R M & U OF PANCHET
HYDEL STATION UNIT # 1 (46 MW)

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-495-571-11000A-A001 (REV00)
(AUGUST-2022)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
POWER PROJECTS ENGINEERING INSTITUTE BUILDING
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA

	TITLE: R M & U OF PANCHET HYDEL STATION UNIT # 1 (46 MW) TECHNICAL SPECIFICATION FOR HVAC SYSTEM	SPECIFICATION No: PE-TS-495-571-11000A-A001	
		SECTION	
		REV. 00	DATE: AUGUST 2022
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977041/2022/PS-PEM-MAX

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SECTION-I

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INTENT OF SPECIFICATION

977041/2022/PS-PEM-MAX

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1.0 INTENT OF SPECIFICATION

1.1 The specification covers design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing and shipment till storage area and delivery from storage area to site, unloading, handling & on-site transportation, storage, preservation , security / safety at site , Erection & Commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer / client O&M staff and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order for R M & U OF PANCHET HYDEL STATION UNIT # 1 (46 MW).

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **HVAC SYSTEM.**

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all terms required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

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1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – C1 shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.

Further, In case of any discrepancy in section 'C1' and section 'C2', Section-C2 shall prevail (customer specification).

1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please refer relevant clause of GCC.

1.12 Since this job is for renovation and modernization of existing plant, sizes and locations of various rooms/buildings/openings/ foundations etc. are fixed. Any major modification in the same is not envisaged. Thus, bidders, in their own interest, are advised to visit the site and assess the work requirements in line with scope of HVAC covered in this specification, before quoting for this tender.

	R M & U OF PANCHET HYDEL STATION UNIT # 1 (46 MW) PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA	SPECIFICATION No: PE-TS-495-571-11000A-A001
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SECTION: I

SUB-SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

01.00 PREAMBLE

Panchet reservoir is one of the four multi-purpose reservoirs included for construction in the first phase by Damodar Valley Corporation (DVC). It was constructed across the Damodar River at Panchet in Dhanbad district of Jharkhand state and was opened in the year 1959. The Station has an installed capacity of generating 80 MW power with two (2) generating units of 40 MW each. The hydel power station started in 1959 with one unit of 40 MW (Unit # 1). The second unit of 40 MW (Unit # 2) was commissioned in 1991.

Unit # 1 of Panchet Hydel Station has outlived its service life and is operating at de-rated capacity. As such, M/s DVC decided to renovate, modernized and up-rate the Unit # 1.

The Technical Specification (**Volume-II, III & IV**) shall be read in conjunction with the Commercial Specification (**Volume- I)** of Tender Document. Volume-II of Technical Specification deals with the Technical Specification for Mechanical and Civil works whereas as Volume-III deals with Technical Specification for Electrical and C&I work. This Technical specification also describes dismantling of Turbine, Generator, electrics and all equipment, renovation of embedded parts, supply, erection, testing commissioning and demonstration of Performance Guarantee of Turbine generator, governing system, excitation system, other auxiliaries for Turnkey Installation of Unit # 1 of Panchet Hydel Station of DVC in Dhanbad District of Jharkhand.

01.01 Location details

Panchet Hydel Station is a dam toe power house located at the toe of Panchet reservoir on the river Damodar near the border of Dhanbad and Purulia districts of Jharkhand and West Bengal respectively. Panchet Hydel Station is approx 10 KM from Kumardubi Railway station and 25 KM from Asansol Railway station, West Bengal. The site is approx 50 KM from Dhanbad, Jharkhand. Longitude and Latitude of site location are as follows:

Longitude : 86°44' E

Latitude : 23°40' N

Tail water level (TWL) of the Panchet Hydel Station during months of January 2019 is as follows

- Tail water level (when two units operating at full load) = 327.0 ft
- Tail water level (when one unit operating at full load) = 324.2 ft
- Tail water level (when one unit operating at no load) = 317.2 ft.

Temperature of water

Minimum : 8 ºC

Maximum : 35 ºC

Raw Water Analysis Data of Panchet reservoir

Sl. No.	Item	Unit	Value
1	PH	No	8.7
2.	p-alkalinity	Ppm as $CaCO_3$	7.0
3.	Total alkalinity	Ppm as $CaCO_3$	90.0
4.	Total dissolved solids	Ppm	232.7
5.	Chloride as Cl	Ppm as chloride	15.5
6.	Sulphates as SO_4	Ppm as sulphate	66.2
7.	Calcium as Ca	Ppm as $CaCO_3$	64.0
8.	Magnesium as Mg.	Ppm	59.0
9.	Sodium as Na	Ppm	-
10	Potassium as K	Ppm	-
11	Conductivity	Micromho/cm	358.0

Panchet Reservoir Data

Description	Elevation in ft. (m)	Storage capacity (in MCM)
Top of Reservoir	El. 457ft (139.3m)	-
Maximum flood level/Top of the spillway gate/ full reservoir level (FRL)	El.445ft (135.5m)	1497.54
Normal water level (NWL)	El.410ft (125.0m)	410.77
Dead storage level/Minimum draw down level (MDDL)	El.392ft (119.5m)	182.56
Live storage (MDDL to FRL)	-	1314.98
Active storage (MDDL to NWL)	-	228.21
Dead storage (up to EL 392ft)	-	182.56
Flood reserve (between El 445ft to EL 410ft)	-	1086.76

If any further details regarding raw water are required then necessary analysis shall be carried out by tenderer.

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TECHNICAL SPECIFICATION

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SPECIFIC TECHNICAL REQUIREMENT

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1.0 FUNCTION

The purpose of the system is to provide HVAC (Air conditioning and ventilation) for different areas of "**PANCHET HYDEL STATION UNIT # 1 (46 MW)"** under the scope of this tender. To achieve proper working conditions inside the power house complex, Fire Water Pump House etc. , HVAC system is provided to serve the following purpose:

i. To prevent temperature stratification
ii. To remove contaminated air
iii. To remove waste heat from equipment
iv. To provide outside fresh air necessary for human comfort
v. To evacuate smoke and remove heat

2.0 SYSTEM DESCRIPTION

Conditioned and dehumidified air shall be supplied to different zones of the powerhouse in accordance with heat generated in each zone. The power station shall be divided into two zones as below:

(A) Air Conditioning Zone
(B) Ventilation zone

2.1 AC SYSTEM ZONE CONSIST OF THE FOLLOWING AREAS.

2.1.1 Water Cooled Package Type Air conditioning plant shall be provided to cater to the air conditioning requirements of the Power house.

2.1.2 Split AC for Air Conditioning of Control Room in the Fire Water Pump House and any other areas.

2.2 VENTILATION SYSTEM CONSIST OF THE FOLLOWING AREAS

2.2.1. VENTILATION SYSTEM OF POWER HOUSE

2.2.1.1 Dry type ventilation system shall be provided for the ventilation of Power House. Centrifugal Fans are provided outside the Power House area for supplying air to the various areas of power house through ducts.

2.2.1.2 Exhaust Air shall be taken out of the building through the Axial Exhaust Fan mounted on the wall of the Power House.

2.2.1.3 Ventilation System for Turbine Pit: Centrifugal Type Exhaust Fan with Duct and diffusers are provided for Exhausting heat generated in the Turbine Pit. These fans are located just outside the Turbine Pit of unit No. 1.

These fans are operated as per requirement when the plant is operating.

2.2.1.4 Ventilation System for Area below generator floor (Drainage Gallery): Axial Type Supply Air Fan is located at generator floor. Supply Air Duct is taken to the basement through floor opening at the generator floor at El. 333. As the basement is unmanned, only during maintenance activity, tube axial fan is operated which sucks air from the generator floor and discharges it in basement.

2.2.2 VENTILATION SYSTEM FOR AUXILIARY BUILDING

Dry Mechanical type Ventilation System shall be provided for following areas:

2.2.2.1 Toilets, Battery Room, Mechanical Workshop, Electrical Workshop / Tool Room of the power house.

2.2.2.2 Switchgear room, Fire Water Pump House, Toilet for Fire Water Pump House

2.3 Complete Structural work for erection of mechanical, electrical and C & I equipment, support, inserts for duct / fans / pipes / cable tray etc. is in bidder's scope. Following may please be noted.

1) Duct support structure outside and inside power house for routing supply / exhaust duct / cable trays etc. from blower room housing centrifugal fans shall be in bidder's scope. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by bidder subject to customer / BHEL acceptance during detail engineering.

2) Fixing frame works for diffusers and grilles in the scope of Vendor.

3) Anchor fastener / HILTI fasteners shall be used by vendor for fixing duct/ pipes etc. wherever applicable.

4) Duct supporting and accessories material such that hangers, tie rods, nut, bolts, lock nut, washer, HILTI fastener, gasket, bracing, adhesive, sealant, rivets, angles, channels, bracket support etc. for completeness of duct installation in all aspects shall be in bidder scope.

Any other type of structural work for complete HVAC system is deemed to be in bidder's scope even though specifically not mentioned above.

3 DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA – AMBIENT CONDITIONS

3.1.1 The outside design conditions considered shall be under: -

	Summer	Monsoon	Winter
DBT (°C)	**45**	34	**10**
RH (%)	24	65	-

3.1 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

3.2.1 The inside design conditions to be maintained shall be as under: -

23°C ± 2^0C & RH 55% ± 5% for control room etc.

3.2.2 Fresh air requirement shall be minimum 1.0 air change per hour for control room areas or 16 CFM per person whichever is higher. For other areas like office, Fresh air shall be considered as per ISHRAE.

3.2.3 A design margin of 10% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area.

3.2.4 Necessary Heater and Humidifier shall be provided (if required).

3.2.5 Efficiency of centrifugal fan and pump shall not be less than 70%.

3.3 SYSTEM DESIGN CRITERIA - VENTILATION SYSTEM

3.3.1 Inside design temperature. 3 deg. C above the ambient temperature.

3.3.1 Ventilation provision for various location is envisaged as follows

S.No.	Name of premises	Type of Ventilation	ACPH
1.	Power House area	Ventilation by Centrifugal Fan connected with Duct	
a.	Machine Hall / Service Bay / Generator / Turbine floor		2
b.	Switchgear room in power house		4
c.	Panel room in power house		4
2.	Battery room	Wall mounted Exhaust fans (spark proof with flame proof motor) with ducting (if required) Fresh air supply through of Louvers	8
3.	Toilets & pantries for Power House and other areas	Exhaust by means of propeller type exhaust fan. Supply through door undercuts / door louvers	8
4.	Mechanical workshop	Exhaust by means of propeller type exhaust fan. Supply through intake louvers	6
5	Electrical Workshop	Exhaust by means of propeller type exhaust fan. Supply through intake louvers	6
6.	Fire Water Pump House	Exhaust by mean Axial exhaust fan.	6

3.3.2 Air quantities shall be calculated based on heat load basis based on heat dissipation values from the various equipment, other heat source in various areas and the air quantity calculated based on air changes per hour and adopting higher of the two values.

3.3.3 The maximum air velocity through ventilation duct shall be 12.0 m/sec.

3.4 CODES AND STANDARDS

The following standards, codes and technical documents are used for the design of HVAC system.

3.4.1 ASHRAE**/** ISHRAE Guide and data book, American Society of Heating, Refrigerating and Air Conditioning Engineers.

3.4.2 IS: 655/ IS 277 for Sheet Metal Air ducts.

3.4.3 IS: 4720, Indian Standard Code of Practice for Ventilation of Surface Hydel Power Stations.

3.4.4 IS: 3103- Code of practice for industrial ventilation

3.4.5 ANSI/ Standard 62- Ventilation for acceptable indoor air quality

3.4.6 IS 659- Safety code for Air-conditioning.

3.5 GENERAL PRINCIPLES

3.5.1 Cooled air shall be supplied generally at low points of the powerhouse and exhaust air shall be at high points.

3.5.2 Areas such as battery room, toilet and pantry which are exposed to harmful gases or odors shall be maintained at negative pressure and these harmful gases / odors shall be exhausted outside the power building with the help of separate exhaust air fans.

3.5.3 Lighting load considered shall be 1 Watts/sq. feet.

3.5.4 The Occupancy considered shall be 1 person in 25 SQM or (actual) whichever is higher.

3.5.5 All the equipment for HVAC system shall be designed for continuous duty.

3.5.6 For winter Load calculations, only the lighting load shall be considered and equipment load shall be considered as Zero (0).

3.5.7 The heat dissipation values from various equipment / Occupants shall be taken into consideration while designing the HVAC system.

4. GENERAL DESCRIPTION OF VENTILATION AND AIR CONDITIONING SCHEME

4.1 VENTILATION SYSTEM

4.1.1 POWER HOUSE AREA

4.1.1.1 Ventilation system shall be provided for maintaining an air temperature of 3 degree above ambient temperature in summer season.

4.1.1.2 The supply air quantity requirement will be worked out based on heat load calculation from first principle as well as for maintaining minimum no. of air changes as per IS:4720 / as mentioned in table given above, under clause 3.3.1 (higher of the two). The higher value of the two shall be adopted for supplying air to various areas of power house.

4.1.1.3 In order to meet the above requirements, Two Nos. Centrifugal Fans, DIDW Type (One towards DAM site and other towards Transformer side), each of capacity 65000 CMH, 60MMWC Static (min). is provided and same are placed in fresh air blower room.

4.1.1.4 60% of air supplied to Power House area except Battery rooms & toilets, shall be exhausted with the help of Axial exhaust fan. 4 Nos. Axial fan of capacity 20,000 CMH each shall be mounted on the Power House machine hall.

4.1.1.5 The exhaust air from toilets and battery room in power house shall be evacuated by means of separate exhaust fans.

4.1.1.6 Automatic motorized dampers shall be provided at the discharge duct of Centrifugal Fan at power house. Fire rating of dampers shall be 90 minutes.

In order to avoid spreading of fire, the motorized damper with in-built controller having a provision of interfacing with the control panel of fire-fighting equipment of power house shall be considered.

4.2 AIR-CONDITIONING SYSTEM

4.2.1 POWER HOUSE AREA

4.2.1.1 Water cooled package type air conditioners (PAC) along with Condenser Water Pumps, Cooling Tower, Make Up Water Tanks, Associated Ducting shall be provided for power house as per details given below.

Sr. No.	Air Conditioning System Size
1.	Water Cooled Package AC: 4x50% Capacity, 15.0TR actual capacity Cooling Tower 2x100% Capacity, Design Flow Rate, 1.1 Times the pump flow rate, Approach – 4 Deg. C, Range – As per OEM, Min. 4 Deg. C, Wet Bulb Temperature – Min. 29 Deg. C, COC – 3.0 Condenser Water Pumps: 2x100 % Capacity, Min. 30 CMH Fresh Air Fan with Pre and Fine Filters, VCD etc: 1x100 %, Capacity as per heat load calculation Make Up Water Tanks: 2 Nos. 2.0 CMH, MS / FRP Make Up Water Pumps – 2x100% Capacity, Min. 1.0 CMH Cyclone Separator – As per requirement, Min. 30.0 CMH Duplex Strainer – At the suction of Make Up Water Pumps & Condenser Water Pumps

4.2.1.2 Winter heating section shall consist the strip heater in the duct plenum as per heat load calculation.

4.2.1.3 For control of humidity, pan type humidifiers of suitable capacity shall be provided inside package air conditioners room.

5. LAYOUT CONSIDERATIONS:

5.1 AIR CONDITIONING SYSTEM

5.1. **Water cooled package type air conditioners (PAC) along with other equipment's** shall be housed at various locations, as under:

Sr. No.	Equipment	Location
1.	Water Cooled Package AC	Adjacent to Control Room at EL. 347.67 Ft
2.	Cooling Tower	Above Control Room Area, At El. 356.6 Ft, Dam Side
3.	Make Up Water Tank	Above Control Room Area, At El. 356.6 Ft, Dam Side
4.	Condenser Water Pump	Above Control Room Area, At El. 356.6 Ft, Dam Side
5.	Make Up Water Pump & Cyclone Separator	At El. 356.6Ft, Dam Side, Make Up Water Connection to be taken from El. 333 Ft.

The locations and space requirement of the AC equipment given above may change during detail engineering.

5.1.2 Suitable provision (transducer, control cables etc) shall be kept for transmission of relative humidity and temperature data from AC system to the control room.

5.2 VENTILATION SYSTEM

Sr. No.	Equipment	Location
1.	Centrifugal Fan (1 No.), Located towards DAM Side	Fresh Air Blower Room of approx. Dimension 4.9M x 4.0M x 2.7 M (Ht), Above Control Room Area, At El. 356.6 Ft, Dam Side. Duct shall be taken to below floor from the floor opening in the blower room. Floor Cut out in the Room for Duct Dropper is approx. 1700mm x 1100mm and same is located at a distance of approx. 700mm from the 4.0 M Wide Wall. Centrifugal fan selected should fit in above room size with the floor opening.
2.	Centrifugal Fan (1 No.), Located towards Transformer Side	Fresh Air Blower Room of approx. Dimension 4.9M x 4.0M x 2.7 M (Ht), Outside Power House entry, adjacent to transformer area, At El. 360 Ft Duct shall be taken to below floor from the floor opening in the blower room. Floor Cut out in the Room for Duct Dropper is approx. 1700mm x 1100mm and same is located at a distance of approx. 700mm from the 4.0 M Wide Wall. Centrifugal fan selected should fit in above room size with the floor opening
3.	Exhaust Air Fan for Power House	Power House Walls, Approx. at El. 375 Ft. Tentative opening available for Exhaust air fan is given at the end of the specification. Axial fan selected should fit in above opening.
4.	Centrifugal Type Exhaust Fan, SISW for Turbine Exhaust	Centrifugal Type Exhaust Fan with Duct and diffusers provided for Exhausting heat generated in the Turbine Pit. These fans are located just outside the Turbine Pit at El. 333 Ft.
5.	Ventilation System for Area below generator floor (Drainage Gallery)	Tube Axial Type Supply Air Fan is located at generator floor. Supply Air Duct is taken to the basement through floor opening at the generator floor at El. 333 Ft.

6. EQUIPMENTS DETAILS

6.1. SPLIT AIR CONDITIONER

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements for auxiliary / local control room etc. For these areas multiple working split ACs shall be provided. Local isolator / MCB shall be provided with split units.

Hand operated remote and other accessories as specified. Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners. Each split unit shall also be provided with suitable rating stabilizer. 100 % stand by split AC units shall be provided.

Split AC shall conform to latest available highest BEE rating (5 Star).

6.2 WATER SOFTENING PLANT

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be taken to a sump through HDPE piping to the plant drain.

Softening plant of various AC systems shall be designed for effective capacity of cooling tower makeup water requirement considering the evaporation, cooling tower blow down, misc. drift losses and water required for regeneration plant. The service cycle (i.e., time between two successive regeneration) shall not be less than 20 Hrs.

The clarified water analysis is attached under Project Information of this specification. The make-up water to AC Cooling Tower will be a soft water (Total Hardness ~ 20-30 ppm as CaCo3) which shall be achieved through the blending of clarified & soft water (Softening plant Outlet) the CT is expected to operate at 5 Cycle of concentration & accordingly provision for suitable blowdown to be provided.

The softening plant shall be resin based & it is proposed to have it on a prefabricated & preassembled skid (comprising of Softener, ACF & DMF) to minimize Site activities. Suitable disposal of brine solution shall be envisaged as shown in sketch attached (Refer Annexure A).

The softening plant shall be complete with all instrumentation & required facilities as per the system requirement including initial fill of resin. Suitable cooling water treatment program (Viz scale inhibitor/Corrosion inhibitor/Bio dispersant etc.) must be dosed to maintain a corrosion and scale free water chemistry in the cooling water circuit. The required chemicals for initial commissioning and further till handing over shall be in the scope of bidder. Further the reject of the water softening plant shall be to the nearest plant drain by the bidder.

As soft water shall be corrosive in nature, piping and valves from softening plant to make up water tank and from make water tank up to cooling tower shall be of MS RL or suitable material which shall be decided during detail engineering without any implication.

Industrial Salt for Water Softening plants of air conditioning systems to be supplied on and where basis as per site requirement by the bidder. Minimum Quantity of Salt for Water

Softening Plant is specified in the Price Schedule. Additional Quantity, if any shall be supplied on pro-rata basis by the bidder.

6.2 VENTILATION EQUIPMENT:

A WALL MOUNTED AXIAL FLOW FAN / TUBE AXIAL FAN / PROPELLER FANS

Each wall mounted axial flow fan shall be complete with

(i) Fan impeller with aerofoil section of cast aluminium alloy & casing/short duct as required.

(ii) Electric drive motor with coupling if any, including motor brackets.

(iii) Inlet cone and grouting framework, if any.

(iv) Rain protection cowl with bird-screen adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

(v) Axial fans will be of propeller type, for fans with 5 mm of wc fan static pressure and Tube Axial type for fans with static pressure above 5 mm of wc.

(vi) Each Axial fan comprises of fan, fan motor, inlet and outlet cone (for Tube axial), Louvered shutter (exhaust fans), bird screen and supporting arrangement.

(vii) For other details please refer relevant clauses of Customer technical specification section C2-A.

1	Axial flow supply fans with 30 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	2.2 KW	800mmx800mm
b.	7,500 CMH	1.5 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	500mmx500mm
2	Axial flow supply fans with 20 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	600mmx600mm
3	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
a.	Capacity	Motor rating	Wall opening
b.	15,000 CMH	2.2 KW	900mmx900mm
c.	10,000 CMH	1.5 KW	800mmx800mm
d.	7,500 CMH	1.1 KW	700mmx700mm
e.	4,000 CMH	0.75 KW	600mmx600mm

f.	2,000 CMH	0.55 KW	500mmx500mm
4	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	4,000 CMH	0.55 KW	600mmx600mm
f.	2,000 CMH	0.37 KW	500mmx500mm
5	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1000 CMH	100 W	300 / 380 mm circular

7. CONTROL PHILOSPHY

HVAC System shall be controlled through DCS System. Critical signals from instruments and equipment's shall be transferred to main plant DCS for monitoring and control purpose.

All fire dampers shall be closed on getting signal from the respective fire panels. Necessary cabling required for the purpose shall be covered under HVAC bidder's scope. Further the respective Centrifugal Fan motor / Package AC Unit motor etc shall stop on closure of fire damper.
Detailed control philosophy shall be discussed and approved during detailed engineering stage.

For other details please refer to relevant clauses of Customer technical specification section C2-A.

8. ACCEPTANCE TEST

a. **Air conditioning system:** Room condition test shall consist of taking the reading of dry bulb and wet bulb temp at different locations points to be mutually decided at site in the areas which are air-conditioned by the respective system/plant. Room condition test shall be done after stabilization of the system. The dry and wet bulb temp shall be measured by sling psychrometer which will have accuracy of +/-0.5% with a least count of 0.5 deg C. This will be carried out for 24 hrs continuously and readings will be taken every two hours. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer during month April to June when the dry bulb temp is generally high and during. The format for recording the readings shall be defined in PG / Demonstration test procedure during detailed engineering stage. Relative humidity shall be determined from psychometric chart

b. **Ventilation system:** Temperature test at the out let of AHU and at different floors at mutually agreed locations. The dry bulb temp shall be measured by sling psychrometer which will have accuracy of +/-0.5% with a least count of 0.5 deg C. This will be carried out for 24 hrs continuously and readings will be taken every two hours. Standby equipment should be changed over during these 24 hours. This test

shall be carried out during summer between months April to June. The format for recording the readings shall be defined in PG / Demonstration test procedure during detailed engineering stage.

c. All shop testing and test at site as specified shall be carried out.

d. The Noise level of the AC system shall not be exceeded 55dB (A) in rooms as in the Control Rooms, Offices & Reception Room.

e. The Noise level of the rotating derive shall not be exceed 85dB (A) at 1.0m from source at 1.5m elevation.

Acceptance Test to be covered separately and should cover followings;

1. Performance Testing (Air Quantity at various floors)
2. Air Balancing
3. Leakage
4. Noise level
5. Vibration level
6. Fire Dampers working
7. Interlocking with Local Control Panel
8. Motor Current
9. Temperature / Humidity at various location of different floors
10. All equipment (fans, blowers, motors, Compressors, Pumps, heater etc.) checking.

For other details please refer relevant clauses of Customer technical specification section C2-A.

	R M & U OF PANCHET HYDEL STATION UNIT # 1 (46 MW) HVAC SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-495-571-11000A-A001	
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		SUB-SECTION : C 1	
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9.0 GENERAL

1) Basis of design, all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.

2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.

3) All drawings and documents shall be computer based.

4) All commissioning spares & consumables for trouble free operation shall be provided by Vendor.

5) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

6) Indicative list of makes is enclosed elsewhere in the specifications; however, these equipment's / items shall be subject to Customer & BHEL approval during detail engineering Stage.

7) Drain piping within room and up to the drain point to be provided by the Vendor.

8) Tools & tackles as required for regular maintenance shall be supplied by Vendor.

9) Instruments, consumables, lubricant required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

10) Only calibrated instruments shall be used by HVAC supplier for testing of various equipment.

11) Temperature gauges shall be provided with thermo wells and fixing arrangement.

12) Pressure gauges shall have provision for air venting.

13) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.

14) Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

15) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipment's as per design basis / details furnished.

16) The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of HVAC system.

- Design dry bulb temperature and relative humidity of conditioned air, Vibration and noise level etc.
- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder.

17) For motorized fire damper power supply shall be derived by from DCS. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

18) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements for installing the equipment as per the specification and layout requirements given in the specifications.

19) Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to DCS / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.

20) In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

21) Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

22) The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor’s account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer’s place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

23) Flat, platform type RCC / PCC foundation shall be provided for installing PUMP, PAC and FAN etc. Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.

24) Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.

25) HVAC plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

26) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.

27) The bidder's proposal shall be for equipment in accordance with the tech. Specification.

28) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification during detailed engineering.

29) The bidder shall arrange to provide training on complete HVAC system including operation & Maintenance for Employer Personnel.

30) The tools and machine required for erection of equipment shall be arranged by Vendor.

31) Construction of openings in brick-walls, as required, for routing the ventilation, Air conditioning ducts and installation of axial fans, shall be in bidder's scope of works. Floor openings, as available at site, for duct routing can be used by bidder during erection of duct.

32) Further, sealing of duct opening, grouting of foundation / foundation bolts including special type of grouting like GPX2 etc. are in the scope of HVAC system supplier.

33) Necessary duct mounted Booster fan (if required) to maintain the static pressure for Package AC / Precision AC / Ventilation duct shall be provided without any implication.

10.0 EXCLUSIONS

Items of works listed below are excluded from scope of the HVAC plant supplier.

a) Construction of HVAC plant room, air handling unit room, foundations for HVAC equipment's.

b) False ceiling, drop ceiling.

c) Provision of drain traps / points,

d) Fire water tank.

e) Dismantling of existing HVAC System

11.0 Terminal Point

Make Up Water for HVAC system: One No. Tapping shall be provided at El. 333 Ft, Dam Side. Further routing of the water to HVAC System shall be in Bidder scope.

12.0 Codes and Standards

Design, manufacture, inspection and testing of the equipment covered by the specification shall conform to the latest edition of the standards and codes of HVAC system.

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SECTION: I

SUB-SECTION: C2-A

CUSTOMER SPECIFICATION

(TECHNICAL REQUIREMENT)

06.06 AIR CONDITIONING & VENTILATION SYSTEM

SCOPE OF WORK

The scope of work of the turnkey package supplier shall also include the air conditioning & ventilation systems for the Control room, IOs room, DCS room, machine hall, turbine pit, underground passages towards spiral casing, draft tube fire water pump house, toilets, etc and other area of panchet hydel power station as per system requirement. To avoid dusty environment a separate cubical with air conditioning for excitation and AVR panels to be provided located at machine hall. Design / engineering, manufacture / procurement, inspection, shop painting and testing, supply, transportation to tenderer's site stores, transportation of materials from above site stores to erection site, storage, testing, erection, commissioning of and PG testing Air Conditioning and ventilation systems including its electrics and civil works.

The air conditioning shall include Water Cooled Package AC for the central control room premises and other room as per requirement inside the panchet power house area. The capacity of PAC shall be finalized during detailed engineering. However, Split AC shall be provided for the remotely located isolated premises, if any.

The tenderer shall clearly specify basis of design being offered along with back up guarantee on his design. The performance chart of the equipment shall be submitted by successful tenderer for design & operating condition. The details of experience and credentials w.r.to the design, supply & installation of previous AC system shall be furnished in the tender.

06.06.01 Design criteria for Air conditioning & ventilation systems

The following design data shall be considered for selecting and sizing of various equipment for air conditioning systems:

SEASON	TEMPERATURE^{0}C (DBT)	RELATIVE HUMIDITY (%)
AIR CONDITIONING & VENTILATION SYSTEM		
SUMMER	45	24
MONSOON	34	65
WINTER	10	-

The air conditioned rooms shall be maintained at 23±2 ^{0}C and 55±5 % RH.

The ventilated rooms shall be designed with air changes as per IS4720 and the heat load basis, whichever is higher. In case of exhaust ventilation, the inside temp. shall be maintained with 3 deg C delta T.

06.06.02 Design Requirements

The air distribution system shall be sized to have a constant frictional drop along its length. The maximum air velocity shall be restricted to 8 m/sec for supply air duct and 6 m/sec for return air duct in air conditioning system. The maximum air velocity shall be restricted to 12 m/sec for supply air duct in ventilation system to be provided in the pit areas / underground premises.

All Grills/Diffuser shall be selected to give maximum room or space coverage and low noise characteristics. Care should be taken while designing the SA grill location so that it will not fall just over the electrical / instrumentation panes.

The noise level within the air conditioned area shall be restricted to 65 dB (A) level. Acoustic insulation shall be provided inside duct surface for a length of 5 m from PAC mouth.

Noise level of equipment shall be limited to 85 dB(A) at 1 m distance from the equipment unless stated otherwise elsewhere.

Motor rating shall be minimum 20% more than the BkW at normal operating condition in summer.

10% safety margin over and above the computed value during design stage shall be considered for selection of all equipment (chiller, AHU, pumps, cooling tower, ventilation fans, etc.).

Monorail with chain pulley block shall be provided for handling of equipment having

weight more than 250 Kg for air conditioning system.

Fire damper (interlocked with FDA system) shall be provided for all served premises.

Design and selection of equipment shall be made keeping the following also in view:

a) Safety of personnel
b) Uninterrupted operation
c) Long life of equipment
d) Easy maintenance at low cost
e) Lowest operating cost
f) Spares shall be easily available

Applicable standards and norms

All equipments, systems and practices shall conform to those contained in the following publications, norms/guidelines, standards, acts and rules.

Publications of Bureau of Indian standards (BIS)

American Conference of Governmental Industrial Hygienists (ACGIH) publication USA.

Interplant standard specifications (IPSS) for steel plants.

Publications of International standards organization (ISO).

VDI stipulation of vibration level.

ARI Standard 550-92.

Electrics for the equipments/ units shall be in accordance with the details laid down in the relevant Indian electricity Rules (IER) as applicable.

The list furnished for standards and norms may not cover certain aspects or products. In such cases where norms/standards/guidelines other than those listed above are followed, the Tenderer shall furnish a copy of such documents in support for the purchaser's perusal and acceptance of this project. Whenever a contradiction is found between the different documents, the decision of the purchaser shall be final and binding.

06.06.03 Equipment and System Description

Air conditioning facilities

Control room, IOs room, DCS room, AVR & excitation panels etc and other area as per system requirement of the Panchet Hydel Station shall be air conditioned by means of Water Cooled Package AC with 100% standby.

The above central air conditioning system with 100% standby shall have compressors, condensers, 100% standby condensing water pumps with necessary electrics & instrumentation, insulation (both thermal and acoustic as required), duct & pipe work, air supply grills, etc. The necessary cooling tower and make up water tank for the central air conditioning system shall also be provided & located suitably.

The return air from the central control room and other room shall be collected in the gap between the roof and false ceiling and led back to the PAC . Necessary thermal and under deck insulation shall be provided.

The isolated premises with small size & heat load, if any shall be served with Hi-wall Split AC, if desired by the client.

06.06.04 Technical specification of the equipment

Brief description of main equipment is given below:

ii. Condenser for PAC

Condenser shall be horizontal, shell & tube type construction dual refrigerant circuit water-cooled type. Unit shall be equipped with integral finned type, solid drawn, seamless copper tube. The tubes shall have internal turbulator. Fins shall be made of Aluminium having 25 nos. per inch (min). Condenser shell will be constructed and tested in accordance with section VIII, division I of ASME pressure vessel code. The shell and tube shall be designed to withstand the hydro-test pressure @ 1.5 times the working refrigerant / water pressure respectively. Condenser shall be provided with multiple pass to give optimum water velocity through tubes combining efficient heat transfer and allowable pressure drop.

Fouling factor to be considered while designing the condenser shall be 0.00025h-ft^{2}F/Btu and temperature difference between inlet and outlet water shall be approx. 7.5^{0}F. Integrally finned copper tube from outside having minimum 25 fins per inch shall be expanded into tube sheets for leak proof joints.

With special tube arrangement and the partition plate allowing cooling water to pass through the condensed refrigerant and thereby sub-cooling the liquid. This produces higher refrigeration capacity without increasing the power consumption.
Condenser shall be tested as per ARI standard 550/590 1998.

- Thermal insulation over condensate drains line to avoid condensation over cold surface.
- Insulated & aluminum cladded Chilled Water pumps
- Make Up Water tank to be located at the top most point of the building.

- Condenser cooling piping network, pipe & fittings, valves and instruments.
- Mechanical draft FRP Cooling tower with FRP Basin
- Water Cooled Package AC with Fan, Filter, Cooling Coil, Valves & Fittings
- Ducting network with damper, diffuser/ grill, acoustic and thermal insulation.
- Acoustic treatment for the whole of the PAC Rooms
  Humidity control arrangement with strip heater and humidification system.
- Make-up air connection with filter & damper in different PAC Rooms
- Under deck thermal insulation for the exposed roof of PAC Rooms & Control Room

- Monorail with hoist and its accessories in the chiller plant.
- Magnetic flow meter at the inlet & outlet of chiller shall be provided.

06.06.05 Split Air conditioning system

Non-ductable type Split air conditioners shall be provided to meet the desired inside condition (temp. & RH) as per requirement in the premises (remotely located places) where duct of the centralized air conditioning system cannot be provided. It shall be energy efficient and of 5 star rating or equivalent.

Split air conditioning unit mainly comprises of two units, viz. indoor and outdoor unit. Indoor unit comprises of cooling coil, fan, supply air grill, filter. Outdoor unit comprises of air cooled condenser, blower, hermetically sealed compressor. Sealed refrigerant piping interconnects the indoor and outdoor sections. Outdoor unit shall be installed in open space for easy heat dissipation from condenser along with the ease of approach for maintenance. Preferably a canopy shall be provided over the outdoor unit. Indoor unit shall be wall mounted type as per requirement. Remote control unit, thermostat and other standard accessories shall be included with the system for the control over temp. & RH. Split air conditioner unit shall conform to IS: 1391-1992 Part II. Eco-friendly refrigerant such as R410A / R407C / R32 / etc. shall be used.

06.06.06 Safety Devices

The units offered shall be provided with all necessary safety devices, which are essential for proper operation of the equipment. These shall not be limited to the scope of this specification and shall have all safety devices required for optimum operation of the unit. The following minimum safety devices are suggested :

a. Low voltage cutout
b. Low evaporating cutout
c. In-built internal overload
d. High condensing pressure cutout
e. Motor overload trip/protection

06.06.07 Centrifugal pump (chilled water & condenser water)

The pumps shall be designed, manufactured and tested as per IS: 5120.1977 (R.A.1997) Amendment 2000, IS: 9137-1978 (R.A. 1993), IS: 6595-1993 (Part II) or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated in this specification.

The horizontal split casing type centrifugal pumps along with their auxiliary equipment shall be designed and manufactured for continuous duty at full load. Speed of pumps shall not be more than 1500RPM.

All the pumps shall be capable of developing the required total head at rated capacity for continuous operation. The pumps shall operate satisfactorily at any point on the H-Q characteristic curve over a range of 50% to 130% capacity or capacity corresponding to 75% of the total heads whichever is lower.

Capacity Vs. discharge pressure curves 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 cavitations at any of the operating points. The shut-off head shall be minimum 10% more than the working head.

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.

The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantle-able without disturbing the suction, delivery pipe connections and motor.

The equipment design shall incorporate provisions for reduction in noise level. The noise level shall not exceed 85 dBA at 1m distance from the source. The velocity of vibration level shall be limited to 4.5mm/sec.

The required NPSH required at duty point shall be at least 1.0 m lesser than the available NPSH.

The power rating of the pump motor shall be larger of the following:

a) Continuous motor rating (at 50^0C ambient) shall be at least 10% above the maximum load demand of the driven pump in the entire range of operation to take care of the system undulations.

b) For parallel operation, motor rating should be sufficient enough for running of single pump also.

The common base frame for pump and motor shall be in one piece with suitable holes for grouting. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15mm drain piping. Pumps shall be supplied with suitable drain pans or drain rim type base plates with valved drain connections. Pump foundation shall be floating type. Necessary neoprene pad required at bottom of RCC inertia base shall be supplied by tenderer.

Coupling guard, made of expanded metal and bolted to the base plate shall be supplied for all pumps.

Horizontal split casing pump shall be provided with tyre coupling. Mechanical seal shall be provided for central air conditioning system pumps. Pump shall be so designed that the impeller and accessories of pump is not damaged due to flow reversal.

Standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the maximum discharge head or twice the rated discharge head whichever is higher. The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.

i. Casing

The casing shall be of cast iron and shall be designed for a pressure not less than the shut-off pressure at the highest operating speed plus the maximum pressure that may be encountered at the pump inlet. In addition, CI casing shall have corrosion allowance of not less than 3 mm.

ii. Impeller

Impeller shall be of bronze. Impellers and balancing drums (if provided) shall be statically and dynamically balanced as per ISO- 1940. Dynamic balancing shall be at the operating speed of the pump. For multi stage pumps, all the impellers shall be assembled together for balancing. Provision shall be made for adjusting the clearance between the impeller and the casing to compensate for wear.

The impeller shall be keyed or screwed on to the shaft in such a way that it does not come-out due to reverse rotation of the pump.

iii. Shaft

The shaft shall be of AISI-410 and shall be designed for critical speed. The ratio of critical speed to speed of shaft shall be not less than 1.2 for solid shafts.

iv. Shaft sealing

Mechanical type Shaft seals shall be provided to prevent leakage out of, or into, a pump over the range of specified operating conditions. The seals shall be suitable for variations in inlet conditions that may prevail during start-up and shut down. They shall be accessible for inspection and replacement without disturbing any part of the installation.

v. Bearing

Two bearing assemblies shall be provided, one within the frame to carry radial load only and the other to carry both radial and axial thrust. Bearings shall be of manufacturer standard design, antifriction type, oil / grease lubricated. Suitable thrust bearings shall be provided in the pump to take total thrust of the pump including hydraulic thrust. Suitable tapped holes shall be provided for refilling of oil in the bearing housing if required.

vi. Base plate

All horizontal pumps shall be supplied with sturdy base plates as per manufacturer's standard, common to pump and drive. Base plates and pump supports shall be constructed so rigidly and the unit so mounted as to minimize misalignment due to

piping strain, internal differential thermal expansion, etc. Base plates shall be fabricated from MS channels.

Companion flanges, bolts, nuts & gaskets

Plate flanges having raised face shall be provided at suction and delivery side of pumps and they shall be of mild steel and conform to table 17 of IS: 6392-1971 (R.A.1988). Slip on raised face flanges to 150 Lbs. class conforming to ANSI B16.5 shall also be acceptable.

Black bolts and nuts conforming to IS 1362-1992 shall be provided for the companion flanges.

CAF gaskets of 1.5 mm thickness conforming to IS: 2712-1979 (R.A. 1994) shall be provided for the companion flanges.

Recirculation water and chilled water piping with accessories:

Water pipe line shall be of MS Class C and as per IS 1239, part I, pipe fittings shall be as per IS 1239, part II.

Velocity of water in pump suction line and delivery line shall be within 0.75 and 1.5 m/sec respectively.
Duplex pot strainer shall be provided in condenser water line and recirculation water pipeline for air washer systems. Angle strainer shall be provided in suction line of chilled water pump and butterfly valve and non return valve shall be provided in the delivery side of pump.
Heavy class piping is to be used as per IS: 1239 for interconnecting water piping network.
Butterfly valve shall be provided in water pipeline for control and regulation purposes.

Pipe fittings like bends, elbows, flanges, sockets, nipples, etc. shall be as per relevant IS/BS standards.

Drain piping network shall be provided as required for insulated condensate drain from AHUs, for pump gland drain, etc.

Pipe supports shall be steel, adjustable for weight and coated with rust preventive primer and finish coated with synthetic enamel paint. Where pipe and clamp are of dissimilar material a gasket shall be provided in between.

Spacing of pipe supports shall not exceed the following:

Pipe (mm)	Spacing (Mtrs.)
3 to 12	1.25
19 to 25	1.85
32 to 150	2.50
150 and above	5.00

All piping shall be tested to hydrostatic test pressure of at least one and half times the maximum of operating pressure for period of not less than 24 hours. System may be tested in sections and such section shall be securely capped.

Tenderer shall provide all materials, tools, equipment, instruments, services and labour required to perform test and remove water resulting from cleaning and/after testing.

Pressure gauge dial diameter shall not be less than 150mm. The pressure gauge shall be with appropriate working range and be complete with shut off gauge cocks etc., duly calibrated before installation. Pressure gauges shall be provided at all the locations needing information on pressure variation.

06.06.08 Flexible Connection

Suitable flexible connections of tarpaulin shall be provided between adaptor section and fan inlet as well as between fan outlet damper and ducting.

06.06.09 Adjustable Louvre Grills (Supply Air Grills)

1.25mm MS sheet shall be used for manufacturing 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 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 grill shall project into the main duct. The adjustable louver grills shall be provided with volume control damper as well as double deflection flap/ grill for direction control.

06.06.10 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 following codes & standard shall be followed:

IS : 226 Specification for structural steel (standard quality)

IS : 655 Specification for metal air duct.

IS : 277, 2003 Specification for galvanised steel sheets (Grade-275)

SMACNA Sheet Metal and Air Conditioning Tenderers National Association

The interior of all ducts shall be smooth for free flow of air. The radius to bend shall be preferably 1.5D. Guide vane shall be provided in all large duct bends and bends with radius less than 1.5D for proper air flow. Branch damper shall be provided at the branching of sub-duct from main duct.

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.

06.06.11 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 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 MS angle iron (40x40x3) and hung from steel rods (10mm dia). Ducts supported on wall and building structures shall be suitably fixed with angle, rod and flat etc.

06.06.12 Insulation

The following items are to be insulated:

a. Inside surface of the packaged chiller evaporating section.
b. Condensate drain
c. Chilled water expansion tank
d. Chilled water pumps
e. Chilled water pipe line network including valves and fittings

Method of application of insulation

A) Thermal insulation of chilled water pipe line

1) Pipe line should be cleaned and bitumen/cold adhesive compound should be applied.

2) Fire proof PUF half pipe section insulation material of 48 kg/m^3 density with 24G Aluminium cladding for indoor laid piping. For outdoor piping & piping crossing over high ambient exceeding 45^o C sand cement (4:1) plaster in two layers totalling 15mm in thickness shall be provided over the insulation sections by reinforcing with 22G GI wire netting. A water proofing compound shall be added to the cement before it is applied. Finally the cemented surface shall be painted with two coats of cement based paint of white colour.

No combustible material, lining etc. shall be used anywhere in the entire chilled water system.

Insulating materials required to be incorporated in the works for insulation of

pipes and equipment etc. shall be non combustible, self extinguishing type. The Tenderer shall produce test certificate in support of this requirement. No obnoxious gases shall emit from the insulation in case the insulation accidentally catches fire.

i. Insulation - Duct thermal Systems

Thermal insulation of duct shall be carried out with Aluminium foil faced Fibre glass of density not less than 24 Kg/m^3. The thermal conductivity shall not exceed 0.03 Kcal/hr Sq. m deg C. Thickness of Insulation shall be 50mm. 75mm wide aluminium tape shall be used for covering the joints of the foil face of insulation.

Application

- Clean the surface of duct and apply one coat of Black Japan Paint of approved make @7Sq.m/Kg.
- Apply a thick layer of CPRX compound @1Kg/Sq.m of area.
- Fix the insulation material of required thickness before the adhesive dries up. All longitudinal joints/traverse joints shall have the foil overlap of 50mm with Aluminium tape of minimum 75mm width.

ii. Insulation - Duct acoustic

Acoustic lining of Duct shall be carried out with 15mm thick Fibre glass rigid board of density not less than 32 Kg/m^3. All ducts up to a distance of 5m from AHU outlet (including plenum, if applicable) or as required to reduce noise levels to below 58 dB(A) into the conditioned space, shall be acoustically lined from inside.

Application

- Clean the inner surface of duct that is to be lined, with wire brush to remove the dirt.
- Apply Black Japan paint in the frame of duct.
- The adhesive shall be non flammable and having vapour barrier property.
- Fix insulation material of 12mm thickness and cover with RP tissue paper and then cover the material with 26G perforated aluminium sheet having 2mm dia

perforation at 3mm centre to centre distance with the help of nuts and bolts. It shall be neatly finished to give true surface finish.

iii. Insulation – AHU room acoustic

Acoustic lining of AHU rooms shall be carried out with 50mm thick fibre glass of density not less than 48 Kg/m3 or as required to reduce noise levels to below 58 dB(A) into the conditioned space.

Application

- Clean wall/ceiling surface which is to be acoustically finished.
- Fix seasoned wood / GI frame C section of size 50x50X50 mm or of equal insulation thickness as specified, to the wall/ceiling with screw / bolts.
- Apply two coats of black Japan paint on wall/ceiling
- Insulating material of 50mm thickness shall be fixed in GI frame of 600mmX600mm dimension and covered with RP tissue.
- Covering the finished surface with 24G aluminium perforated sheet for getting the acoustic finish of the room.

iv. Underdeck Insulation

Underdeck Insulation of exposed roof of all the areas shall be carried out with 50mm thick Fire retardant quality Expanded Polyesterene of density not less than 24 Kg/m3. The thermal conductivity shall not exceed 0.024 Kcal/hr. Sq.m ºC.

Application

- Clean the roof surface which is to be insulated.
- Apply 2 coats of Black Japan Paint on ceiling.
- Fix GI frame C section of size 25 x 50 x 25mm, or of equal insulation thickness as specified, to the ceiling including the soffit of the beam with screws/bolts.
- Apply a coat of adhesive to the underside of the roof.
- Insulating material of 50mm thickness shall be fixed in GI frame of 1000 mm x 500mm dimension.
- The insulation shall also be carried out to the exposed beams and columns within the air-conditioned space.

06.06.13 Strip Heater Box / Pan Humidifier

Strip heater box shall comprise of finned heater, mounting plate, heater box/ casing made of 18 SWG G.I. sheet, cable terminal, and terminal box with handle, 40x40x3 MS angle flange/ frame. Strip heater box shall be placed/ inserted in supply air duct. Safety thermostat / geyser stat shall be mounted on strip heater package to prevent overheating. Strip heater box assembly shall be a pre-fabricated unit with all its terminals & controls pre-wired.

Pan humidifier shall comprise of pre fabricated SS tank duly insulated along with sealed heater flanged on the tank body with provision of make up with float valve, quick fill, overflow and drain line with GM valves and humidistat, control element all pre wired ready to be hanged underside of supply air duct for generation and control of humidity during dry season.

06.06.14 Thermometer and Pressure Gauge

The pressure and temperature gauges shall be with appropriate working range and be complete with shut off gauge cocks etc., duly calibrated before installation. Pressure gauges shall be provided at all the locations needing information on pressure variation.

Dial type (150 mm) mercury in steel thermometer shall be provided for measuring the water temperature at inlet & outlet of condenser. The range of thermometer shall be 0-100^{o}C.

Dial type (150 mm) pressure gauges shall be provided at inlet as well at outlet of condenser water lines.

06.06.15 Fire Damper

Fusible relief type fire dampers having 90 mins fire rating as per UI-555 shall be provided for all the supply air duct / return air path. The casing thickness shall be 2mm (min.) and blades of 1.6mm (min.) of MS construction. Limit switch shall be connected to the fire damper for transmission of damper closure signal to the fire panel for subsequent switching off the air circulation device in case of fire.

06.06.16 Valves and Strainers:

Isolation valves (gate valve with flange ends) shall be provided in different branches of chilled water pipe lines so that a particular section of pipe line can be isolated during troubleshooting / repair work without shutting the entire chilled water plant.

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 & Disc facing ring	:	SS as per AISI 410
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 RA latest rev.
11.	Bolts & nuts	:	Black Hexagonal bolt with nut as per ASTMA 307 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
18.	Service	:	Re-circulation water/Make up/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	:	Re-circulation water/ Make up water/chilled water

15.	Hydrostatic Testing	:	As per relevant IS and pressure rating of PN 1.6

Non-Return Valve

1.	Type	:	Double 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
16.	Service	:	Recirculation water/chilled water

Butterfly Valve

1.	Type	:	Wafer type CI Butterfly valve
2.	Body & Cover	:	Cast iron as per IS:210-1993 (RA -1999) GR.220
3.	Disc	:	- Do -
4.	Seat, Body/disc	:	EPDM
5.	Pin	:	Stainless Steel, AISI-410
6.	Bolting, internal	:	- Do -
7.	Bolting, external	:	Carbon Steel
8.	Pressure rating	:	PN=1.6/1.0 N/mm2
9.	Manufacturing Std.	:	IS:13095-1991(RA'98)/AWWA:C-504/BS:5155/ IPSS-1-06-012
10.	Hydro static testing	:	For PN 1.6: Body - 24 kg/cm2g Seat/Back seat - 16 kg/cm2g For PN 1.0: Body - 15 kg/cm2g Seat/Back seat - 10 kg/cm2g
11.	Test certificates	:	Required for material/hydro testing
12.	Service	:	Chilled water /Cooling water
13.	Maximum operating temperature	:	50 ^{o} C
14.	Type of operation	:	Lever operated upto DN 250 Gear operated, manual type $\geq$DN 300

Y- Strainer

Y- Strainers shall be installed on water pipelines before chilled water pump to arrest suspended particles of 1000 microns or bigger size in chilled water network.

- Y - Strainers Filter basket area to the pipe cross section area ratio shall be minimum 6: 1. Basket Filter bodies and internals shall be designed to withstand design pressure with normal surges. Strainer elements shall be of

SS construction.

- Pressure equalizing connections for both the chambers shall be provided for smooth changeover.
- Two nos. dial type pressure gauges of size 150 mm diameter shall be provided suitably mounted at the inlet and outlet mains of each strainer.
- 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 life.
- Provision shall be made for collection of drainage water from the strainers.
- Valves to be supplied shall conform to the following standards. Pressure rating of all valves shall be 16kg/cm2.

  Gate valves : IS : 778-1984 reaffirmed in 1990 .

  Globe valves : IS : 778-1984 reaffirmed in 1990
- Strainer element from 3 mm thick sheet with 5mm dia holes enclosed with 20 mesh 37 SWG wire mesh with suitable stiffeners on circular and longitudinal direction.

Following material of construction shall be considered:

1.	Body	:	Carbon Steel as per IS 2062 :1992 Grade
2.	Cover	:	- do -
3.	Filter element	:	SS 304
4.	Spindles	:	EN-8
5.	Valve disc	:	IS:210-1978 (reaffirmed in 1990) FG 300/or MS
6.	Valve seating	:	IS:318-1981 (reaffirmed in 1991) LTB-2 Gr.2
7.	Companion flanges	:	IS:6392/1971, Table-17 (RA88)
8.	Gasket sealing rings	:	CAF gasket as per IS:2712-1979 1.5mm thk.

06.06.17 Duplex filter

Duplex basket filters of nominal shall be installed on Condenser water line to arrest suspended particles of 1000 microns or bigger size in supply water/chilled water.

- Duplex basket filters shall be of cylindrical MS construction.
- 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. 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 changeover 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 filter.
- 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.
- Each filter 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 life.
- Provision shall be made for collection of drainage water from the filters.
- Valves to be supplied shall conform to the following standards. Pressure rating of all valves shall be 16kg/cm2.

  Gate valves : IS : 778-1984 reaffirmed in 1990 .

  Globe valves : IS : 778-1984 reaffirmed in 1990
- Filter element from 3 mm thick sheet with 5mm dia holes enclosed with 20 mesh 37 SWG wire mesh with suitable stiffeners on circular and longitudinal direction.

Following material of construction shall be considered :

1.	Body	:	Carbon Steel as per IS 2062 : 1992 Grade
2.	Cover	:	- do -
3.	Filter element	:	SS 304
4.	Spindles	:	EN-8
5.	Valve disc	:	IS:210-1978 (reaffirmed in 1990) FG 300/or MS
6.	Valve seating	:	IS:318-1981 (reaffirmed in 1991) LTB-2 Gr.2
7.	Companion flanges	:	IS:6392/1971, Table-17 (RA88)
8.	Gasket sealing rings	:	CAF gasket as per IS:2712-1979 1.5mm thk.

06.06.19 MAKE UP WATER TANK

Steel tank of suitable capacity fabricated from 6mm thick MS plates (as per IS:2062) in welded construction shall be provided at the highest point of the chilled water circuit for chilled water expansion cum make up. This tank shall be complete with all accessories like ball and float valve for make up connection, quick fill, drain overflow, etc.

06.06.20 Cooling Tower

Induced draft type, FRP cooing tower shall be provided for cooling of the condenser water of adequate capacity to cater to the heat rejection of the condenser water. The capacity of the cooling tower basin shall be adequate to take care of the entire water required for the A/C Plant. The cooling tower shall be built on RCC basin.

The cooling tower shall be with large air – to – water volume ratio, highly effective drift elimination and suitable for adjustment to the seasonal variations and circulating water flows with design at wet bulb temperature of 29^{o}C (to be finalized during detailed engg. as per the prevailing site condition).
The cold water basin shall be of FRP construction. Cooling tower basin shall have accessories and connectors for makeup, quick fill, drain and over flow. Ball & float valve is to be provided for makeup water line.

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/hot-dip galvanized steel. Neoprene rubber gaskets must be used on all bolted joints as a seal against water leakage. Propeller type adjustable pitch axial flow multi bladed fan with direct drive/shaft driven arrangement shall be considered for cooling tower. Motor of induced draft fan shall be of weather proof construction. The cooling tower shall be provided with fan with speed less than 725RPM, drive motor including direct drive arrangement (belt drive not acceptable) galvanized steel ladder and all standard accessories.

06.06.21 Performance Guarantee

The PG test will be conducted for three (3) consecutive days i.e 72 hours in the Summer season as per the date mutually decided by employer/consultant/successful tenderer.

PERFORMANCE GUARANTEE FIGURES

Parameter for the conditioned space	Guarantee figures	Rejection/modification criteria
Served premises temperature Air flow at supply grill	Design temperature variation less than ± 2°C Design air flow variation less than ± 10 %	Design temperature variation equal or more than ± 2.5°C, Design air flow variation more than ± 15 %

EQUIPMENT SCHEDULE

Sl. NO.	EQUIPMENT SPECIFICATIONS	Heat loads, persons and size of room	QUANTITY
I	**AIR-CONDITIONING :**	TO BE DECIDED BY TURNKEY SUPPLIER	TO BE DECIDED BY TURNKEY SUPPLIER
1a	Water Cooled PAC with 100% Standby with Induced draft cooling towers, condenser water pumps with 100% standby, make up water tanks, safety interlock and controls, instruments, electrics & automation, Acoustic & ThermalInsulation, strip heater & pan humidifier system, piping & ducting as specified in this tender specification		
1c	Piping, valves & fittings, insulation.		
1d	Ducting with necessary insulation, SA grills / diffusers, return air grills, motorized fire damper, etc.		
1d	Electrics and Instrumentations		
1e	Supply, laying & termination of power & control cables as per scope of work and site condition.		
1f	Monorail with hoist & its complete accessories in chiller plant.		

The above list is only tentative. Any other area that needs Air conditioning and not covered above shall also be provided with necessary facilities.

Following drawings/ document need to be submit after placement of order.

i. Chiller Packages

a) Nominal capacity / Actual capacity at site condition (TR)
b) Rated & Designed capacity conditions
c) BKW/TR of the chiller at rating/operating condition
d) Electrical feeder rating to be provided
e) Overall size
f) Shipping & Operating weight

ii. Refrigerant Compressor

a) Manufacturer
b) Model No. / Whether ARI certified
c) Refrigerant
d) Capacity at operating conditions (indicate conditions)
e) Maximum speed/operating speed
f) BHP at operating conditions
g) BHP/TR at operating conditions
h) BHP consumption
100% load
75% load
50% load
i) Types of controls offered and make
j) Motor :
Make :
Type :
Rating (KW) and rpm :
k) Starter: Make & Type
l) Capacity control
m) Lubrication
n) Total weight
o) Noise level at 1 meter distance in dB (A)
p) Vibration level
q) Vibration isolator details

iii. Condenser

a) Manufacturer
b) Shell diameter and length (mm)
c) Tube material
d) Fouling factor
e) No. of tubes
f) Tube diameter (mm) and thickness

g) Tube length (mm)
h) Tube surface area inside (m^2)
i) Tube surface area outside (m^2)
j) No. of passes
k) Water flow (m^3/hr)
l) Water velocity (m/sec)
m) Water temperature entering (^oC) / leaving (^oC)
n) Operating charge
o) Pressure drop
p) Refrigerant temp (^oC)
q) Maximum cooling capacity (K Cal/hr.)
r) Operating weight (kg)

iv Chiller

a) Manufacturer
b) Shell diameter and length (mm)
c) Tube material
d) Fouling factor
e) No. of tubes
f) Tube diameter (mm) and thickness
g) Tube length (mm)
h) Tube surface area inside (m^2)
i) Tube surface area outside (m^2)
k) Water flow (m^3/hr)
l) Water velocity (m/sec)
m) Water temperature entering (^oC)/leaving (^oC)
n) Pressure drop
o) Refrigerant temperature inlet /outlet (^oC)
p) Maximum cooling capacity (K Cal/hr.)
q) Operating weight (kg)

v. List of Controls Offered

Name of Control	Make/Model/No.
1)	

vi. Cooling Tower

1 Make & Model
2. Type of Tower & Nos. of cell
3. Capacity per cell, m^3/h
4. Overall dimension LXBXH
5. Rated water flow, m^3/h
6. Design wet bulb temp., ^oC
7. Approach, ^oC
8. Cooling range at rated flow, ^oC
9. Evaporation loss at rated condition, %
10. Temperature of leaving air, DBT/WBT
11. Water flow area, m^2/cell

12. Water flow rate/m^2 of water area, $m^3/hr/m^2$(L)
13. Fan – speed, diameter, effy., air flow/cell.
14. Fan motor KW/RPM/Frame size/Protection degree/make
15. Fan shaft HP
16. Vibration level of Tower

Centrifugal Pump (Separate for chilled water & condenser water)

1 Make & Model
2. Capacity in m^3/h
3. Total head in m of water column
4. Material of impeller & casing
5. Type of seal
6. Type of pump / Pump RPM
7. Liquid to be handled
8. Drive details
9. Power consumption at pump shaft / Offered motor KW/P
10. Efficiency
11. Type and No. of bearings
12. Foundation bolts

Ducting Including Supply Air Diffusers with Volume Control Damper

a) Ducting

1. m^2 of duct work
2. Weight of duct work
3. Weight of support and flanges
4. Material and thickness of duct work & GI glass
5. Duct support type and material
6. Velocity of air for different section of duct

Supply Air Diffuser with volume control facility

1 Size
2 Quantity offered
3 Material of construction & thickness
4 Provision of horizontal & vertical direction control
5 Weight
6 Velocity of air
7 Methods of volume control

Return air grills/intake air louvers

1. Size
2. Quantity offered
3. Material of construction
4. Weight
5. Velocity of air

Insulation (Thermal & Acoustic)

1. Make & Type
2. Quantity
3. Density in kg/m3
4. Thermal conductivity
5. Sound absorption co-efficient
6. Moisture absorption co-efficient
7. Material of construction and its thickness
8. Application procedure reference standard.
9. Vapour barrier material
10. Fire resistance property
11. Cladding material

Dry Panel Filter (for AHU room)

1. Make & Model.
2. Capacity in m^3/h
3. Pressure drop in mmWC.
   When clean
   When dirty
4. Effective cross sectional area in m^2
5. Velocity through filter in m/sec.
6. Material of filtering panel.
7. Cleaning efficiency Vs particle size

8. Methods of surface regeneration.
9. Filter box construction details.
10. Overall dimensions & no. of filters.
11. Fixing frame details
12. Total weight

Valves / Strainer

1. Type
2. Make & model
3. Nominal bore in mm
4. Working pressure/Test pressure in kg/cm^2
5. Medium handled
6. Type of end connection
7. Material of construction
8. Type of drive (if any)
9. Total weight & quantity

Dampers / Grills

1. Size
2. Quantity offered
3. Material of construction & thicknesses
4. Provision of horizontal & vertical direction control
5. Weight
6. Velocity of air

Water Pipe & fittings

1. Material
2. Make and Class
3. Pipe size, thickness, length, weight & quantity
4. Type & quantity of fittings

Instruments & Controls

1. Make & model of pressure gauges
2. Quantity & fixing details of pressure gauges
3. Range provided in the pressure gauges for measurement
4. Make & model of temperature gauges
5. Quantity & fixing details of temperature gauges
6. Range provided in the temperature gauges for measurement
7. Details of other instruments and controls if any

Split AC

1. Make & Model
2. Quantity
3. Capacity in TR
4. Air Flow m3/h

5. Flow direction and volume control grill
6. Material of construction
7. Compressor type
8. Drive details and total power consumption
9. Overall dimensions
10. Refrigerant type
11. Filter efficiency
12. Weight of unit
13. Noise level at 1m distance in dB(A)
14. Fixing details.
15. Vibration level.
16. Accessories included

Electrically operated damper

1. Type of actuator
2. Motor kW /Pole (in case of electrically operated damper)
3. Pneumatic piston (for pneumatic operated damper): make, type and weight
4. Compressed air requirement with pressure for pneumatic operated damper

Monorail with hoist –

1. Capacity, model, make, lift, span, material, travel speed, Duty classification, total weight of hoist, etc.

06.07 VENTILATION SYSTEM

Replacement of existing ventilation system fan, motor, cables, starter / switch and other associated auxiliaries, including all electrical facilities, suction air filters, dispenser installed in the ducts casing etc. Replacement & re-designing of ventilation system including ducting installed in the turbine pit, staircase, and passages towards draft tube and spiral case area (up to man hole of the spiral case-end point) shall be done. New ventilation system including equipment, duct, electrical panels & cables shall be provided. Tenderer shall submit the design calculation and get the approval of the doc. before proceeding further. Minimum 10% margin need to be provided all above the air requirement.

New exhaust fans of adequate capacity shall be provided in fire water pump house for ventilation system.

At present four nos (4) nos exhaust fan installed in the machine hall. Same need to be replaced by the tenderer. Tenderer shall assess the capacity of the ventilation system required for the proper environment of the machine hall and accordingly the ventilation system shall be supplied & installed.

Tenderer to ensure sufficient and effective ventilation in all the area for safe working of the O&M personnel. All required civil, structural, electrics and instrumentation shall be included in the scope of work of the tenderer.

The above list is only tentative. Any other area that needs ventilation and not covered above shall also be provided with necessary facilities.

	R M & U OF PANCHET HYDEL STATION UNIT # 1 (46 MW) HVAC SYSTEM CUSTOMER SPECIFICATION	SPECIFICATION No: PE-TS-495-571-11000A-A001
		SECTION : I
		SUB-SECTION : C2-B
		REV. 00 / DATE: AUGUST 2022

SECTION: I

SUB-SECTION: C2-B

CUSTOMER SPECIFICATION

(PROJECT SPECIFIC GENERAL REQUIREMENTS)

03.0 SPECIAL INSTRUCTIONS TO TENDERERS

This part of the specification describes the general technical rules to be followed while carrying out the work of Unit # 1 with installation of new Turbine Generator including auxiliaries of Panchet Hydel Station.

All such items, even though not specifically mentioned in this Tender specification (TS), but considered necessary for safe & satisfactory operation and guaranteed performance of the offered system & equipment, shall be considered included in the offer.

Tenderer shall visit and carefully examine the site and surroundings to satisfy himself about the nature and condition of all existing facilities, general site condition, etc. and all other matters affecting the works for executing this contract, before quoting against this specification.

The Owner/Purchaser will provide all cooperation to the representative of the tenderer in obtaining the required information during the visit to site. Condition of the plant, equipment and system shall be carefully assessed by the tenderer for assessing the scope of work. Information on the plant and system given in this specification, Sub-Section of the specification shall not be construed in any manner whatsoever, so as to limit the scope of work by the tenderer for achieving the Turbine generator performance.

Claim and objection due to ignorance of site condition shall not be considered after submission of offer.

All equipment, system and works covered under this specification shall comply with all latest regulations and safety codes as applicable at Panchet Hydel Station, Jharkhand, India. All systems and equipment shall comply in all respects with the requirements of the latest editions of the related IS, IEC, IEEE, VDE, DIN, JIS or any other approved international codes and standards. The electrical equipment shall also conform to the latest Indian Electricity rules, Electricity Act as well as Jharkhand Government rules.

Other standards are acceptable if they are established to be approved equal or superior to the listed standards subject to approval by the Purchaser. Tenderer shall provide English version of the codes and standards as applicable.

Proposals not meeting the above stipulations of the codes and standards may not be acceptable.

Tenderer shall study the quality of water at site for suitable design of submerged components of the turbine and material shall be so selected that cavitations and corrosion are minimised.

Special instructions indicated in Volume - I is complimentary to the above mentioned instructions and bidder to consider all instructions as a whole.

GENERAL TECHNICAL RULES

04.00 GENERAL TECHNICAL RULES:

04.01 Introduction

This part of the specification describes the general technical rules to be followed while carrying out the work of Unit # 1 with installation of new up-rated Turbine Generator of Panchet Hydel Station. The technical requirement for electrical and instrumentation works are described in Volume - III of the Tender Specification.

The purpose of this 'General Technical Rules' is to provide the tenderer with certain general information on the location and conditions existing at site and to lay down common guidelines and specifications which Tenderer shall follow in designing the plant and execution of work. Adherence to the 'General Technical Rules' shall, however, not relieve tenderer of his responsibility regarding type, quality of materials, workmanship and requirement as specified by the Purchaser/Consultant under 'Technical Specifications' 'Invitation to Tender' and 'Draft Contract'.

Tenderer shall satisfy himself regarding the site conditions and other relevant matters by visiting site. It is desirable, for compelling reasons, to deviate from these instructions; tenderer is required to obtain prior approval from the Purchaser/Consultant.

All equipment to be supplied and/or engineering services and technical services to be rendered shall be manufactured/executed in accordance with the best trade/ engineering practices judged by the established standards and as given in the Technical Specification. Wherever the codes are not mentioned, the best international standards to be approved by the Purchaser/Consultant shall be followed.

Any supplies and services which might have not been specifically mentioned in the Technical Specification, but are necessary for efficient and smooth operation and maintenance of the work under Indian conditions, unless expressly excluded from the scope of supplies and services shall be supplied/provided by Tenderer without any extra cost to the Purchaser/Consultant.

04.02 Plant and Equipment

a. General

The selection, design and manufacture/fabrication of plant and equipment shall be suitable for the intended service and duty conditions and ensure maximum interchangeability of components and least maintenance. The unit shall be complete in all respect.

All the equipment, technological structures, pipes, valves, fittings, etc shall be subjected to inspection and testing as per accepted national or international standards and practices. All the components shall be subjected to inspection and testing as per standard practices of the manufacturer prior to offering them for inspection by the Purchaser/Consultant/his authorized representative.

All equipment shall be complete with approved safety devices, wherever a potential hazard to personnel and/ or equipment exists. There shall be adequate provision for safe access of personnel to and around the equipment for operational and maintenance functions.

All equipment shall be complete in all respect including all accessories essential for proper installation, operation and maintenance irrespective of whether such items are specifically mentioned in the specifications or not.

All working parts shall be arranged for convenience of operation, inspection, lubrication and ease of repair and replacement of parts and sub- assemblies with minimum downtime.

Suitable working platforms, walkways, hand railing, cross over, ladders, lifting tackle and tools required for the above shall be provided.

The fabrication and assembly areas shall be kept clean and free from contamination. During assembly of major components, a polythene covering shall be maintained in position to prevent ingress of dirt, grease, etc from overhead cranes or other equipment.

During fabrication, equipment, pipes, etc shall be kept sealed to the extent possible to avoid entry of foreign matter and contamination by dirt.

Piping shall be degreased after fabrication and maintained sealed until the end is presented for welding or jointing.

All equipment will be visually inspected in the presence of an inspector immediately before closure. A system of physical identification and accountability will be used to account for all tools, test equipment, shipping blanks and other items used during assembly to obviate the possibility of their being left inside vessels or equipment.

On completion of manufacture, each pressure vessel shall be pressure tested at room temperature at site/ manufacturing works in accordance with the appropriate code. On completion of construction/erection at site, the entire assembly shall be leak tested as above.

b. Design Considerations

Life of the Electro-mechanical generating equipment i.e., turbine, generator, transformers, auxiliaries, etc. shall not be less than forty (40) years

The Unit shall be designed for unconstrained operation over maximum net head and minimum net head and full range of ambient and other environmental conditions.
The turbine settings shall be as available and indicated in Chapter-6 of this Volume.
Speed rise, pressure rise, run away speed shall be governed by the limits specified in relevant IS.
Chemical analysis of water and data including the petro graphic analysis shall be taken into consideration while designing the turbine and other auxiliary equipment susceptible to abrasive effects of silt. Suitable materials, protective coatings and painting shall be provided to resist silt abrasion as per site conditions.

The operation of the Unit shall be smooth and quiet. The noise level shall not be more than 90 dBA at a distance of 1metre from any equipment.

c. Layout Considerations

Layout of equipment shall be developed considering the proper utilisation of space and functional requirements. The equipment layout shall be compact so as to economise use of materials.

Maintenance facilities shall be provided as required for assembly, disassembly and handling during maintenance of all equipment and auxiliaries.

d. Operating Capability of the Generating Unit

The Unit shall be capable of giving the rated output continuously as specified by the manufacturer at the rated design head and rated discharge and shall be capable of operating between the minimum and maximum head specified in this specification (Vol-II) and ambient temperature at site specified.

The maximum continuous over load capacity of the unit at the generator terminals during the high head conditions or high discharge conditions or both as guaranteed by the manufacturer shall be based on the hydraulic parameter of the station

The Unit and associated auxiliaries shall be suitable for continuous operation without any restriction within a frequency range of -5% to +3% (47.5Hz to 51.5 Hz). All the equipment driven by the electric motors shall give their rated performance even at a power supply frequency of 47.5 Hz.

Provision shall be made for starting the Unit in auto mode up to synchronisation by a single command and loading of the unit to full load quickly. The design of the equipment and control system shall permit participation of the unit in auto frequency control mode.

The Unit and all its associated auxiliaries shall be designed for trouble free operation up to maximum rating of the unit for complete range of operation for active power and reactive power output

The redundancy in the Unit auxiliaries and station equipment shall be provided so that the generating unit continue to operate even in the event of outage of a part of the auxiliary system.

04.03 Manufacturing and fabrication

a. General

All forgings, castings and structural materials shall conform to the relevant BIS/International standards/ equivalent ASTM/EN/DIN.

Special non-ferrous materials required for manufacturing parts subject to heavy pressure, severe working conditions, and/or requiring high tensile strength, toughness and resistance to corrosion shall be used.

Bronze used for manufacturing parts such as bearings, shall preferably be forged or centrifugally cast.

b. Working Stresses

For rotating parts the unit stresses due to run away speed of turbine shall not exceed two third of the yield strength of the material of construction.

Stresses for other materials will be as per OEM standard conforming to relevant standard.

04.03.01 Bearings

All parts subject to reciprocal motion and rubbing against other parts shall be provided with bronze or other suitable liners to minimise wear. The liners shall conform to IS;318 or as detailed against the particular equipment capable of being adjusted to compensate for wear. All rotating parts supported on frames shall have proper bearings depending upon speed, torque, load condition, etc.

04.03.02 Machine frames and bases

All machine bases shall be designed for maximum strength and rigidity consistent with good design.

Base plates shall be of welded steel construction. Those shall be designed with sufficient depth and stiffness to ensure rigidity of assembly.

If bases are made of two or more parts to make up height, locating pins shall be provided. Machined bolts shall be used in drilled and reamed holes for connecting the parts.

The machine frames shall have suitable eye bolts or hooks in requisite numbers for lifting purposes during erection and maintenance.

04.03.03 Nuts, Bolts, Studs and Washers

Machining and manufacturing of all the nuts, bolts, studs and washers shall conform to International Standards.

Nuts and bolts for pressure parts shall be of the best quality steel. Nuts, bolts and studs shall be of materials most suitable for the service operating conditions and designed to ensure the stresses arising in normal operation. For bolts used in critical areas the tenderer shall provide the following details:

i) Allowable elongation
ii) Recommended torque

Fitted bolts shall be a close fit in the reamed holes they occupy, and shall be marked in a conspicuous position to ensure correct assembly.

The threaded portion of any bolt or stud shall not project more than 1.5 threads above the surface of its mating nut.

Where practicable the use of slotted head screws shall be avoided in machinery component assemblies, hexagon socket screws being preferred.

04.03.03 Steel Forging

The tenderer shall supply a list of all important forgings and draw up material specification for each one. Copies of this list and specifications shall be supplied to the Purchaser/Consultant for his use. In each case the quality and inspection requirements shall be clearly stated.

Whenever possible steel forgings shall be in accordance with the requirements of IS/ International Standards. Forgings shall be free from cracks externally or internally, extensive non-metallic inclusions and surface defects. Tenderer shall carry out non-

destructive testing of forgings during machining to verify that no unacceptable defects are present.

Repairs by welding or other means shall not be undertaken on forgings at any stage of the production cycle.

Each forging shall be suitably branded with an identification number which shall be transferred throughout all final machining stages. The identification number shall be marked on all documents and test certificates relative to the forging.

04.04. Castings

a. General

All castings shall be homogeneous, free of shrinkage, under sizing, porosity or voids welding, filling, interlocking or plugging of defective parts shall be done with the approval of Purchaser/Consultant in writing. All repairs shall be subjected to non- destructive examination after heat treatment.

b. Steel Castings

The Tenderer shall prepare material purchasing specifications for all important castings. Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the Specification shall be issued to Purchaser/Consultant for his use.

Castings may be repaired by welding provided written approval of the Purchaser/Consultant is obtained in advance. The Tenderer shall submit drawings, sketches or photographs showing the location and principal dimensions of the defects together with the proposed weld repair procedure.

Only welders who have passed an appropriate qualification test shall be employed on the repair of castings. All repairs shall be carried out by the metal arc process.

Ultrasonic inspection shall be applied to all important castings to locate the extent of sub-surface defects and to check the wall thickness.

All castings shall be identified by stamped, or cast-on reference marks which shall be entered on all relevant documents and test certificates.

Purchaser/Consultant may require that certain castings shall be examined using radiographic inspection to locate the extent of sub- surface defects and to check the wall thickness.

c. Cast Iron Castings

Cast iron shall not be used for any part of equipment which is in tension or which is subjected to impact.

d. Aluminium Bronze Castings

The Tenderer shall prepare material purchasing specifications for all important aluminum bronze castings. Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the Specification shall be issued to the Purchaser/Consultant for his use. The inspection and quality requirements shall include an analysis of each cast, mechanical testing of test bars from each cast, pressure testing, penetrant flaw detection and radiographic examination of selected critical areas.

04.05 Hydraulic system

Hydraulic systems required for various units referred herein generally cover the following: Hydraulic fluid reservoir, pumps of various kinds, valves, accumulators, Hydraulic cylinders, oil coolers, Hydraulic motors, various accessories such as filter, strainers, hydraulic pipe work, fittings, flexible hose supporter for equipment, sealing devices, instruments for indicating, recording and integration of various parameters such as pressure, temperature, velocity etc., control devices for manual and automatic operation of the system, safety devices and alarms for abnormal operating condition, interlocks for sequencing and safe operation.
Hydraulic fluids shall be used on the basis of proven performance, operating condition, operating costs and easy availability.

The Hydraulic power system shall be suitable in every way for the service intended and shall be oriented forwards maximum interchangeability of component and minimising maintenance.

Hydraulic systems shall have filters at various points with adequate capacity and necessary filtration rating so as to keep the hydraulic fluid within permissible limits of contamination to achieve maximum life of the components.

Each hydraulic circuit shall be designed to minimize surge pressures, etc.

The hydraulic system shall be designed taking into account the maximum pressure encountered. Also, one must ensure while designing the system that the components of hydraulic systems are compatible with the hydraulic fluid selected at operating condition in the plant and under atmospheric conditions prevalent at Panchet Hydel Station. First fill of the hydraulic shall be in tender scope.

The hydraulic units will be of standard make.

04.06 Lubrication

Tenderer shall provide for proper lubrication systems for all moving parts of the equipment supplied.

All oil lubrication systems shall preferably be of circulating type complete with oil reservoir, pumps with motors, filter pressure vessels, pressure regulators, heat exchangers, oil heater, temperature controllers etc., flow switches, level switches, pressure gauges, pressure switches, temperature gauges, oil flow indicators, etc. The oil tanks shall have adequate capacity so as the return oil de-aerates, gives away heat picked up from lubricating points before again being pumped.

Wherever there is chance of water ingress into the oil lubrication system, the provision for water detection/removal shall be provided.

The selection/design and construction shall be suitable in every way for the service intended and shall be oriented towards maximising interchange- ability of components and minimising maintenance.

04.07 Optimization of Indian supplies & services

The Tenderer shall make all efforts to optimize the supplies and services from Indian sources and shall, however, ensure that the performance of the plant and equipment are achieved as envisaged in the Technical Specification.

04.08 Pumps

Centrifugal pumps shall be provided unless technical or strong economic reasons dictate that a positive displacement, either rotary or reciprocating is more appropriate.

04.09 Valves

a. **General**

All valves shall be suitable for the service conditions under which they are required to operate. The design, construction and choice of material shall take into account all operational requirements.

Parallel slide, butterfly or gate valves may be used for air, water services, and sluice valves for low head applications.

Any valve which is designed for unidirectional flow shall have an arrow embossed or cast on the valve body clearly indicating the required flow direction. All the valves provided with hand wheel/lever shall be clearly marked with “OPEN” and “CLOSED” positions and an arrow to indicate the direction of opening/closing.

Gate, globe, butterfly and non-return valves shall be provided with bypass arrangement as per applicable standards. Bypass arrangement may be integral with the valve or connected between pipes.

All valves, unless otherwise approved or specified, shall be of the external rising spindle type. Where desirable to protect the spindle against ingress of dirt, or where the position of the valve may create a hazard to operators when the spindle is extended, suitable spindle covers shall be provided. The spindles and operating gear of all valves for use outdoors shall have weather and dust proof protection.

Special attention shall be given to the operating mechanism and correct lubrication of all valves to ensure a minimum of maintenance and ease of operation.

All valves shall be positioned so as to be readily accessible for operation and maintenance from permanent floors, galleries or access platforms.

Eye bolts or similar facilities shall be provided, where necessary, to facilitate the handling of heavy valves or components.

When valves are required to be locked in position for operation they shall be provided with a chain, padlock with three keys or other secure locking device.

All valves shall be provided with labels or name plates.

Within two (2) months of award of Contract, a valve numbering scheme to cover the complete Contract Works will be agreed. After approval of the numbering scheme, the tenderer will draw up a valve schedule to cover the Contract Works. The scheduled details of each valve will include the valve number, its title as it appears on the valve label, the nominal size of the valve, its design pressure and temperature, the Manufacturer's name and model number and a brief description of the valve material. The valve schedule will be subject to the Purchaser/Consultant's approval.

b. Butterfly Valves for Auxiliaries.

Constructional features, materials of construction of various components and testing of butterfly valves shall conform to IS13095: 1984 (1990) or reputed International Standards like BS EN 593: 1998 or ANSI/AWWA C504.

The valve must be capable of positive shut-off in both directions against full system pressure. Unless an alternative type is proposed by the Tenderer and approved by the Purchaser/Consultant as being fully suitable for the particular duty, the seating of the disc will be positive (that is, the disc must not be capable of passing through the shut position); a stop fitted on the actuator/ operating lever is not adequate for this purpose. Internal shaft bearings must be capable of opening dry, that is, not dependent on the presence fluid.

Each valves body will be of best quality cast steel conforming to approved standards with a closure seating of bronze or stainless steel, or resilient seal material. The valve disc will be of high quality cast steel with seat facing or bronze or stainless steel which may also include the resilient seal material. Shaft bearings will preferably be of self-lubricating type, with "0"ring seals.
The actual position of the valve disc will be clearly shown by an external indicator.

Valves shall be fitted with sleeve type bearings contained in the hubs of the valve body. Valves shall be equipped with thrust bearings which shall hold the valve disc securely in the centre of the valve seat. Sleeve and other bearings fitted into the valve body shall be of self-lubricated materials that do not have a harmful effect on water or rubber.

The valve must be capable of positive shut-off in both directions against full system pressure. Shaft bearings shall preferably be of self-lubricating type, with "0"ring seals. The actual position of the valve disc shall be clearly shown by an external indicator. Beside mechanical operation tests, each valve shall be subjected to a body pressure/leakage test and disc strength test.

c. Globe Valves

Globe valves shall generally be used for regulating purposes. An arrow indicating the direction of flow through the valve shall be clearly cast or embossed on the body of each valve.

Generally the valves are to be operated with hand wheel. Gear operation shall be provided for gate valves of nominal size DN 125 and above unless otherwise specified. Stem shall be of stainless steel and forged or machined from forged/rolled bar. No casting is permitted.

Gear arrangement shall be totally enclosed bevel gear having grease case with grease nipples/plugs and position indicator for open/ closed position. Gear operators shall be designed to operate effectively with the pressure across the closed valve equal to the cold non-shock pressure rating.
Globe valves shall comply with IS:778-1984, R'90 or IS 2906 or equivalent as might be applicable to the particular installation requirement.

d. Gate and Sluice Valves

Gate and sluice valve shall conform to IS : 780 - 1984, R'90 or IS: 2906
Constructional features, materials of construction of various components and testing of Cast Steel gate valves shall conform to IS or equivalent reputed International Standards like BS, DIN, ANSI/AWWA,API and ISO. For the cooling circuits, process water, make-up water cast steel gate valves shall be provided.

Bodies of valves shall be double-flanged ends and shall be fitted with seat rings securely fixed in machined recesses.
Stem shall be of stainless steel and forged or machined from forged/rolled bar. No casting is permitted.
The wedge-to-stem connection shall be designed in a way that their connection shall be stronger than the weakest stem section in order to avoid detachment of the wedge from the stem while operating the valve.

The guides and lugs shall be provided to guide the wedge through its full travel. The guides and lugs shall be lined with brass or bronze and the liners shall be secured by countersunk screws or rivets of non-ferrous metals.

Hand wheels shall be fixed to stem by a washer and a nut screwed on to the stem. The collar on the stem shall be integral with the stem by forging and shall not be welded on to it. Hand wheels shall be arranged to turn in a clockwise direction to close the valve.

Generally the valves are to be operated with hand wheel. Gear operation shall be provided for gate valves of nominal size DN 125 and above unless otherwise specified. Gear arrangement shall be totally enclosed bevel gear having grease case with grease nipples/plugs and position indicator for open/ closed position. Gear operators shall be designed to operate effectively with the pressure across the closed valve equal to the cold non-shock pressure rating.

e. Safety Relief Valves

Safety relief valves shall be of the spring-loaded type unless otherwise specified, or unless the Purchaser/Consultant has given written permission for the use of a different type of valve actuation.

f. Float Valves

Float valves should be of the equilibrium ball float type. Floats for cold water duty shall be plastic, of a grade that does not deteriorate in sunlight, and for hot water duty be same shall be copper. All operating rods, guides, brackets and covers shall be of non-ferrous material.

Float valves operating in liquids other than fresh water shall be of materials to the Purchaser/Consultant's approval. The float valves shall comply with international standards. Float valves shall be complete with float rods and guides together with covers and brackets where required.

g. Non Return Valves

All non-return valves (NRV) shall be provided with means of draining the space between the valve and its adjacent isolating valve. The design shall preclude the possibility of the valve jamming in the open position; the effect of solid particles settling- out in dead spaces within the valve should be recognized in this respect. Where screw-down non-return valves are supplied, they shall provide a demonstrable leak-tight joint.

Constructional features, materials of construction of various components and testing of double-flanged non-return/check valves shall conform to IS 5312 : 1984 (1990), Part 1 or IS 5312 : 1986 (1991), Part 2 or BS 5153 : 1974 (1991) or equivalent reputed International Standards like DIN, ANSI/AWWA, API and ISO.

Cast steel valve shall be preferred. The body end ports shall be circular. The disk shall be either integral with or separate from the hinge and flat seating face. Where the disk is separate from the hinge, means shall be provided to prevent the disk, hinge pin and retainers becoming detached in service.

Any parts of the valve which can become detached in service, such as hinge pin and disk, hinge pin plugs, hinge pin stuffing boxes and two-piece disks, shall be locked. Hinge pin design shall ensure accurate alignment of the disk and the valve seat.
Where applicable, check and non-return valves shall have an arrow cast or embossed on the side of the valve body to indicate the direction of flow.

h. Motorised Valves

Valves, dampers and similar devices requiring abnormal physical effort to operate or high speed operation, shall be provided with powered actuation. Hand operating equipment shall also be fitted for closing and opening, which is effectively decoupled during power operation.
The following criteria are preferred in the selection of the power source for the servo mechanism

- All motor operated valves shall have de-clutchable 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.
- Isolation and other duties not subject to operation more than once in 10 minutes - electrical, compressed air.
- Continuous or intermittent modulation - compressed air, or hydraulic fluid. Modulating Electrical Actuators shall be to the Purchaser/Consultant's approval.
- Continuous or intermittent modulation involving heavy control forces likely to produce fluttering or hunting-hydraulic fluid, electrical.
- Emergency control or isolating duties - compressed air, spring loaded, or hydraulic fluid with sufficient reservoir capacity to complete the operation without an external source.

Electric actuators for on/off duties shall be fitted with travel limiting devices capable of accurate and positive adjustment. Torque limiting or other devices shall be provided to prevent damage to the mechanism in the event of jamming of the driven device.
All powered valve or damper mechanisms shall be provided with accurate indication of the position of the driven device.

i. **Hand Operation Requirements**

Where required, valve spindle shall be lengthened so that the hand wheel shall be at a height approximately one meter above the level of the floor or platform from which the valve is to be operated and where necessary they shall be provided with pedestals of rigid construction. All thrusts when opening or closing the valve shall be taken directly on the valve body. Pedestal hand wheels or valve tables shall be provided at a convenient operating floor or intermediate floor level. Such pedestals and valve tables shall be mounted direct on floors or steel members and not on floor grills or plating.

All valve hand operating mechanisms shall be easily operable by one person. Special attention shall be given to the operating mechanism for large size valves with a view to ensuring that a minimum of maintenance is required and to obtaining quick and easy operation.

All gate, globe and screw down non-return valves shall be of the non-rising hand wheel pattern unless specifically approved by the Purchaser/Consultant.

All valves shall be closed by rotating the hand wheels in a clockwise direction when looking at the face of the hand wheel. In cases where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced to ensure clockwise closing. The face of each hand wheel shall be clearly marked "open" or "closed" with arrows indicating the direction of rotation to which they refer.

Plastic valve hand wheels will not be acceptable. All valve spindles shall be fitted with indicators so that the valve opening can be readily determined. In the case of valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

04.10 Pipe work

During detailed engineering stage tenderer should submit schedules of the pipe work to be provided under this Contract for approval of Purchaser/Consultant. These schedules shall state, for each pipe work system or parts of a pipe work system, the design and

operating pressures and temperatures, the fluid transmitted, the piping and valve materials, the types of valves, any corrosion allowances, the pipe work design code, insulation proposals, pipe supports and any other data relevant to the mechanical design of the pipe work system or part of a pipe work system.
All piping shall be routed to provide a neat and economical layout and requiring the minimum number of fittings. Piping shall be arranged so that full access is provided for the operation and maintenance of equipment and that removal or replacement of equipment can be achieved with the minimum dismantling of piping.

In specification the term "high pressure" refers to where the design pressure exceeds 20 bar.

Mild steel / Carbon steel pipelines shall be used in general for water supply facilities and SS pipes for soft / DM water. Material of pipes selected shall be indicated by tenderer in the offer and the same will be subject to Purchaser's /Consultant's approval. The steels shall be suitable to withstand the temperature and pressure conditions involved in the operation of the plant under all circumstances.
No piping less than 20 mm nominal bore shall be used except for instrument services or services specifically approved by the Purchaser/Consultant.

In any one system or pipe service all pipe work and fittings shall be of the same material or similar analysis unless specified or agreed to by the Purchaser/Consultant.
The number of joints shall be kept to a minimum necessary for efficient maintenance of the plant. Tees and bends shall be to standard dimensions. Bends shall be of the pulled type or forged. Hot bending with packing may be used for larger sizes according to facilities available, but hot bends in alloy or stainless steels may only be made after permission has been given by the Purchaser/Consultant. Where pipelines are to be mechanically cleaned (pigged) the bend radius shall not be less than five pipe diameters unless approved by the Purchaser/Consultant.

Adequate provision for expansion of the pipe work shall be made. Expansion joints or bellows shall be used only where they can be justified technically and economically. The pipe network shall be provided with air release valves at high points and drain valves at the lower points.

All drain and vent valves shall be located in easily accessible positions. All drains and vents shall discharge to safe locations. Drains and vent pipe work shall be neatly run and shall not interfere with maintenance or operating access requirements.

PIPE SPECIFICATION

A) Black Pipes DN 15 to DN 50:

1. End condition : Bevel Ends
2. Material : ASTM.A.53 Gr:B/IS:1239 (Part-I) 1990
3. Manufacturing : Seamless
4. Thickness : As per Schedule 80. (DN15: 3.7 mm, DN20: 3.9 mm, DN25: 4.5 mm, DN32:4.9mm, DN40: 5.1 mm, DN50:5.5mm)

B) Carbon Steel Pipes DN 65 to DN150 as per IS:1239-1990(R.A.-2004) :

1. End condition : Bevel Ends
2. Class : Heavy
3. Material : As per IS: 1387 / IS 1239 - 1990 (Part-I)
4. Thickness : As per Schedule 40. (DN65: 5.2 mm, DN80: 5.5 mm, DN100: 6 mm, DN125:6.6mm, DN150: 7.1 mm)

C) Pipes above DN 150 as per IS:3589-2001:

1. End condition : Beveled ends for butt welding
2. Material : Carbon steel, Gr. Fe 410
3. Thickness : DN200-DN350: 9.52 mm, DN400 & above: 12 mm

Pipes of size more than DN300 will be spirally welded.

D) Carbon Steel G.I (Galvanised Iron)

Pipes DN 15 to DN 150 as per IS: 1239- 2004:

1. End condition : Screwed up to DN 50, Beveled ends for all the sizes above DN 50.
2. Grade : Heavy
3. Material : Carbon steel, Gr. Fe 410

E) S S Pipe & Pipe Fittings

1. As per ASTM A 312 – Pipe, seamless ANSI B36.10, Schedule 40 (size 6mm-200mm)
2. As per ASTM A 358 – Pipe, welded, ANSI B16.9, Class 3000, Schedule 40, Sizes more than DN250
3. SS butt welding fittings: ASTM A403 WP304, ANSI16.9
4. SS socket welding fittings: ASTM A182 WP304, ANSI16.11

F) MS pipes (without inside surface protection) handling DM/ soft water: upto DN300: seam less { IS 1239, P-1 heavy grade, IS3589,t=9.52 mm) DN300- DN700: 12 mm, more than DN700: 16 mm.

04.10.01 **Pipe Supports and Anchors**

Pipe work shall be supported and anchored in an appropriate manner. The Tenderer shall take all necessary precautions to ensure that the piping shall be free from vibration by the installation of vibration dampers or other acceptable means. The Tenderer shall prepare and include in the plant operating and maintenance manuals, pipe work layout and other similar drawings marked to show the position of every pipe support.

Table for maximum span of supports

Nominal pipe size (mm)	Maximum span for liquid services (m)
25	2.1
40	2.7
50	3.0
65	3.4
80	4.0
100	4.3
150	5.2
200	5.8
250	6.7
300	7.0
350	7.6
400	8.2
450	8.5
500	9.2
600	9.8
900	12.0
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.

04.10.02 Pipe Terminations and Connections

All pipe connections shall be fusion welded except where flange connections are required or specified to facilitate erection or maintenance or where pipe materials used preclude welding.

Pipe work flanges shall comply with the requirements of the code to which the pipe work is designed.

Jointing material, bolts, nuts and washers shall be provided where necessary for flanged pipes, valves and fittings supplied under this Contract.

04.10.03 Internal Cleaning of Pipes

Tenderer is responsible for ensuring that the internal surface of all pipelines is thoroughly clean before the pipelines are placed in commission.

The procedure adopted is to include the following:

a) Thorough cleaning of all internal surfaces prior to erection to remove accumulations of dirt, rust, scale, and welding slag due to site welding before erection.

b) Prior to, and during erection, all parts shall be inspected to make sure that they are clean and adequate steps shall be taken to prevent entry of foreign matter both during and after erection. Each section erected shall be cleaned out before being connected into the previous section. All headers shall be cleaned before closing up.

c) Thorough cleaning of all pipe work after erection by flushing with water.

d) Already embedded pipes shall be cleaned with wire brush/ pickling to bring back original / required ID.

e) For lub oil line pipe line to be cleaned by picking process or other standard process accepted by manufacturer.

Tenderer shall provide all necessary facilities in the pipe system for carrying out the requirements of item (b) including and temporary pipe work, valves and supports.

04.10.04 Traps, Drains and Vents

Tenderer shall provide all traps, drains and vents which are called for in this specification or which are necessary for plant operation, line or plant filling.

Drains and vents from different systems, or parts of systems operating at widely differing pressures, shall not be interconnected. At highest point for vent and lowest point for drain should be provided to avoid the water hammering.

04.11 Welding General Requirements

a. General

All welding shall conform to the relevant National or International Standard Specification as agreed by the Purchaser/Consultant.

b. Welding Equipment

Any welding equipment which in the opinion of the Purchaser/Consultant, unsuitable or unsatisfactory for the service for which it is being used, shall be replaced by Tenderer without any time implication.

The absence of comment by the Purchaser/Consultant shall not be taken as approval for any equipment.

c. Weld Procedure Documents

Complete and full detailed weld procedure documents shall be kept and these shall be made available to the Purchaser/Consultant on request.

Prior to the commencement of the welding the Tenderer shall submit to the Purchaser/Consultant for approval the welding procedures to be used in the fabrication of the relevant sections of work.

d. Welders Qualification Tests

All welders shall be qualified for the work and shall hold current welders qualification certificates in accordance with National Standards.

Records showing the date and result of the qualification tests performed by each welder and weld operator together with the identification number assigned to him shall be available for scrutiny by the Purchaser/Consultant.

e. **Welding Inspection**

i. **Quality Requirements for Welds**

All welds subjected to non-destructive tests shall be entirely free from cracks or crack like defects, lack of root fusion, lack of sidewall fusion, root burn through or tailed pores. The standard for porosity and slag inclusions will be as indicated in the agreed standards for design and welding.

ii. **Visual Weld Inspection**

Each weld shall be subjected to a stringent visual inspection and shall be free from undercut, cracks, porosity and other surface imperfections.

Fillet welds shall be checked for dimensional tolerance and from using a fillet weld gauge. Fillet welds should be slightly concave in form and each leg of the weld shall have equal length.

iii. **Non-Destructive Examination**

All non-destructive examinations shall be supervised by a fully qualified and experienced specialist appointed by the Tenderer. Individual operators in each of the respective techniques shall be qualified and trained in the respective subject.

Dye Penetrant Test, Ultra Sonic Examination, Radiography; Magnetic crack detection shall be carried out in accordance with Standards.

iv **Weld Repairs**

The Purchaser/Consultant's approval shall be obtained prior to commencement of any repair or rectification work.

Weld repairs shall be made to the same procedure as for the original weld. All tests shall be repeated after the repair has been completed.

v. Mandatory Inspections

All transmission welds between dissimilar materials, such as high alloy steel to carbon steel, or non-ferrous materials to steels, shall be subjected to 100% ultrasonic examination or crack detection wherever practicable. In addition, all butt welds between dissimilar materials shall be subjected to 100% radiographic examination.

All welds in ferritic alloy steels, e.g., having a carbon equivalent value in excess of 0.40%, and high yield-strength steels, e.g. having yield strength greater than 300 MPa, shall be subjected to 100% ultrasonic examination and crack detection wherever possible. In addition, all butt welds in these materials shall be subjected to 100% radiographic examination.

04.12 Noise and Vibration

a. **Noise**

Maximum noise level tolerable in work areas shall be within the applicable limit. As per applicable code & standard. The equipment and the services shall be designed such that limits are not exceeded. Tenderer shall indicate the maximum noise level guaranteed for each equipment/system with detailed description of noise control measures adopted, if any.

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b. **Vibration and Balance**

Plant shall be designed and constructed to operate without vibration in so far as the nature of the works will permit. Where vibration must be expected this shall be reduced to the minimum which can be achieved by good design and careful balancing in the case of rotating plant.

The amplitude of vibration of rotating plant when measured on the bearing housings under steady state conditions at the designed operating speeds shall conform to IEC 34-14 (1982) or equivalent International Codes.

04.13 Scaffolding, Stairway and Ladders

Where safe and easy plant operation and maintenance cannot be arranged from provided floor levels, Tenderer shall supply and erect all platform galleries, stairways, access ways and ladders necessary for providing the required safe and easy access to the plant items. Tenderer shall ensure that the whole of the access ways are of uniform design and pattern throughout the Works. Where access is required for operation then standard design stairways must be provided, but if infrequent access for maintenance only is required then vertical ladders will be considered.

04.14 Safety Guards

All moving parts, shafts, couplings, flywheels, bare conductors and hot or cold surfaces shall be adequately and securely guarded in accordance with the prescribed legislation and to the Engineer's approval so as to afford complete safety to all personnel.

04.15 Special Tools and Tackles

The following tools and appliance shall be supplied under this tender for use by the Purchaser.

a) One set of all special tools and tackles including testing, calibrating and measuring instruments required for assembly, disassembly and maintenance of all equipments/ systems covered under the scope of the contractor shall be supplied by the Contractor. These shall not be used for erection/ commissioning purposes and shall be in an unused and new condition, when they are handed over to the purchaser/owner. A list of such special tools and tackles shall be submitted along with the offer.

Supply of all instrumentation measuring devices etc. (both test grades as well as standard) needed for conductance of demonstration / commissioning/ performance guarantee test. The instrumentation specifically brought by the contractor for the purpose of various PG testing alone, can be taken by the contractor after conductance of the PG tests.

b) One set of special lifting and handling appliances required for the normal maintenance of unit # 1.

Each tool or appliance is to be clearly marked with its size and/or purpose.

The tools and appliance supplied shall not be used for erection purposes by Tenderer and shall be handed over in new condition.

The exception to this is the special lifting and stud tensioning equipment which may be used provided that when it is handed over to the Purchaser it has not been subjected to more than normal wear and is still fully suitable for its intended use. In case of doubt, the Purchaser will require the tenderer to replace the worn appliances. Copies of certified test certificates for lifting appliance must be handed over at the Taking over Date.

Each set of tools and appliance under category (a) shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant and equipment in question. If the weight of any box and its contents should be such that it cannot conveniently be carried. It shall be supported on steerable rubber-tyred wheels.

Each cabinet and box shall be painted, fitted with lock and clearly marked in white letters with the name of the item of equipment for which the tolls and appliance contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle in this contract. Suitable lifting lugs, ears or eye bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.

The tenderer shall provide a schedule of all lifting tackle and tools and appliance

being supplied for the approval of the owner engineer/consultant.

The tenderer shall provide all runway beams, trolley, chain blocks, special slings etc. necessary for the safe and efficient handling and maintenance of the works. The tools and appliance with the appropriate storage racks, cabinet and boxes shall be handed over the Purchaser at the time of taking over.

Where the tenderer includes site erection any special tools or appliance required solely for erection (but not for maintenance) shall be provided by the tenderer for own use and shall remain the property of the tenderer.

04.16 Painting

a. **General**

The primers & finishing paints will conform to latest Indian Standard or equivalent international standards. There shall be of approved quality and shade.

General precautions for painting such as preparation of surfaces, application of paints, inspection and testing etc. will be as per relevant clause of IS:1477 (Part I & II) and shall be followed, wherever possible.

General compatibility between primer and finishing paints recommended by the paint manufacturer, supplying these paints shall be followed.

General compatibility between successive coats must be ensured.
Unless otherwise specified, the general colour scheme for finishing coats for different types of equipment and pipelines as per requirement of the Purchaser/Consultant are to be followed. The colour schemes, however, may be changed, if necessary, by the Purchaser/Consultant at any stage before the start of the painting of the equipment.

b. Painting instructions

In general, unless otherwise specified, all plant and equipment & pipelines will be given one coat of antirust primer, lacquers, etc. at the supplier's works after completing surface

preparation to remove grease, rust, scales and other foreign materials. The second coat of antirust primer will be applied immediately after erection after completing requisite surface preparation) followed by two coats of finishing paint of approved quality & shade.

Technological structures, crane girders & other structures shall be given one coat of primer during manufacturer & one coat of primer after erection followed by two coats of finishing paint.

For equipment where original colour as per supplier's practice is desired, both primer & finishing coats will be applied at supplier's works before dispatch of equipment.

Structures embedded in concrete shall have no shop painting applied. The portion of the column that is to be embedded in concrete shall be given a coat of portland cement slurry after thoroughly cleaning the surfaces from mill scale, grease & oil immediately after fabrication.

The portion of the structures embedded underground shall be given two coats of red lead graphite primer at shop and finished with two coats of bituminous black paint of approved quality.

Machined/plain surfaces shall be coated with white lead and tallow before dispatch or before being put into open air & covered with gunny cloth.

Surfaces to be site welded shall have no shop paint applied within 100mm of welding zone. After site welding normal painting application will be followed.

Areas which become in-accessible after assembly shall be painted before assembly.
Cables & other electrical accessories shall have adequate antirust protection. Chequered plates shall be given primer coats only.
The phosphate coated surface shall have one coat of baking based and two coats of finished paint of amino alkyd resin stone enamel.
External surface of pipe fittings shall be thoroughly cleaned by wire brushing and given two coats of red oxide zinc chromate primer at supplier's works & two coats of final synthetic enamel paint after erection.

The equipment which is to be dispatched in knocked down condition and require assembling at site shall be given two coats of rust and corrosion preventive primer and one coat of synthetic enamel paint of approved quality and shade. After assembly at site, such equipment shall be given one final coat of synthetic enamel paint.

The equipment which can be sent as a single block unit duly shop assembled, shall be given full application of paint i.e. two primer coats of rust and corrosion preventive primer and two finish coats of paint of approved quality and shade as per relevant Indian Standards/equivalent international standards.

All painting shall be carried out by brushing or roller application with prior permission of the Purchaser/Consultant.

All metal parts not accessible for painting shall be made of rust and corrosion resisting materials. Interiors of equipment will be suitably quoted with anti-rust compounds.
The fasteners shall not be painted. These will be dispatched with application of anti-rust compound.
Any special painting requirement indicated on Tenderer's drawings by the Purchaser/Consultant during approval stage shall be binding.

c. Surface preparation and environmental conditions

All surfaces to be painted shall be thoroughly cleaned of dirt, grease, rust & mill scale. Removal of rust & scale shall be by hand brushing, power driven wire brushes or by sand blasting, as the surface condition/service condition warrants.

The paint shall be applied on the metallic cleaned surface after it is perfectly dry but not later than 3 hours after cleaning of the surfaces. Reasonable time gap should be allowed between any two consecutive coats of primer or finishing coats.

Surfaces coming in contact with acid & acidic fumes alkalis, soda, detergents etc shall be cleaned thoroughly to get complete metallic surface as per IS;1477 Part I & II or BS 4232-1967. After sand blasting the surface shall be cleaned with cotton rags, soaked in

benzene, to remove fine rust, grease, etc. No sand blasted surface shall be exposed to weather for more than 3 hours.

The choice of primer & finishing paint will depend on the environmental condition to which the plant & equipment and pipelines are exposed to.

Paints are to be applied on dry surface only under agreeable weather conditions. Painting in damp & foggy weather conditions will not be permitted.

For a selected primer the method of surface treatment best suited for that primer & suggestion of paint manufacturer shall be obtained and followed.

Zinc rich primer paints which have been exposed for a long time before the finishing coat is applied shall be washed down thoroughly to remove soluble zinc salt deposit.
The recommendation of paint manufacturer shall be forwarded to the Purchaser/Consultant for approval.

d. Primer paint

In general, two coats of primer paints conforming to relevant Indian Standard or equivalent international standards shall be applied on all unmachined surfaces, except noted otherwise.
Where equipment is to be finish painted for dispatch, both coats will be applied before finishing coats at supplier's works.

Where equipment warrants finishing coat after erection, one coat will be applied just after manufacture at supplier's works and the second coat just after erection at site after surface cleaning.

Equipment on which primer coat has been damaged due to prolonged exposition at site, final erection or transport, shall be given two coats of primer at site before applying finishing coats. Before applying paint the surface will be thoroughly cleaned by sand paper.
The primer applied should be compatible in quality and colour schemes with the subsequent finishing coats.

Unless stated otherwise, the following primer paints shall be used depending upon the exposition and environmental condition to which the plant & equipment, structures & pipelines are exposed to :

- Aluminium zinc oxide - conforming to IS;2931
- Red oxide zinc chromate - conforming to IS;2074
- Heat resistant aluminium primer paint - conforming to IS:161
- Air drying chemical resistant paint
- Epoxy resin paint (cold cured) -
- Poly urethene paint
- Chlorinated rubber based conforming to DEF-1402, Ministry of Defence

e. Finishing paint

Two coats of finishing paint compatible with the primer and conforming to relevant Indian Standard or equivalent international standards shall be applied on all unmachined surfaces unless mentioned otherwise.

Unless noted otherwise, the following finishing paints will be applied on plant & equipment, structure & pipelines depending upon the exposition and environmental conditions to which the plant & equipment, structures & pipelines are on subjected to:

- Synthetic enamel conforming to IS;2932 exterior type
- Epoxy based finishing paint -
- Heat resistant silicon based Aluminium paint IS:161

The finishing paint shall be of approved colour. The undercoat shall have different tinge to distinguish from the finishing paint.

The surfaces of the equipment on which finishing coats of paint has been damaged due

to prolonged exposition at Tenderer's work, erection site, during transport, storage or final erection shall be thoroughly cleaned & touched up with the same paint as applied previously.

f. Thickness of coat of paint

A single coat of paint when dry should have a thickness of 25 to 30 microns (0.025 to 0.030 mm) or 1 mil to 1.25 mils.

Total thickness of 4 coats (2 primer coats + 2 finishing coats) should have thickness of 100 to 125 microns (0.100 to 0.125 mm) or 4 to 5 mils.

In case of bituminous aluminium gilsonite based paint 3 coats are to be applied. The total thickness of 3 coats will be not less than 100 microns (0.100 mm) or 4 mils.

Immediately following the award of the Contract, the Tenderer shall submit the names of the proposed paint supplier and applicator together with a quality assurance program for approval. All paints for one section shall be provided by one manufacturer and preferably shall be manufactured in one country to ensure compatibility.

04.17 Coding Scheme

A coding scheme for identifying the drawings, plant and equipment, structures, spares and shipping documents shall be adopted by Tenderer.

a. **Coding scheme for drawings**

A ten (10) digit drawing numbering scheme is proposed for all the plant and equipment/spares to be supplied. The scheme will be cleared by the Purchaser/Consultant.

b. **Coding scheme for plant and equipment/ spares (Equipment identification number)**

Eight (8) digit coding scheme is proposed for all such items of supply. The first 3 digits conform to the shop complex, next 3 represent the equipment number. Suffixes of 2 digits may be used at the end of six digits, wherever necessary. (Identification number presently

used by plant people shall also be given for easy identification number).

c. **Shipping code for plant and equipment/spares**

The various items of plant units which arrive at site in packages have to be stored at proper areas/stores so that they can be retrieved easily and also to ensure the completeness of supply proper storing of the packages have to be done without opening the packages. As such, the boxes/packages have to be marked so that the contents may be easily identified for proper storage and easy retrieval.

Shipping code will comprise:

- Code number assigned to Tenderer
- Code number of equipment
- Package SN/total number of packages

d. **Colour scheme for plant & equipment**

Purchaser/Consultant will indicate the colour scheme to be followed during painting of the plant and equipment. This as well as the equipment identification number will be indicated by the Purchaser/Consultant soon after the Tenderer submits the list of plant and equipment along with GA drawings.

04.18 Erection, testing & commissioning of plant and equipment and pipelines

a. **General**

Tenderer, amongst other things, shall be responsible for renovation of the plant equipment to be reused and erection of plant and equipment, fluid system, electrics, auxiliaries, etc. as per the scope of supply within the design limit as given in the Technical Specification.

Tenderer shall delivery of the equipment and transport the same to his store/erection site, maintain his own stores for the storage of equipment and all related documents and records and finally transport the equipment to site for erection. Tenderer shall take an erection-cum-storage insurance policy covering all the risks including third party liabilities for equipment as well as human life. All security arrangements also shall be made by Tenderer.

Tenderer shall unpack the cases and do visual checking against physical damages of equipment and do cleaning of the equipment before start of erection.

Tenderer shall be responsible for proper and neat storage and also undertake conservation of all consignments including damaged boxes. During storage of equipment, Tenderer shall take into account deterioration and carry out the re-conservation of the complete equipment/parts/supplies as may be necessary as per the Storage Instructions of the Manufacturer of equipment/components. Tenderer shall also supply the consumables required for such re-conservation/conservation work and repair/replace parts required thereof for the proper functioning of the equipment after erection and commissioning.

Damage/shortage of the equipment/component during transit/transfer/storage, shall be made good by Tenderer without loss of time so as not to upset the agreed erection and commissioning schedule and at no extra cost to the Purchaser/Consultant. Delay on account of settlement of insurance claims by Tenderer shall not be taken into cognizance by the Purchaser/Consultant.
Tenderer shall be liable to make good any damage to existing equipment and/or facilities caused by Tenderer's personnel. In case any existing equipment or facility is required to be dismantled for erection of the new equipment, the same shall be restored at no extra cost to the Purchaser/Consultant.

Equipment will be installed on the existing civil foundation provided by the Purchaser. However, if any deficiency is noticed in the quality of concreting, dimensions, center-lines, levels, locations, etc of the foundation or anchors bolts or other embedments, the same will be rectified by Tenderer at no extra cost. Chipping/ rectification of the equipment for proper erection, alignment, etc. shall be done by Tenderer. Chipping/dressing of the foundation with air or air and water jet prior to placing the equipment will also be carried out by Tenderer.

Tenderer shall lay and maintain properly all the temporary supply lines at the erection site for temporary power, water, and air connections required for erection purposes, from the points earmarked by the Purchaser/Consultant for this purpose.

Tenderer shall provide all necessary construction tools, compressors, small hand tools, instruments, all commissioning instruments, welding equipment, service bolts, nuts, jigs and fixtures, winches, alignment tools, precision levels etc. and other equipment which may be required for carrying out the erection work efficiently within the time schedule. Unless otherwise specified, the above construction materials shall be the property of the Tenderer after the erection work is over. Special tools & tackles obtained by the Purchaser/Consultant with the equipment will, however, be the property of the Purchaser/Consultant.

Tenderer shall provide all temporary ladders, scaffolding materials, platforms, supports and other necessary facilities required for handling, erection and visual inspection of supplies at the point of installation and shall also provide necessary packing plates, wedges, shims, leveling screws, etc. required for erection of plant and equipment.

Tenderer shall provide erection consumables like oxygen and acetylene gas, welding rods, solder lugs, oil, grease, kerosene, cotton waste, etc. required for erection of plant and equipment.

Tenderer shall erect and maintain his own site offices, main stores and site temporary stores as required for the work and arrange for maintaining in neat manner the area placed at his disposal.

Tenderer shall provide sufficient fencing, notice boards and lights to protect and warn others as may be considered necessary by the Purchaser/Consultant.

On placement of order, the Tenderer shall provide his scheme for mobilisation with bar chart indicating clearly the resources, of erection machinery man-power and machinery proposed to be deployed to ensure timely completion of work and quality of workmanship.

The plant and equipment will be erected as per the instructions of the manufacturers/suppliers and under the supervision of the supervisory personnel, to be deputed by the Tenderer at site. Tenderer shall also undertake rectification work on account of manufacturing defects, required for proper erection and assembly which can

be done at site only according to site condition.

Tenderer shall align, level, couple and securely fix all equipment, steel structures and accessories in accordance with drawings and/or instructions.

All precision survey instruments including leveling instruments shall be arranged by the Tenderer.

Tenderer shall supply materials and carry out flushing and first filling of oil and lubricants, grease, chemicals and as required till successful commissioning.

Laying and termination of cables, bus bars, bus ducts and earthing shall be done by Tenderer.

Installation and connection of all pipings and fittings from the headers termination points to the equipment and inter-connection of all service lines within the design limit after the main headers/termination points shall be Tenderer's responsibility.

Tenderer shall check electrical connections to individual items.

Tenderer shall be responsible for calibration of all the instruments used at site.

Tenderer shall be responsible for checking the correctness of erection of mechanical equipment, auxiliary systems, electrical equipment, other equipment, etc. as per the specification and relevant drawings.

Tenderer shall arrange all facilities at site to undertake radiographic testing and stress relieving of butt welded pipe joints, as required.

Tenderer shall be responsible for the management of erection work with proper and adequate supervision for ensuring progress of erection work and quality of workmanship.

Tenderer shall deploy required number of supervisory, skilled, unskilled and auxiliary labor as required, for the erection work and comply with such reasonable instructions of

the Purchaser/Consultant in the interest of satisfactory progress and completion of the work according to the schedule.

Tenderer shall be responsible for total commissioning of the Plant including mechanical run, commissioning and demonstration of Performance Guarantee Parameters.

Tenderer shall organise the work in a manner that other work at site is not impeded and the workmen therein not endangered. He shall arrange temporary access at site, if required, for the erection work.

Tenderer shall intimate the Purchaser/Consultant/ concerned Plant authorities in writing well in advance about the requirement of shut down of any of the existing units/facilities for inter-connection/ incorporation of additional facilities. The shut down period shall be mutually discussed and finalised. The work to be undertaken during the shut down period shall be planned meticulously by the Tenderer to reduce the shut down period to the minimum.

Tenderer shall make temporary arrangement for maintaining the continuity of the services/ facilities before commencement of the diversion of existing service lines wherever shut down is not possible, without any extra cost to the Purchaser/Consultant.

Tenderer shall return to the Purchaser/Consultant all crates, packing cases and packing materials and all returnable supplies belonging to the Purchaser/Consultant at a place designated by the Purchaser/Consultant at the erection site in the conditions these exist during and after erection work is completed.

The tests/checks to be conducted during erection by the Tenderer shall be as per the manufacturer's instructions. The Tenderer shall attend to the rectification of erection defects, if any, expeditiously. The Tenderer shall arrange all testing instruments for such testing at site.

Tenderer shall carry out final painting including supply of paint of the plant & equipment and pipelines, etc. erected as per the instructions of the Purchaser/Consultant.

Grouting of the equipment on the foundations with shrinkkomp /ferro grout shall be the responsibility of the Tenderer.

Tenderer shall indicate to the Purchaser/Consultant well in advance the requirement of services such as electric power, water, EOT crane, etc. required during construction/erection period.

Tenderer will arrange for the staying facilities of his working personnel.
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 documents otherwise required or implied by statutory regulations or practices, shall be strictly followed by the Tenderer during the execution of the Contract. The Tenderer shall set up a suitable safety organisation of his own at site in this regard.
The Tenderer shall comply with all Statutory Rules & Regulations with respect to the employment of labour at site including payment of minimum wages as per Govt. rules, deduction of employees contribution to Provident Funds, depositing the same along with Tenderer's contribution to the Provident Fund Commissioner, Employees State Insurance and other statutory deductions/obligations.
At the end of the work the Tenderer shall remove all such temporary structures put up by him and hand over the site to the Purchaser/Consultant in neat and tidy manner.

09.19 Supervision of erection, testing, commissioning and performance guarantee tests

Tenderer shall depute at site engineer/ specialists from various disciplines for the supervision of entire renovation works, erection, testing trial run, commissioning and performance guarantee tests of the plant and equipment under his scope of work engineers/specialists from various disciplines. The above mentioned engineers/specialists shall supervise the erection, testing, commissioning and conducting of performance guarantee tests of the plant and equipment with their auxiliaries so as to establish to the Purchaser/Consultant that the guarantees as stipulated by the Purchaser/Consultant and agreed by Tenderer are fully met.

The Purchaser/Consultant may place his engineers of respective disciplines to witness successive steps adopted in successful erection, testing, commissioning and performance guarantee tests.
For mechanical completion, erection, testing, commissioning and performance guarantee tests refer other section of this tender specification.

04.20 Contract Terminal Points

Tenderer's responsibility for making connections shall be as follows unless otherwise stated in the Specification:

a) Where pipe work and ducting supplied under this Contract connects the equipment already existing or supplied by the Purchaser, the connection shall be made under this contract.

b) This contract includes the terminating and connecting up all cables, which are supplied under this Contract except where noted.

c) All associated existing cabling not included in the Contract will be checked and tested under the supervision of the Purchaser/Consultant but it will be the responsibility of the Tenderer under this Contract to assist the Purchaser/Consultant in re-checking all final connections and to ensure the subsequent satisfactory operation of the equipment.

Tenderer shall be deemed not to have fulfilled his obligation insofar as the commissioning of the plant in concerned until complete end-to-end tests have been carried out to the satisfaction of the Purchaser/Consultant.

2.2 **Drawing / Documents for Approval**

2.2.1 The Contractor shall submit the various drawings and documents to the Engineer / Consultant for approval, as per the following schedule.

S. No.	Description	No. of Copies	Time of Submission in weeks from the Effective Date of Contract	
			Imported	Indigenous
A	**Basic Engineering:**			
1.	Name Plate and Numbering System	7		
2.	PERT/CPM Network Level 2	7		
3.	List of Drawing and Documents (for information and to be updated quarterly)	7		
4.	Inspection procedures & Quality Assurance Plan	7		
5.	Site plan / layout drawing showing battery limits and co-ordinated plans of all units and facilities including requirements of utilities and other parameters at battery limits (in 1:500 scale).	7		
6.	Design Engineering Assumptions/ Basic Data	7		
7.	Relay settings with supporting calculation	7		
8.	Turbine Model test results	7		
9.	General arrangement & layout drawings including plans and cross-sections for different units/systems/services including equipment disposition and facilities	7		
10	Civil engineering design criteria	7		
11.	Single line diagrams, block diagrams, GA and layout drawings for electrical system/eqpt	7		
12	Instrumentation and control schemes and sequence logic diagrams, List of	7		

	Instruments and Instruments data sheets, Panels and desk front view diagrams, Control room layout drawings			
13.	Design criteria, general arrangement and layout drawings for pipework and duct work.	7		
14.	Plans for safety measures	7		
15.	Equipment list and motor list (for information).	7		
B	**Design and Engineering:**			
1	Technical Data sheets of Turbine, Generator, Generator Transformer, Unit Aux. Transformer and all other equipment under new supply	7		
2	GA & Sectional drawings for foundation of buildings and equipment including cable routes etc	7		
3	Outline architectural drawings of new control room	7		
4.	Structural design drawings (supported by design calculations)	7		
5.	Equipment General arrangement & major assembly and sub-assembly drawings (including equipment for various services)	7		
6.	General arrangement of control desks, etc.	7		
7.	Colour schemes	7		

2.2.2 After approval by the Employer / Consultant, the Contractor shall submit approved drawings and documents in 10 copies, to the Employer.

2.3 **Drawings / Documents for Information / Review**

2.3.1 The Contractor shall submit to the Employer for information / review of the drawings and documents as per the Schedule given below :

Sl. No.	Description	No. of Copies	Time of Submission in weeks from the Effective Date of Contract	
			Imported	Indigenous
1.	Cable layout drawings	7		
2.	List of electrical drives	7		
3.	Control schematic of all electrical equipment	7		
4.	Cable tray arrangement, cable schedule and instrument pipe schedule and routings	7		
5.	Lighting, earthing and lightning protection drawings	7		
6.	Terminal plans and interconnection diagrams for electrical equipment.	7		
7.	Conduit drawings and cut out details	7		
8.	Loop schemes, power supply and distribution schemes and panels and desk internal wiring diagrams. External connection including terminal wiring diagrams for power, control and instrumentation cables	7		
9.	Detailed drawings for pipe works and ductwork	7		
10.	Drawings/documents for approval of statutory authorities.	7	As required	As required
11.	Procedure for storage and reconservation including those for electrical and instrumentation items	7		
12.	Erection drawings, erection specifications and Erection Instructions	7		

13.	Integrated Operation/ safety and Maintenance Manuals	7		
14.	Installation, erection and commissioning manuals	5		
15.	Manufacturing drawings for spares (excluding those for proprietary items) and Ordering Specifications for spares including spare lists	5		

2.3.2 After "no comment" clearance by the Employer, the Contractor shall submit the final drawings and documents in 10 copies, to the Employer.

2.4 **As-Built Drawings and Documents**

The Contractor shall submit As- built drawings & documents after performance Guarantee Test, but before release of payment for PG Test certificate.

S. No.	Description	No. of Copies	Time of Submission in weeks from the Effective Date of Contract	
			Imported	Indigenous
1.	General arrangement, assembly and sub-assembly drawings	5		
2.	Performance data	5		
3.	Test charts and inspection certificates in bound volumes	5		
4.	All design calculations with respective approved design criteria in bound volumes	5		
6.	Electrical & instrumentation drawings	5		
7.	Civil working drawings	5		
11.	Operation and safety manuals	10		
12.	Maintenance manuals	10		
13.	List of spares (Operation, Maintenance)	1		
14.	One polyester film 1 set reproducible 1 set / microfilm 1	1set		

	set of each of the as-built drawings and documents including design calculations incorporating approved changes, if any, during construction,erection and commissioning (all drawings even if there is no change). One CD ROM set for all As-built drawings, O&M Manuals, Operation Safety Manual and Maintenance Manual.			

2.5 Equipment drawings and Erection Instructions drawings for the Plant and Equipment shall be supplied by the Contractor at least one month before the shipment / despatch of the Plant & Equipment.

2.6 Approval in respect of drawings shall be accorded by the Employer/Consultant within fifteen (15) days of receipt of the same. In case drawing is not complete and/or is not approved, the comments shall be furnished to the Contractor within fifteen (15) days of receipt of drawing.

9.12 QUALITY ASSURANCE

DASH BOARD OF Horizontal Centrifugal Pumps/Vertical Centrifugal Pump/Submersible Pump/ Sump Pumps/Sludge Pumps/

Tests / Check Items / Components	INPROCESS TESTS												FINAL TESTS					
	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	Ultrasonic test	Radiographic test	Dye Penetration Test	Magnetic particle test	Balancing	Hyd. Test	Inclusion rating	Pressure Drop	Performance Test	NPSH Test	Vibration	Noise	Strip Down Test	Dimensional
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10	11.	12.	13	14.	15.	16.	17.	18.
Pump Casing	Y[c]	Y[c]	-	-	-	-	Y	-	-	Y	-							
Shaft	Y[c]	Y[c]	Y	Y	Y[b]	-	Y	Y	-	-	Y							
Impeller	Y[c]	Y[c]	Y	-	-	-	Y	-	Y	-	-							
Rotor	-	-	-	Y	-	-	-	-		-	-							
Fabricated Items	Y[c]	Y[c]	-	-	-	Y[d]	Y	-	-	Y[e]	-							
Strainer																		
a) Body	Y	Y	-	-	-	-	Y*	-	Y	Y	-	-						
b) Assembly	-	-	-	-	-	-	-	-	-	-	-	Y**						
Pump final Assembly													Y[f]	Y[g]	Y[h]	Y[i]	Y[j]	Y

Y. To apply

a. UT for shaft dia ≥ 50mm and Plate thickness ≥ 16mm.
b. Chemical / Mechanical shall be one per heat/HT batch.
c. 10% Random on Butt Welds & 100% on Fillet Weld.
d. Pressure containing parts.
e. Performance Test on each Pump to determine the characteristic curve (Head, Capacity, efficiency & Power) at Design speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%, 25%, 50%, 65%, 80%, 100% and 125% of Design Flow with cold water.
f. NPSH (R) test shall be carried out on one Pump using cold water at pump flows of 25%, 50%, 65%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1% and 3% head break by Suction Throttling Procedure / varying suction pressure.

g. Vibration on all Pumps shall be measured in transverse, Horizontal and Vertical directions at all measuring points.

h. Noise Level on each Pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 meter horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.

i. One Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive vibration, High noise, high bearing temperature etc. is observed during performance test.

Note:

1) Quantum of In-Process Checks/ Tests is 100% until & unless specified otherwise.
2) Bidder shall furnish details of proposed test procedure including test lay out, type and level of accuracy of instruments, sample calculation, etc.

* In case of fabricated construction.

** One per type and size.

Results must show no minus tolerance with regard to flow and head.

No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

9.13. QUALITY ASSURANCE

DASH BOARD FOR MECHANICAL ITEMS

SN	Tests/Checks	Material Test	WPS/ WQS/PQR	DPT/MPI	Ultrasonic Test	Radiographic Test	PWHT	Assembly / Fit up	Dimensions	Hydraulic	Pneumatic Test	Balancing	Functional/operational	Performance Test	Other Tests	All Tests as per relevant Std
1	Pipes & Fittings	Y[a]							Y	Y[5]						Y
2	Diaphragm Valves	Y[a]							Y	Y[5]			Y		Y[6]	Y
3a	Cast Butterfly Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]			Y		Y[7]	Y
3b	Fabricated Butterfly	Y[a]	Y	Y[3]	Y[12]	Y[12]	Y[12]	Y	Y	Y[5]			Y		Y[7]	Y
4	Gate/ Globe/ Check Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[8]	Y
5	Dual Plate Check	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[4]	Y
6	Plug / Ball Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y			Y
7	Rolled & Welded Pipes	Y[a]	Y	Y[3]		Y[1]			Y	Y[20]						
8	Coating & Wrapping of	Y[a]							Y							Y[2]
9	Strainers	Y[a]		Y[3]					Y	Y[20]					Y[9]	
10	Rubber Expansion Joints	Y[a]						Y	Y	Y[10]					Y[11]	
11	Site Welding		Y	Y[3]		Y[1]				Y[20]						
12	Compressors/ Blowers	Y[a]		Y[3]	Y[b]			Y	Y	Y[20]		Y		Y[18]	Y[19]	Y
13	Atmospheric Storage Tanks/Mixing Tanks	Y[a]	Y	Y[3]				Y	Y	Y[20]					Y[13]	Y
14	Pressure vessels /Air Receiver & Heat exchangers	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]					Y[23]	Y
15	Air Drying Plant	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]	Y		Y		Y[24]	
16	Fans	Y[a]		Y[3]	Y[b]			Y	Y			Y		Y	Y[14]	Y

	NOTES
Y	To apply
a	One per heat/heat treatment batch/lot.
b	For shaft/spindles/forgings diameter ≥ 50 mm & Plate thickness ≥ 16 mm

1	Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2	Tests for primer and enamel / Coal Tar Tapes as per AWWA-C-203 / IS 15557
3	On machined surfaces of castings/shaft/spindles/forgings. DPT/MPI on root run (after back gouging/chipping – as applicable) for 100% and on finish butt & fillet welds for 10%.
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh (10^5) Cycles shall be carried out as a type test.
5	Valves shall be tested for Body, seat & back seat leakage as applicable. Hydraulic test pressure shall be as per relevant standard. & shall be done as per relevant standard. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator. Valves shall be offered for hydro test in unpainted condition
6	Tests on rubber diaphragm such as hardness, bleed resistance test, rubber to fabric bond, flex test & type test for 50,000 cycles shall be carried out.
7	In addition to Body & seat hydrotest, disc-strength shall be carried out as per relevant standard
8	Blue matching for metal-seated valves, Wear travel for gate valves, pneumatic seat leakage test & reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg absolute for valves to be tested for vacuum operation for internal pressure 25 mm of Hg absolute for a period of 15 minutes
9	Pressure drop across the strainer for each type and size as a special test shall be carried out
10	During hydraulic and vacuum tests in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.
11	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149, ageing test and adhesion strength of rubber to fabric & rubber to metal shall be carried out.
12	a) For fabricated butterfly valves: UT as per ASTM A-435 on plates for body and disc shall be carried out. b) 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc c) Post Weld Heat Treatment (PWHT) as per ASME, Section-VIII, Division-I on butt joints of body and disc of thickness above 30mm shall be carried out.
13	Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted.
14	All fans shall be subjected to run test and Vibration, noise, temperature rise, and current drawn shall be measured during the run test. Performance test of one fan of each type and size shall be carried out as per applicable standard for air flow, static pressure, speed, Efficiency, power consumption.
15	In case of diaphragm/plunger, only proven material shall be used and certificate in this regard shall be submitted for review.
16	All pumps to be performance tested as per Hydraulic Institute Standard/Relevant standard. Performance test to include check for noise, vibration level and bearing temperature rise.
17	Pumps shall be tested at 200% of pump rated head or at 150% of pump shut-off head whichever is higher for 30 min duration.
18	Performance testing of each compressor/ Blower / Vacuum Pump shall be carried out at shop as per BS-1571/ IS: 5456 /ISO 1217/ Pneurop 6612/ equivalent as applicable. Noise & vibration shall also be measured during performance testing.
19	For Compressors capacity control and operation of safety valves shall be checked during inspection at shop
20	Pressure retaining parts shall be hydraulic tested. Hydraulic test pressure shall be as per applicable std / 1.5 x design pressure or 2 x working pressure whichever is higher for 30 minutes duration. Atmospheric tanks shall be water fill tested
21	RT on weld joints shall be as per respective code requirements. Heat Treatment of the Tank/Vessel shall be done as per fabrication code requirement.
22	Dished ends shall be stress relieved as per relevant code. However, dished ends welds (if manufactured by using welded plates) shall be subjected to 100% RT and stress relieved.
23	Tube to tube sheet joints of heat exchanger shall be subject to mock up test. Coolers/heat exchanger shall be hydro tested on tube side and shell side
24	Refrigerant compressors shall be tested as per relevant std and certification from manufacturer for the same shall be submitted. Due point measurement & function of auto drain trap shall also be carried out.
25	Concentricity/ centering & Axial Run out Shall also be measured

QUALITY ASSURANCE

AIR CONDITIONING AND VENTILATION SYSTEM

1.00.00 CHILLING UNIT

1.01.00 Refrigerant Compressor (Screw/Scroll)

1.01.01 Hydraulic/Pneumatic test of castings of casings shall be carried out. No leakage shall be permitted.

1.01.02 DPT of screw, impeller, shaft, vanes, casing etc. after machining shall be carried out.

1.01.03 All rotating parts of screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3

1.01.04 Leak tightness & vacuum check for chilling units / compressor in assembled condition shall be carried out. No leakage shall be permitted.

1.01.05 Performance test of assembled compressor and Chiller assembly shall be done to check for following :

i) No load air run (free run) test of all types of compressor to check FAD (Free air delivery), Noise, Vibration & Temp. rise of bearing & body.

ii) Functional run test for Chiller assembly shall be carried out.

1.02.00 CONDENSER & EVAPORATOR

1.02.01 DPT shall be carried out on welds if applicable.
1.02.02 10% RT of butt weld joint on shell shall be carried out if applicable.
1.02.03 Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.
1.02.04 Mock-up test of tubes to tube sheet expansion shall be carried out.In case such test is already carried out for similar tube/tube sheet thickness and materials, records for the same shall be furnished for NSPCL review.

1.02.05 Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. 'No leakage' shall be permitted.

2.00.00 AIR HANDLING UNIT

2.01.00 20% DPT of welding on fan casing, impeller, hub & blades as applicable shall be carried out.

2.02.00 UT on fan shafts (dia equal to or above 50mm) shall be carried out. DP of fan shaft after machining shall be carried out

2.03.00 Rotating components of fan shall be dynamically balanced to ISO 1940 Gr. 6.3

2.04.00 One fan of each type and size shall be performance tested as per AMCA / BIS for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise and Vibration.

2.05.00 One per type of assembled AHU (AHU casing and fan assembly) shall be subjected to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.

2.06.00 All cooling coil shall be pneumatically tested and no leakage shall be permitted.

3.00.00 CENTRIFUGAL PUMP

3.01.00 UT on pump shaft (dia equal to or above 50 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.

3.02.00 All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3

3.03.00 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.

3.04.00 **Standard Running Test**

i) All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horse power. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard only.

ii) Noise and vibration shall be measured at shop for reference purpose only.

iii) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.

iv) NPSH test shall be conducted with water as the medium, if required as per approved data sheets.

4.00.00 FANS:

4.01.00 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

4.02.00 DPT of fan shafts shall be carried out after machining.

4.03.00 UT of fan shafts (dia equal to or above 50mm) shall be carried out.

4.04.00 Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3

4.05.00 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.

4.06.00 One fan of each type and size will be performance tested as per corresponding BIS code for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

5.00.00 LOW PRESSURE AIR DISTRIBUTION SYSTEM

5.01.00 Functional test for fire damper along with solenoid shall be done.

5.02.00 Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished.

5.03.00 Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.

6.00.00 INSULATION :

6.01.00 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.

6.02.00 Thermal conductivity tests (for thermal insulation only) shall be done once in 12 months for insulation material manufactured during 12 months period for the same density and thickness of material as applicable as per IS:3346 or equivalent standard.

7.00.00 COOLING TOWER

7.01.00 UT of fan shaft and drive shaft (dia equal to or above 50mm) shall be carried out.

7.02.00 DPT of fan hub and shafts shall be carried out after machining.

7.03.00 Colour of fills shall be as per approved data sheet.

7.04.00 Fan assembly shall be statically/dynamically balanced.
Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. For Cooling Towers being supplied in knocked-down condition, these tests shall be done at site

8.00.00 AIR FILTERS :

Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA(Absolute) filters shall be tested as per applicable code.

9.00.00 PIPES & FITTINGS :

9.01.00 All pipes and fittings shall be tested as per applicable codes / standard.

9.02.00 Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement.

10.00.00 VALVES & SPECIALTIES

10.01.00 Visual and dimensional check of valves as per relevant codes and approved drawing.

10.02.00 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

10.03.00 Refrigerant line valves shall be pneumatically tested for body and seat leakage test.

10.04.00 Valves shall be offered for hydro test and pneumatic test in unpainted condition.

10.05.00 Functional check of the valves for smooth opening and closing shall be done.

10.06.00 Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.

11.00.00 Packaged Air Conditioners (PAC)/ SPLIT/CASSETTE AC

11.01.00 For PAC Units, Split/Cassette Air conditioner up to 10 TR capacity will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate. However for these units capacity assessment shall be done at site as per approved procedures.

11.02.00 For Air Cooled PAC of Capacity more than 10TR, One Unit (Both indoor and out door interconnected) of each type and rating shall be subjected to production routine test inclusive of Performance Test as per IS:8148 at prevalent ambient condition.

12.00.00 Air Washer and Unitary Air Filter (UAF)

12.01.00 Random 10% DPT on weld joints shall be carried out

12.02.00 Hydraulic test of pressure parts at 1.5 times the design. Pressure and water fill test of tanks shall be carried out

12.03.00 Trial assembly of Air washer/UAF for one of each size shall be done in shop.

	R M & U OF PANCHET HYDEL STATION UNIT # 1 (46 MW) HVAC SYSTEM TECHNICAL SPECIFICATION (ELECTRICAL PORTION)	SPECIFICATION No: PE-TS-495-571-11000A-A001	
		SECTION : I	
		SUB-SECTION : C3	
		REV. 00	DATE: AUGUST 2022

SECTION: I

SUB-SECTION: C3

TECHNCIAL SPECIFICATION

(ELECTRICAL PORTION)

	ELECTRICAL EQUIPMENT SPECIFICATION FOR HVAC 1X46MW PANCHET HEP RMU	SPECIFICATION NO. VOLUME NO. : **II-B** SECTION : **C** REV NO. : **00** DATE : 28.07.22 SHEET : 1 OF 3

TECHNICAL SPECIFICATION

FOR

HVAC

(ELECTRICAL PORTION)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications.
d) Erection and Commissioning spares.
e) Erection & Maintenance tools & tackles.
f) Electrical load requirement for HVAC.
g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL
i) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
j) Motor shall meet minimum requirement of motor specification.
k) LT switchgear panels shall meet minimum requirement of LT switchgear specification.
l) LT power & control cables shall meet minimum requirement of LT power & control cables specification.
m) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with this two signed and stamped copies of the following shall be furnished by the bidder as technical offer:

a) A copy of this sheet "Electrical equipment Specification for HVAC" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
b) List of Erection and Commissioning spares.
c) List of Erection & Maintenance tools & tackles.
d) Electrical load requirement

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures :

a) Electrical scope between BHEL & vendor.
b) Technical specification, datasheets & quality plans for 415V Electric motors.
c) Technical specification, datasheets & quality plans for 415V LT Switchgear.
d) Technical Specification, datasheets & quality plans for LT power & control cables.
e) Technical Specification, datasheets & quality plans for cabling, earthing & lightning protection.
f) Electrical Load data format.

5.0 The stipulations of specification (in decreasing order) Section-C(customer specification), Datasheet-A, followed by those of Section-D, shall prevail in case of any conflict between the stipulations of specification Section-C (customer specification), Datasheet-A and Section-D.

6.0 In case of conflict between any two clauses within the section, stringent of the two shall be considered.

REV: 00 DATE: 28.07.22

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	Local Motor starter for wall mounted supply and exhaust fans is in vendor's scope.
2	Local Push Button Station (for motors)	Vendor	Vendor	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in vendor's scope b) one end equipment in vendor's scope	 Vendor Vendor	 Vendor Vendor	1. Finalisation of cable sizes shall be done by Vendor meeting specification requirements. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by Vendor. 3. Termination at equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	
5	Cable trays, accessories & cable trays supporting system	Vendor	Vendor	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power cables 3. Solder less crimping type heavy duty copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer approval at contract stage.
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	Vendor	Vendor	
10	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer approval at contract stage.
11	Mandatory spares	Vendor	-	Vendor to quote as per specification.
12	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
13	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing & cable routing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies.

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
16	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details. Electrical equipment layout drawing shall be to BHEL approval.
17	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

02.03 ELECTRICAL SYSTEM DESIGN

02.03.01 General

Standards

The design, manufacture, assembly and testing as well as performance of the equipment shall conform to the relevant IS specifications (latest revision). In case the tenderer 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 tenderer may base his proposals on IEC/BS/VDE/DIN recommendations or other reputed national or international standards subject to the approval of the purchaser/Consultant.

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, the Government of Jharkand and with the Indian Electricity Rules.

Climatic Conditions

The climatic conditions generally prevailing at Panchet have been described in Volume I (Commercial Volume).

Electrical Equipment selection and derating shall generally be based on ambient temperature of 50 deg. C.

02.03.02 Design Criteria

Standard Voltage levels

The standardized voltage levels as given in table no. 02.01 shall be adopted.

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अभियांत्रिकी विभाग/Engineering Department
दामोदर घाटी निगम/DVC
कोलकाता-54/KOLKATA-54

Table 02.01

Standard Voltage levels

Sl.No.	Description	Voltage level
1.	Generation	11kV, 3 Phase, 3wire, 50Hz, Resistance earthed
2.	Evacuation and Transmission	132 kV, 3 phase, 3 wire 50 Hz, effectively earthed
3.	Station supply	415 V, 3 phase, 4 wire, 50 Hz, effectively earthed.
4.	A.C. Drive motors	415 V, 3 phase, 4 wire effectively earthed
5.	Metering	110 V, AC PT. voltage
6.	Control & protection of EHV, LT switch-gear, D.C. drives	220 V, DC 2 wire unearthed
7.	Panel lighting and space heaters	230V, 1 phase, 2 wires 50 Hz, A.C. with point earthed.

Permissible variations

The system unit/plant equipment shall be designed suitably for variation in voltage and frequency as indicated in Table 02.02

Table 02.02

Variation in Voltage and Frequency

Sl.No	Description	Voltage	Frequency
1.	Permissible variation with rated performance/ rated current and control effectiveness system maintained	+ 6% to - 6% ,	+ 3% to - 5% For LT system
		+ 6% to - 9% ,	+ 3% to - 5% For HT system
		+10% to -12.5%	+ 3% to - 5%For EHT system
2.	Permissible variations for control and regulation equipment with rated performance and control quality maintained.	+/- 10% ,	+3% to - 5%
3.	Permissible voltage dip at LT switchgear bus for starting of LT motors	- 5%	

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Engineering Department
दामोदर घाटी निगम/DVC
कोलकाता-54/KOLKATA-54

Power Sector Hydro Business Group
सेक्टर-62, नोएडा उ.प्र. Sector-62, Noida U.P.

Basic Insulation Levels

Equipment shall be designed suitably for basic insulation levels as given in Table 02.03.

Table 02.03

Basic Insulation Levels

Sl.No	Nominal voltage kV	BIL kV (peak)
1.	132 kV	650
2.	11 kV	75
3.	415 V	1.1

Symmetrical short circuit ratings

The three phase symmetrical short circuit ratings of the switchgear at different voltage levels will be as indicated in Table 02.04.

Table 02.04

Symmetrical Short Circuit Ratings

Sl. No.	Voltage level	Symmetrical Breaking capacity	Making
1.	132 kV	40 kA	100 kA
2.	11 kV	40 kA	100 kA
3.	415 V	50 kA	75 kA
4.	220 V DC	10 kA	-

The rated short circuit withstand duration for switchgear of 132 kV is 3.0 sec and for 11 kV it will be 3 Secs whereas for 415 V including MCCs it will be 1 sec.

Motor Starting and permissible voltage dips :

Voltage dip on starting of the largest motor shall be limited to 15% of the nominal voltage at the motor terminals.

System Earthing

132 kV systems is effectively earthed.
11 kV System earthed through resistance
415 V system will be effectively earthed in line with IE Rules.

Other Requirements

The electrical distribution scheme to be provided will be subject to approval of purchaser/purchaser's consultants.

Miscellaneous items such as relays, type of relays, relay ranges, number of poles for relays, scale of meters, CT ratios, links, fuses, switches, indication lamps, terminal blocks, aux. relays, timers associated with main relays, size of control cables shall be supplied as per the approved scheme/to achieve scheme requirements.

All LT CTs shall be of 5A secondary and HT/EHT CTs shall be 1 amp. secondary. Control cable from CT to panel shall of 4 sq.mm. copper.

Energy meters and corresponding CTs and PTs shall be as per amendment dated 04.06.2010 to CEA (Installation and operation of meters) regulation 2006 shall be as follows :

Energy Accounting and audit meters

1. In generating stations, the accuracy class of meters at a point after the generator stator terminals and before the tap off to the unit auxiliary transformer (s) shall

not be inferior to that of 0.2S accuracy class. However, the accuracy class of other meters shall not be inferior to that of 1.0S accuracy class.

2. The accuracy class of meters in transmission system shall not be inferior to that of 0.2S accuracy class.
3. The accuracy class of meters in distribution system shall not be inferior to that of 0.5S accuracy class.
4. The accuracy class of Current transformer (CTs) and Voltage transformers (VTs) shall not be inferior to that of associated meters

All erection/installation accessories, cable termination and jointing kits, cable fixing, dressing, tag numbers, route markers, supporting materials for all equipment shall be part of the tenderer's scope.

Motor space heater (if required) power supply shall be fed from respective shop MCC/Distribution board. Space heaters will be interlocked with motor main power supply.

Earthing mat is already provided for complete power plant area. Existing earthing connections/ strips needs to be checked for continuity and to be refurbished / extended if needed for making suitable to connect all equipment in the scope of tenderer.

Selection of components and cable size for MCCs shall be as per chart given in Annexure-I.

Tenderer to submit a system wise drive list indicating process interlocks, permissive conditions etc. with places and mode of control for each drive control system philosophy with provision of various control, indication, measuring devices at various places. This shall be approved by the purchaser/consultant. Based on above approved philosophy tenderer shall have to provide all equipment/materials and prepare a control scheme/logic diagram.

Above mentioned control philosophy and interlocking logic shall be prepared as per the technological requirement.

Tenderer shall include in his scope dummy panels for switchgear and control panels, wherever civil beam blocks cable entry to panel.

For control and protection requirement, DC supply shall be used.

02.03.03 **Design of Electrical Auxiliary System.**

The electrical auxiliary system shall be designed considering available short circuit levels, switchgear duties and voltage dips on auxiliary buses for the various operating conditions. The impedance values of transformer shall be selected with a view to limit the fault levels and voltage dips.
Manual transfer of auxiliary loads shall be provided during unit starting and during planned shutdowns, whereas fast automatic transfer shall be provided between the two incomer. buses of 415V switch boards.

02.03.04 **Power Distribution Scheme**

The electrical power distribution and control scheme shall be based on the scheme elaborated below. Tenderer shall follow the system design in general on these lines and design the equipment based on criteria given in earlier paragraphs. The generator shall generate power at 11 kV. The generator shall be connected to 132 kV system through existing 3 phase, 60MVA, 11/132 kV transformer.
The generator shall generate power at 11 kV. The generator shall be directly connected to 132 kV systems through HT Bus duct to existing 3 phase, 60MVA, 11/132 kV transformer.

The electrical distribution scheme shall be based on unit and station auxiliaries system feeding separately. The unit loads shall be fed directly through 750 kVA,

11/0.433kV transformer for each unit. The scheme is shown in single line diagram and is further elaborated in the following paragraphs of this chapter.

Power Evacuation

The transformer yard and the switchyard are existing and located adjacent to power plant building to interconnect the power plant to grid at 132 kV for the purpose of power evacuation.

02.03.05 **Elaboration of Electrical Scope of Work**

The scope of work and different design requirement have been given in different chapters, however, for ease of understanding it is briefed in following paragraphs.

12. LT Motors

AC squirrel cage industrial motors shall be fed at 415V, 3 phase, 50 Hz, with DOL start.415 V AC energy efficient motors shall be provided to all auxiliaries covered under this package as per system requirement.

13. Cabling (Cables, Cable supporting materials, trays etc)

All HT/LT power, control cables and cable accessories supporting structures, cable installation, cable terminations with necessary junction boxes and fire sealing are under the scope of tenderer for all areas covered in the package.

All control and protection cables required for connection to relays, meters, signalling alarm, control, monitoring etc. at main station building shall be provided, laid glanded and terminated at both ends by the tenderer.Existing cables shall be removed and placed in proper condition in a place identified by the purchaser's store.

All erection/installation accessories, cable termination and jointing kits, cable fixing, dressing, tag numbers, route markers, supporting materials for all equipment covered in the package shall be part of the tenderer's scope.

Selection of components and cable size for MCCs shall be as per chart given in Annexure-I.

Tenderer shall have to submit the layout indicating location of all major electrical equipment and cable routes including levels of floor, clearances, entry/exit points, cable structure details during detailed engineering stage.

Earthing Materials

New GI flexible/flats are to be provided for connecting all equipment within battery limit to existing earth grid.

Local Control Station

Local Control Station shall be provided near all motors.

15. **Cabling and Linking of All Switchyard Equipment pertaining to unit-1 to Unit control Room is in the scope of tenderer.**

4 LT motor protection (for motors less than 75 kW)

The motors rated below 75 kW shall have bimetallic relays. Also following protections shall be provided

i) Under Voltage

ii) Overload

iii) Single phase preventor.

iii) 415 V Motor Feeders (Above 110 kW)

- Comprehensive motor protection relay (Microprocessor based)

iv) 415 V Motor Feeder (less than 110 kW)

- Undervoltage
- overload
- single phase

04.10 ELECTRIC MOTORS

04.10.01 **Low voltage squirrel cage induction motors :**

Constructional features:

- Frame sizes and ratings and other facilities as per IEC
- For motor frames upto 315, cast iron or steel construction body; for frames above 315,steel construction shall be used.
- Casing feet to be integral with the motor body.
- Degree of protection for motor, bearings and terminal box to be IP-55.
- Cylindrical shaft ends, unless otherwise specified
- Shaft extension as per requirement.
- For motor of rating upto 5 kW, Ball bearings shall be used for both DE & NDE end. For ratings above 5 kW the DE end shall be provided with roller bearing and NDE end shall be provided with ball bearing.
- Bearings shall be suitable for running of motor in either direction. Terminal box:
- Terminal box suitable dimension to receive copper cables and provided normally on the right side as viewed from drive side or on the top as per the requirement.
- Terminal box frame with opening for cable rotatable by 4x90 deg.
- A suitable earthing stud shall be mounted inside the terminal box.
- Terminal Box shall be suitable to receive the aluminium cables as given in Table-I.

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- Extension of Terminal box as required shall be done to receive the Aluminium cables to avoid cramping of the cables in the terminal box.

Cooling:

- Motors shall be of TEFC design

- Ventilation shall be effective irrespective of direction of rotation.

Quality of operation:

- Motors shall be dynamically balanced with full key on the shaft- end and fan.
- Vibration intensity shall be limited as per IS 4729.
- Continuous noise level should not exceed 85 db A at a distance of 1.0 m from motor body

Electrical design

- Suitable for DOL starting

- Motors suitable for being switched on to a solid main even at phase opposition at a maximum residual voltage of 50% i.e. the motor shall be capable of withstanding 150% of the rated voltage.

- Motors capable to start and run-up at a minimum of 85% of rated voltage at its terminals with the driven mechanism/equipment connected.

- Capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% of the rated voltage at its terminals.

- Starting torque shall be not less than 160% of rated torque.

- Starting current shall be less than or equal to six times the rated current.

- Motor shall be capable of withstanding locked rotor current for at least 5 seconds longer than the starting time at 80% voltage under rated load conditions.

- Continuous duty motors shall be capable of three equally spread starts per hour under normal condition or two starts in quick succession from cold or one hot start, under rated load condition.

- All continuous duty motor (S1-100%) shall be of high efficiency to **Eff 1** class as per IS 12615- 2004.

- Motors provided with class 'B' or class ' F' insulation. Permissible temperature shall be limited to 120 deg. C in case of class'B'insulation and in case of class F insulation, permissible temperature shall be 130 deg.C 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.

- Motors selected shall be of normal starting torque type, high starting torque type, high slip type or stall torque type as required for the specific application.

- Four pole motors to be used for all general applications, unless specific drive requirement or economy calls for other poles.

04.10.02 **Valve Actuators**

- The actuator shall be designed for operation on 415V, 3 phase, 50 Hz system.
- The actuators shall be suitable for voltage frequency variations as indicated in Chapter Electrical design criteria.
- The actuators shall consists of motor, torque/ position limit switches, clutch, hand wheel, position indicator, space heater.

- The actuators 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.
- Hand wheel shall declutch 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
- Motor data sheet for each type of motor actuator shall be furnished alongwith internal wiring diagram, suggested control schematic and torque limit switches contact development.

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04.11 CABLES

04.11.01 Cable Specification

Types of cables of following grades and general specifications shall be used taking into consideration the application requirements. All cables shall have FRLS (Fire Retardant Low Smoke) PVC compound for inner and outer sheath.

Type 1 : 11 kV (UE) XLPE Cables

11 kV (UE) heavy duty power cable, 3-core, with compact circular stranded (rm/V) Aluminium. conductor with extruded conductor shielding of semiconducting 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 sheath, galvanised steel wire armoured and FRLS PVC outer sheath of type ST2 compound as per IS : 7098 (Pt-II)-1973 as ammended upto date. Copper screen shall be suitable to carry 1 kA E/F current for one second.

Type 2 :

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, XLPE insulated type A suitable for 70 deg. C. operation, core stranded together provided with a common covering of FRLS PVC inner sheath of type ST1 PVC compound, galvanised round steel armoured and FRLS PVC outer sheathed of type ST1 PVC compound conforming to IS:1554 (Part-I) - 1976, as ammended upto date.

Type 3 :

1.1kV circular stranded (rm) annealed copper conductor, PVC/XLPE insulated of type A PVC compound suitable for 70 deg.C operation,as per IS:5831 - 1970, cores stranded together provided with a common covering of PVC inner sheath, galvanised steel armoured and overall FRLS PVC sheathed of type ST1 PVC compound and multi-core to IS : 1554 (Part-I) - 1976,

04.11.02 Cable Selection

- In general, cables for LT drives shall be selected as per Annexure-I, however, 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 cable 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 grade cables and top surfaces of ducts) : 75 cm for 1.1kV 90 cm for HT cables

- Horizontal formation axial : 15 cm in case of spacing cables laid directly in ground in a group and approximately touching in case of single way ducts or pipes.

Cables laid in free air/in conduits in free air.

Ambient air temperature : 40 Deg.C & As specified for the respective shops.

Cables laid in ventilated ducts/gallery

Ambient air temperature : 40 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 185 sq mm for motors and 240 sqmm for incomers to MCCs, PCCs etc.

For power supply to moving mechanisms subject to vibrations, flexible copper cables preferably single core should be used. In these cases, a separate core should be provided for earthing. Cables used for circuits of tachogenerators, brakes, solenoids, field windings

and secondary windings of measuring transformers shall be copper conductor with cross-sectional area not less than 2.5 sqmm per core. All control cables shall have copper stranded conductors except for mobile and portable equipment where control cables shall be of flexible type. Copper cables shall be used for all cranes/hoists.

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 minium 40% after the test.

04.11.03 Cable termination & joints

Following type of cable termination and joints shall be used for XLPE cables in indoor and outdoor applications :

1. Tapex type
2. Heat shrinkable type
3. Pre moulded push on type

Tapex type system :

The stress grading material shall be wrapped around the cable core, over lapping the edge of the outer conducting layer. The tape layer shall fuse together to form a compact rubber body around the stress grading material and cable core and thereby excert an active pressure on cable.

Heat Shrinkable type system :

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.

Premoulded Push On type system :

Premoulded refers to moulded Ethylene Propylene Diene monomer rubber components. Sealing between the premoulded push on material and cable surface shall be achieved by semi conducting pad which has cold flow properties.

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.

04.12.02 Erection, installation accessories

All support structures required for cables, busducts and for electrical equiment 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 tenderers scope.

04.12.03 Other Items

- All required safety items like rubber mats in front of LT board, shock treatment chart, Two nos. first aid boxes shall be provided in each electrical premises. Junction boxes, wherever required, shall be provided

04.13 ERECTION SPECIFICATION

04.13.01 Guidelines for design of system and engineering the layout of electrical equipment

General

The tenderer shall prepare the layout drawings taking into consideration the requirement listed below.

Electrical premises

All electrical premises shall have adequate space to accommodate the electrical equipment from the point of view of operation and maintenance, and conform to IE Rules & Regulations.

The clearance between the ceiling of the electrical room and top of the tallest equipment shall not be less than 1m, 2m where the equipment are to be maintained from top and additional height of lifting tackle wherever required.
Air tight door arrangement shall be provided for electrical control rooms.

Cable Installation

Cables will have to be run partly along the structures and columns of the buildings, wherever it is necessary i.e. to a nearby shop cable trench /channel or surface duct shall be provided. Cable channels inside turbine floor shall be avoided.

Installation of cables directly buried in ground shall generally conform to the requirement given in IS: 255.

If the cables are crossing the road/rail track, cables shall be laid in concrete cable ducts, G.I. pipes. 25 % spare conduits/pipes/duct openings shall be provided.

Cables in trenches shall be laid on 8 cm of riddled sand and covered with 8 cm of riddled sand. RCC slabs shall be provided for covering these trenches. The maximum trench depth shall normally be 1.5 m and thickness of top cover of 75 mm. If the trench is to cross railway tracks/roads or any load bearing area the cables shall be taken through suitable GI conduits/pipes/ducts.

Laying in surface ducts / on structures

Cable racks for cable trays shall be fixed at a maximum interval of 1.5 m.

Cables leaving the ground/floor shall be protected upto 2 m height by conduits/metallic guards.

Galvanised prefabricated ladder type cable racks and trays shall be provided to lay cables in shafts/cable basements. Cables shall be laid in separate racks according to the voltage/application classification. The cables shall be laid from top to bottom in order of HT on top rack followed by LT cables and other cables on lower racks.

All necessary frame works and fixings for the support of cables and accessories shall be supplied.

Cables shall be suitably protected against heat, and mechanical damages.

Structures for cable laying

Cables shall be laid on ladder type cable trays. Ladder type cable trays shall be selected from sizes 200 mm, 400 mm & 600 mm and shall be fabricated from 40x40x3.1 mm GI slotted angles for longitudinal members and 25x5 mm perforated flats for cross members placed at an interval of 250 mm along the length of cable tray.
Supporting vertical racks and horizontal hooks shall be of 50x50x6 mm angles.Cable racks and hooks shall be of welded construction.

To avoid damage during cable laying, cable structures shall have no scales, abbrasive or rough surfaces or cutting edges.

Transformer installation

Mineral oil filled transformer shall be installed at transformer yard.

Earthing

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe permissible limits.

Parts of all electrical equipment and machinery not intended to be alive shall have two seperate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules and apparatus rated 240 V and below may have single earth connections.

Earthing mat consisting of earthing electrodes and cross connecting conductor is already provided by the purchaser and tenderer has to connect equipment earthing to the grid. Existing earth pits shall be renovated and rusted materials shall be replaced with equivalent material and bimetal washers shall be provided wherever GI strips shall be connected to existing copper network.

For protective earthing separate conductor shall be used for flow of earth fault current as elaborated below.

The LV side neutrals of the distribution transformers shall be connected to two separate earthing electrodes. They shall also be connected with the neutral bus of the corresponding switchgear and in turn switchgear neutral bus shall be connected to the earthing bus of the switchgear. The protective conductor for connection from switchgear earthing bus to MCCs/DBs and further to motors shall be either through fourth core of cable or armouring of cable. In case of armouring on cable, same shall be double steel wire armouring. The fourth core or 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.

Conductor sizes for earth connections :

High voltage systems - 75 x 5 mm GI flat for :

- Transformers
- Earthing resistors
- Earthing leads to earth electrodes.

LT system where the voltage does not exceed 650V normally :

- 6 Sq.mm Stranded GI wire for :

- Motors and starters upto and including 2.2kW, shunt limit switches, push buttons and master controllers, Light fitting,JBs,PBs, etc.

- Instruments and miscellaneous small items protected by fuses of ratings not exceeding 15A.

- 16 Sq mm Stranded wire for :
  - Motors and starters above 3.7 kW and upto and including 15 kW.

25 x 3 mm GI flat for:

- Motors and starters above 15 kW, and upto and including 45 kW
- Control desks, cabinets, LCB, socket outlet isolators, SLDBs/DBs.

50 x 6 mm GI flat for :

- Motors and starters over 45 kW
- Switchboards, MCC,PDB,PCC MLDB.

50 x 6 mm GI flat (minimum) for :

- Main earthing ring in plant buildings
- LT transformer neutral
- LT Switchboards and other equipment protected by circuit breakers.

Sheet metal enclosed panels control desks and boxes

The base frames of all panels, desks, posts etc., shall be welded to structures or to the civil inserts provided on the floor/walls. Fabrication of supports/frames, wherever required, shall be done by the tenderer.

The shipping section shall be placed in position before removing the protective covering to eliminate scratch/damage. The shipping section shall be moved by using rollers under the shipping skids wherever lifting cranes are not available. The contractor shall do the assembly at site as per manufacturer's general arrangement drawings and installation instruction. While assembling a complete board comprising several unit type cubicles, the board as a whole shall be aligned. The panels shall be properly levelled prior to grouting the holding down bolts or welding the panels to the inserts. All interconnection of busbars and wiring between the panels shall be done as per manufacturer's instructions and drawings. Welding work on the panels shall only be carried out after consultation with the purchaser. Damage to the paint due to welding shall be rectified by the contractor.

Miscellaneous equipment

Cables Installations

Cable shall be fixed to racks or trays or cleats as required for proper support, accessibility and neatness of installation. Cable tags shall be provided at a regular interval of 30M. For cable run shorter than 30M one cable tag shall be provided in the middle. These tags shall be in addition to end cable tags. The cable tags shall be marked with cable number, size and voltage grade. Middle tag shall be indicated with destination. The end tag shall be with second terminal point.

Cables shall be clamped rigidly at an interval of not more than 1500 mm in horizontal,and 1000 mm in vertical & inclined run and at bends.

In the cable galleries, cable structures shall be properly arranged giving sufficient clearance for movement of personnel from one part of the gallery to the other. It shall also be possible to escape easily in case of fire.

Cables laid in over ground structures shall be protected from the direct solar radiation. Road crossing points sufficient clearance shall be provided with due consideration to road

traffic. In outdoor structure cat ladder and walkable platform shall be provided to facilitate cable removal/addition on the cable trays.

Perforated trays shall only be used where necessary for the support of a number of small cables. Each tray shall be firmly supported at suitable intervalsand shall carry the weight of its cables without sagging. Trays shall be painted and where the surfaces or edges are cut or otherwise impaired during erection, they shall be made good by coating with aluminium paint.

Small cables may be bunched together under one saddle provided that in any bunch all cables have sheaths of the same material. The number of cables shall not exceed four wide and two deep.

Not more than one cable shall be drawn into one conduit unless otherwise agreed. After the cable has been drawn in, the conduit shall be sealed by an approved means.

All cables shall be tested for proper insulation before start of laying work.

Cables shall be laid in conduits, racks/trays, cable trenches, along with structures or buildings, as per cable routing drawing and cable list.

Suitable adjustment shall be made in cable routes, if required at site, with a view to avoid any interference with any part of building, structures, equipment, utilities and services with the approval of the purchaser.

While laying cables, care shall be taken that kinks, twists or mechanical damage do not occur to the cable.

All bends in cables shall be made with due consideration to the minimum permissible bending radius of the cables.

On being pulled, the cable shall not be allowed to drag drawing along the ground or over a second cable already laid. Special care shall be taken while pulling through an opening where other cables have already been laid. Only approved cable pulling devices shall be used.

No joints shall normally be made at any intermediate point in through run of cables unless the length of the run is more than the standard drum length. In such cases where jointing is unavoidable, the same shall be made inside proper bases having plastic moulds and shall have moulded epoxy resin construction. Provision shall be made for earthing continuity at the joint. Cable splicing and jointing shall be done in accordance with the relevant IS code of practice and manufacturer's instructions. Insulation resistance of cables shall be checked before cable jointing.

Adequate length of cables shall be pulled inside the switch boards, control panels, control desks, etc. so as to permit neat termination.

All cables shall be neatly dressed without interlocking or cross over. While laying the cable vertically, these shall be clamped at suitable intervals. Horizontal runs shall be rigidly secured to trays on racks/hangers in all the places where the direction of the route changes as well as at cable terminations or joints. The clamps shall not be done up so tight that the insulation is damaged or deformed.

Cable markers shall be provided on either side of road crossing at each turning and at 30 m intervals at straight runs for underground cables.

Where cables are required to cross roads, surface drains and water, oil, gas or other pipe lines, they shall be taken through reinforced spun concrete or steel pipes.

Entry of cables from underground to the buildings or trenches shall be through pipe sleeves. After laying of cables, the sleeves shall be sealed with bitumin or epoxy compound with sand matting and cement plaster to make them fully water tight.