC/11/ES/M/0033/TS/27/101

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NOTES:

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REV NO | DATE | ZONE | DESCRIPTION | BY | VERIFIED

REVISIONS

REFERENCES

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STEEL AUTHORITY OF INDIA LTD.
IISCO STEEL PLANT, BURNPUR

मेकॉन लिमिटेड
MECON LIMITED

SECTION	I&PC
LOCATION	R A N C H I
DESIGNED	RAJESH M
DRAWN	RAJESH M
CHECKED & VERIFIED	A. K. MAITI
APPROVED	SIG. – SKD
DATE	16-08-2024

4.08 MTPA EXPANSION PROJECT

CAPTIVE POWER PLANT

CAPTIVE POWER PLANT DDCMIS

AUTOMATION SYSTEM CONFIGURATION DRAWING

SCALE – NTS | SHEET 5 OF 5 | REV 0

DRG.NO. MEC/11/ES/M/0033/TS/27/101