



TECHNICAL QUALIFYING CRITERIA (TQR) FOR VENTILATION SYSTEM

DESCRIPTION OF BHEL REQUIREMENT	TO BE SUPPLIED/ CONFIRMED/ SUBMITTED BY	OFFERED	DEVIATION	REMARKS
The bidder should have designed, supplied, erected and commissioned atleast one number of pressurized ducted ventilation system with centrifugal fans of capacity 50,000 CMH or more. These systems should have been in #successful operation for at least two (2) years prior to the date of techno- commercial bid opening i.e. 08.05.2017. (#) Successful operation means certificate issued by the Customer/ end user certifying the operation without any adverse remark. The following information should be submitted by the vendor about the companies where Ventilation system have been supplied. This is required from all the vendors for qualification of their offer.	Vendor to accept & confirm.			
1. Name of the customer / company alongwith complete postal address where referred ventilation system is commissioned.	Vendor to inform			
2. Month & Year of Commissioning.	Vendor to inform			
3. Detailed Break up of ventilation system supplied including make and capacity etc.	Vendor to inform			
4. Name & designation, Phone and email address of the contact person of the customer.	Vendor to inform			
5. Copy of purchase order and supporting acceptance papers or MOM of commissioning of ventilation system from the customers (clearly indicating type, capacity of main equipment etc.) will be required	Vendor to submit			
6. Letter/ Certificate/ MOM from customer/ end user for satisfactory operation	Vendor to submit			
7. BHEL reserves the right to verify the information provided by vendor. In case the information provided by vendor is found to be false/ incorrect, the offer shall be rejected.	Vendor to accept & confirm			

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TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

TRANSMISSION BUSINESS GROUP

SEC – 142, NOIDA

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अनुभाग / Section	विवरण /Description					पृष्ठ संख्या/ No of Pages									
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SECTION -1

INTENT, SYSTEM DESCRIPTION, DESIGN CRITERIA AND SCOPE

1.0 INTENT OF SPECIFICATION

- 1.1 This specification covers design, manufacture, inspection, testing at bidder's and/ or his sub vendor's work(s), packing, transportation upto port, erection, testing and commissioning, final painting and carrying out acceptance tests at site and guarantee for two (2) years of **Ventilation System** as detailed in this section and in various other sections of this specification for **Gas Insulated Switchyard (GIS) Building, GIS of 2 x 60 MW VYASI Hydro Electric Project, Uttarakhand. Receipt, unloading and storage of all components shall be excluded from bidder's scope.**
- 1.2 The requirement(s) specified under 'SECTION 2, SECTION 3, SECTION 4' and 'SECTION 5' of this specification shall be considered as part of this section. In case of variance between sections, the requirement of Section-1 shall prevail. *UJVN Ltd. contract specification provided as SECTION 2 shall be referred strictly. Requirements of the same regarding system specification & applicable for switchyard part shall be provided by the contractor without any deviation.*
- 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 high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Purchaser/ Customer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance herewith.
- 1.4 The bidder shall be deemed to have understood completely all the tender drawings and documents and quoted accordingly.
- 1.5 The bidder has to note carefully the parameters, estimated capacities of equipment indicated and the tender drawing in the specification are only for guidance of the bidder. The system shall be designed as per relevant standards/ codes and exact capacities and quantities are to be estimated by the bidder. All such estimations and design calculations shall be submitted for Purchaser's approval.
- 1.6 *Deviation:* In case of any deviation, the bidder shall indicate separately the deviations clause-wise with respect to the specification in the 'Schedule of Deviation' given in schedule 1 of section-5. Deviations in any other form including clarifications / assumptions / etc will not be considered and it will be construed that the bid conforms strictly to the specification.
- 1.7 The contract shall be on **Unit Rate Basis** for the package. In case of change in the input after placement of order the additions / deletions to the scope shall be settled on the basis of unit rates agreed between the Purchaser and Contractor.
- 1.8 The Contract shall be on unit rate basis for the quantities furnished by BHEL. Variations (upward/ downward) in quantities during contract stage shall be settled on the basis of unit rates furnished in the bid. However variation in total contract value may vary by $\pm 30\%$.
- 1.9 The Purchaser and Customer in this specification stand for BHEL and UJVN Ltd. respectively. The successful bidder shall be referred to as Contractor.



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2.0 VENTILATION SYSTEM

Minimum size & rating of fans shall be as mentioned in the specification.

a) Ventilation system for 220 kV GIS building

Dry Mechanical ventilation system by adopting centrifugal fans shall be provided for the ventilation of GIS building. Filtered air from centrifugal fans shall be distributed by means of ducting to the GIS buildings near the equipment like GIS etc. The hot air from the hall shall be exhausted by means of gravity operated dampers. The quantity of air exhausted shall be kept lower than the quantity of air supplied in such a way that approximately 3 mm wg positive pressure to be maintained inside the hall. This will reduce infiltration of outside hot and dusty air.

The supply air quantity for each unit shall be supplied from centrifugal fans and filter units. These centrifugal fans shall be located in ventilation fan rooms at EL. 535.

2 Nos. Centrifugal fans (2 x 100%) shall be provided for ventilation of GIS building.

Dimensions of GIS buildings considered for capacity sizing of fans is as below:

Building	Length (m)	Breadth (m)	Height (m)
GIS bldg.	56	15	11

- i) Tentative ventilation duct layout is attached for reference. Duct sizing has not been done and drawing is indicative only for deciding duct routing from AHU room elevation to GIS building elevation. All calculations regarding duct sizing and duct routing to be done by vendor during detailed engineering.
- ii) All equipment shall be designed for continuous duty and shall be located indoor.
- iii) Fire Dampers (Motorized type electrically operated) shall be provided at the duct / Fan opening of the GIS building, wherever required.
- iv) The ducting shall be sized to have constant friction drop along its length with air velocity in the main duct & branch ducts restricted to 10 m/sec and 8 m/sec (max.).

Design Criteria

Ambient Conditions	DB in °C	WB in °C
Summer	40	22.5
Winter	0.3	0
Floor Area	As per GIS Bldg drg.	
Illumination Heat load	2 Watt per sq. ft.	
Equipment heat load	30 kW	
Occupancy	6 people	

3.0 LAYOUT CONSIDERATIONS

- 3.0.1. Two (2) nos. supply air centrifugal fans on 2 x 100 % basis (One working and one standby) shall be provided for GIS building.



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3.0.2. This ventilation system shall also have GSS intake louvers with wire mesh, frame and bird protection screen and HDPE filters of min. 90% arrestance down to 10 micron. The hot air from the hall shall be exhausted by means of gravity operated dampers.

3.1 EQUIPMENT AND SERVICES TO BE PROVIDED FOR VENTILATION SYSTEM

3.1.1. DRY MECHANICAL VENTILATION THROUGH CENTRIFUGAL FANS

(2) nos. supply air centrifugal fans each of 51000 CMH on 2 x 100% (1 no. working and 1 no. standby) basis for the collective requirement of GIS building. It shall also have GSS intake louvers with wire mesh, frame and bird protection screen and HDPE filters of min. 90% arrestance down to 10 micron. These fans shall be housed in ventilation fan room at EL535 shown in power house drawing.

There shall be 18 gauge G.I. common plenum chamber after Centrifugal fans provided with necessary maintenance windows, water tube manometer across air filter, one pressure switch and pilot light on panel to indicate dirty condition of filter for the ventilation system of GIS bldg.

These filters shall be arranged in a panel formation with filter module mounting frame on the downstream side. Supply air shall be taken from plenum chamber to GIS building located at EL.544 through duct which shall run along the length of the GIS Hall with necessary grilles/ diffusers. Motorized & CBRI certified Fire damper shall be installed in supply air path. No exhaust ducting is envisaged in this area. Spring actuated counter weight operated Pressure relief damper with frame & bird screen shall be provided in GIS hall to release excessive pressure inside the hall beyond design over pressure.

There shall be requirement of approximately 3 mm WG positive pressure to be maintained inside the GIS hall.

3.1.2. CENTRIFUGAL FLOW FAN UNITS

Each centrifugal fan shall be complete with:

- Fan impeller (backward curved) with casing & supports.
- Electric drive motor.
- Drive Pulleys, V-belt, belt guards, slide rails etc.
- Dampers and flexible connection with matching flanges.
- Vibration isolators, foundation bolts and nuts.
- Removable drain plug with fan casing.
- Fans shall have a minimum AMCA Class II rating.

3.1.3. SUPPLY / EXHAUST AIR DUCTING

Air distribution from centrifugal fans would be done through ducting system, grilles and diffusers. Ducting shall be fabricated from Galvanized steel sheet (GSS). GSS duct shall be zinc coated conforming to IS 277 coating grade atleast 180. Duct sizing and fabrication shall comply with requirements of IS 655/ ASHRAE/SMACNA. Duct sizing shall be done in a way to ensure air velocity in the main duct & branch ducts restricted to 10 m/sec and 8 m/sec (max.). Flexible connections



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should be provided between fan and ductwork to prevent the noise of fan vibration being transmitted directly to the sheet-metal ducts. The size of the air ducts shall be worked out from the permissible air velocities recommended in the relevant standards/codes in practice.

The diffuser / grills shall be of powder coated MS construction for ventilation system.

Volume control dampers, guide vane, splitter dampers.

Supports and hangers including anchor bolts as required.

Manually adjustable/back draft type/Gravity type/spring actuated exhaust air dampers.

All exposed duct work to the outside shall be provided with Thermal insulation.

Ducts inside GIS hall shall be carried by MC channel, structural angles, hanging in rods with adjustable nuts, MC channel shall be bolted/ anchored to the coloumn face. Maximum allowable distance between duct supports is 1500 mm.

The sheet thickness shall not be below the thickness indicated in the following table, the thickness depending on the length of the longer side of the duct:

From 150 mm to 500 mm	0.63 mm
From 501 mm to 750 mm	0.80 mm
From 751 mm to 1000 mm	0.80 mm
From 1001 mm to 1250 mm	1.00 mm
Over 1250mm	1.25 mm

4.0 SPECIFIC REQUIREMENTS:-

- 4.1 The system shall be designed to maintain specified inside design conditions.
- 4.2 All ventilation system shall operate on 100% fresh air.
- 4.3 Duct portions exposed to the ambient shall be insulated properly.
- 4.4 Ventilation ducts shall be provided with motorized type fire dampers at the supply duct in both GIS buildings which will close in case of fire. Fire Damper shall have fire rating minimum 90 minutes.
- 4.5 The fire damper shall close the air flow inside the duct on receiving fire alarm signal from Fire Detection System. Also respective fan shall trip once the fire damper is closed.

5.0 CENTRIFUGAL FAN

Forward-curved fans

Shall have one double width double inlet (DWDI) fan wheel and scroll. They shall be constructed of heavy gage galvanized steel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have a minimum AMCA Class II rating.

Airfoil fan sections

These sections shall have one DWDI airfoil fan wheel and scroll. Airfoil blades shall be double thickness design. They shall be painted with zinc chromate primer and enamel paint. Fans shall have a minimum AMCA Class II rating.

Fan wheels

Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum



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rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical, and shall be statically and dynamically balanced as an assembly.

Fan shafts

Fan shafts shall be solid steel, turned, ground, polished and coated with rust preventative oil.

Fan motor

Fan motor shall be mounted within the fan section casing on slide rails equipped with two adjusting screws. Motor shall be of high efficiency, open drip-proof or totally enclosed fan cooled NEMA Design B with size and electrical characteristics as shown on the equipment schedule.

Premium efficiency motors shall be available. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All motors shall have 10% voltage utilization range and a 1.15 minimum service factor. Motor shall be compliant with EPACT where applicable.

Fan performance shall be rated and certified in accordance with ARI standard 430.

Mounting

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly which shall be isolated from the outer casing with factory-installed 50 mm. deflection spring isolators and vibration absorbent fan discharge seal. The isolation system shall be designed to conform to seismic zone 5 requirements.

Fan Accessories

Forward curved fans — Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Airfoil fans — Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Plenum fans:

Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Rotor/Fan guard package shall be available as required.

5.1 Air Filters

PRE FILTER

The filter banks shall be composed of panels not bigger than 500 x 500 mm, which can be easily removed by hand. They shall be designed taking care of the recommended velocity of the air passing through an area as per relevant standards/codes in practice. The filters shall be of the viscous impingement type, cleanable, aluminium wire mesh coated with viscous substance such as filter oil or grease. Separation degree may be similar to EU4 (rough air filter), according to EUROVENT or DIN 24185 standards.

The frame structure of the panel cells shall be made of aluminium sections.

A properly positioned pressure gauge of the inclined tube type shall give an indication of the degree of dust loading on the filters for establishing the periods between services.



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Allowable pressure drop: Initial pressure drop – Not to exceed 5.0 mm WC at rated flow. Final pressure drops - Up to 7.5 mm WC. Frame Work - 18 G GSS.

FINE FILTER

Filter Media: Synthetic non-woven for fresh air pressurization (MCC).

- Efficiency: Average arrestance of 80-90% when tested in accordance with BS: 6540 / ASHRAE – 52-76.
- Allowable pressure drop: For HDPE (SNW) - 6 mm WG during clean condition & 12 mm WG during dirty condition.
- Frame Work: 18 G GSS.
- Size -610 x 610 mm (Approx.)
- The filter media shall be of High Density Polyethylene (HDPE) or equivalent.
- The filter media shall be sandwiched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.
- The filter shall have G.I. frames of adequate thickness suitable for long use in an industrial plant.

6.0 ACCEPTANCE TEST

The following measurements are to be done prior to the acceptance of the plant by the client:

- a. Air Quantity measurement to be taken at the Inlet Louver to establish the Equipment capacity in line with the specification requirement.
 - b. Power consumption to be measured for each equipment.
 - c. Measurement of Noise and Vibration for different Equipment.
- Painting of all equipment and structures shall be provided and the colour & quality shall be subject to approval by the Client / Engineer.

7.0 ELECTRICAL REQUIREMENTS

- a. One (1) no. Power distribution board (PDB) for ventilation system of GIS building shall be provided. This PDB shall extend power supplies to centrifugal fan. Two nos. incomers of adequate capacity shall be provided from the ACDB and the same will be terminated in Ventilation system PDB with an electrical changeover switch.
- b. PDB shall be suitable for starting of the ventilation fans. Feeders for working & standby fans in the PDB shall be provided with a timer & switching device that will enable interchange of working & standby fans through switching after periodic time interval.
- c. PDB shall have all provisions for control & monitoring of ventilation system through PLC/ SCADA panel located in control room of main power house.
- d. Interlocking of PDB shall be done with Fire alarm panel to trip Ventilation system in case of fire. Also for control and annunciation of vital signals for ventilation system PDB shall have provisions for interface of with PLC system, additional list of such signals shall be decided during detailed engineering stage.



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- e. 20% spare feeders or min 1 no. spare feeder shall be provided for each type, size/rating of feeder in the PDB.
- f. Refer Switchgear specification in Annexure – II to Section 2. PDB shall be of draw out type and shall comply to this specification.

8.0 MANDATORY SPARES & SPECIAL TOOLS

8.1. Following mandatory spares shall be provided:

S. N.	Item	Qty
1.	Pre-Filters	2 Sets
2.	Fine Filters	2 Sets
2.	V- belts of each type and size	4 Sets
	For Panel	
1.	MCCB each type used	2 nos.
2.	Current Transformer of each type used	3 nos.
3.	Supporting Insulator of each type used (if applicable)	6 nos.
4.	Indication lamps used including assemblies	10 nos. of each type
5.	Fuses of all type used (if applicable)	10 nos. of each type
6.	Control and instrumentation switches	3 nos. of each type
7.	Contactors of each type used	4 nos. of each type
8.	Indicating instruments (if applicable)	2 nos. of each type
9.	Under voltage relays (if applicable)	2 nos.
10.	Over current and E/F relays (if applicable)	2 nos.

8.2. Special Tools

Following tools and maintenance equipment shall be provided for repair and maintenance of ventilation system.

S. N.	Item	Qty
1	RING SPANNER - 6 MM TO 32 MM (12 Pcs)	1 Set
2	OFFSET SCREW DRIVER	1 No.
3	LOCK WITH KEY FOR TOOL BOX	1 No.
4	MS TOOL BOX	1 No.
5	BOX WRENCHES - 6 MM TO 22 MM (14 Pcs)	1 Set
6	FLAT D WRENCH - 6 MM TO 32 MM (12 Pcs)	1 Set
7	ALLEN KEYS - 2 MM TO 10 MM	1 No.
8	CRESCENT SCREW SPANNER	1 No.
9	SCREW DRIVER	1 No.



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10	INSULATED PLIER	1 No.
11	TORCH LIGHT (SUITABLE FOR 2 CELL)	1 No.
12	HAMMER 1 LB	1 No.
13	OIL CAN	1 No.
14	RATCHET 1/4"	1 No.

8.3. General Spare Parts

Following tools and maintenance equipment shall be provided for repair and maintenance of ventilation system.

S. N.	Item	Qty
1	Ball Bearings	1 Set
2	Bearing Bushings	2 Sets
3	Wearing parts of couplings (if applicable)	2 Sets

*In addition to above spares, bidder to provide a list of applicable general spare parts as per clause 3.1.1 of Annexure-III to Section-2 along with their bid that will be considered for bid evaluation.

**List of Recommended spare parts shall be provided as per clause 3.1.3 of Annexure-III to Section-2 of this TS.

9.0 CODES & STANDARD

The design, manufacture, inspection and testing of Ventilation system shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian/ British/American standards.

The equipment shall conform to the latest edition to the following standards:

IS: 655 - Specification of metal Air-Ducts

IS: 4999 (Part-51) - Noise Level

IS: 4671 - Expanded polystyrene for Thermal Insulation purpose



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10.0 GENERAL (SCOPE AND OTHER)

- 10.1 Basis of design, all calculations, 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.
- 10.2 Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.
- 10.3 All drawings and documents shall be computer based.
- 10.4 All commissioning spares & consumables for trouble free operation shall be provided.
- 10.5 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.
- 10.6 Inserts or any support arrangement for fixing ducting, fans etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.
- 10.7 Fixing frame works for diffusers and grilles in the scope of Vendor.
- 10.8 Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.
- 10.9 Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipments etc. is deemed to be included in the scope of Vendor in the ducting items listed in BOQ.
- 10.10 Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.
- 10.11 The tools and machine required for erection of equipment shall be arranged by Vendor.
- 10.12 Tools & tackles as required for regular maintenance and General Spare parts shall be supplied by Vendor.
- 10.13 Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.
- 10.14 Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.
- 10.15 Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.
- 10.16 Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.
- 10.17 The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system.
 - a. Design Auxiliary power consumption, Vibration and noise level etc.
 - b. Performance test of the ventilation system shall be carried out at site after proper installation. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.



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- c. All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provide free of cost which are categorically listed in the Electrical scope sheet of technical specification.
- 10.18 For Ventilation system, Motorized fire damper will be installed at supply air duct. Fire damper will close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Also respective centrifugal fans/ ventilation systems shall trip on receiving fire signal from fire protection system
- 10.19 For motorized fire damper, power supply shall be derived by vendor from respective control panels. BHEL will not provide any feeder for fire damper / 3 Way/ Motorized valve. Suitable transformer shall be provided by bidder (if required) to derive the power input.
- 10.20 Feeder for a combination of fire damper etc. shall be derived from respective control panel by vendor. Distribution through junction box/ distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.
- 10.21 Tender drawings enclosed form the part of specification and the bidder shall check the space requirements.
- 10.22 *Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to PLC/ DCS panel shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the technical specification.*
- 10.23 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.
- 10.24 Quality requirements in the Technical specification are minimum requirements for inspection and testing. Vendor to note that quality plans are subject to Customer approval during detail engineering stage.
- 10.25 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.
- 10.26 Sealing of duct opening, grouting of foundation, foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of vendor.
- 10.27 Flat, platform type RCC / PCC foundation shall be provided for installing fan etc. (customer Scope) Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.



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- 10.28 Supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.
- 10.29 Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.
- 10.30 All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.
- 10.31 The bidder's proposal shall be for equipment in accordance with the tech. Specification.
- 10.32 The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification.
- 10.33 Final coat of paint on all the equipment's / item covered under the package shall be done at the time of handing over of package
- 10.34 Consumables and lubricants shall be in bidder's scope.

11.0 SCOPE OF SUPPLY & SERVICES

11.1 The Bidder shall take a note of the following while preparing his offer:

- a) Supply of power & control cables have been excluded from contractor's scope of supply. Bidders shall submit the requirement of power & control cables (cable size, type & quantity) for Ventilation system alongwith their respective bids. BHEL will provide power & control cables to the vendor as free issue item. Contractor shall have to choose their cables from the available sizes as listed in Annexure – I to Section-1 and necessary modifications in their equipment for termination of these cables shall be made by contractor.
- b) Purchaser will lay two incomer cables upto contractor's PDB in each of the buildings. Termination of the same shall be done by the contractor. Cabling (laying & termination) further to other equipments, panels etc and for control & interlocking of various equipments shall be in contractor's scope.
- c) Necessary cable trays will be supplied on free issue basis to the contractor, however necessary hardware for fixing the same on walls or elsewhere shall be included by the bidders in their offers.
- d) Earthing material viz. GS flat will also be supplied on free issue basis to contractor; however requirement shall be given by the bidders in their respective bids.
- e) Contractor shall submit valid Type test report for approval by Customer. Fresh type test of equipment is not envisaged. It is presumed that equipment offered is duly type tested.
- f) In case the type test reports are found un-satisfactory, tests shall be carried out afresh by contractor without any additional cost implication to BHEL.
- g) Bidder shall provide makes for all items for this system as per the makelist provided in Annexure II to this specification. All such makes shall be subjected to acceptance of UJVN Ltd. during detailed engineering stage. No additional price implication shall be made to BHEL on account of non-acceptance of proposed makes by UJVN Ltd..
- h) Bidder shall submit quality plan of the items of this system during detailed engineering stage in standard quality plan format provided with this specification.



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- i) Obtaining, "As Built" certification from purchaser or Customer on applicable drawings. Completing documentation as per specification requirement shall be in contractor scope of services.

11.2 Erection, Testing & Commissioning (ETC) requirements

- i. The scope of ETC shall include handling of equipment/material at site, erection of equipment /material at site including fabrication, equipment and system testing, commissioning of the entire system. All material, consumables plus tools & tackles required for completion of ETC work shall be arranged by the bidder.
- ii. Conducting performance guarantee tests to the satisfaction of Customer / Purchaser and handing over of the system to Customer / Purchaser. Bidder shall submit the PG test procedure at the time of detailed engineering for approval by customer/ purchaser.
- iii. It is the responsibility of the Bidder to maintain the system till it is handed over to customer / Purchaser.
- iv. Cables laying for incomers to the Power distribution board (PDB) shall be done by the purchaser. The contractor has to lay and terminate all the other power and control cables supplied under the present scope.
- v. Earthing of all installation under the present scope shall be done by the contractor.
- vi. Cable laying & termination between Fire Alarm Panel (FAP) & PDB for Ventilation system in order to switch off the system in case of fire.
- vii. Painting of all the equipments shall be as per customer specification.
- viii. After completion of erection and commissioning of the system, the bidder shall train site engineers of Purchaser/Customer so that they are fully conversant with both electrical and mechanical part of this package.

11.3 Civil Works

Major civil works such as room & foundations for various ventilation equipments, wall openings for duct and PRDs shall be in purchaser's scope. However following shall be in contractor scope of services:

- a. Associated civil works such as grouting, filling up crevices/cut outs etc during installations of equipments shall be in contractor's scope. Any other damage caused to civil works during ETC work of the equipment/system shall be made good to the original finish by the contractor at no extra cost to the purchaser.
- b. Angle supports, M.C. channel etc for supporting of duct.
- c. Furnishing of details for construction of outdoor unit's mounting arrangement.
- d. Providing necessary guidance to/ coordination with civil contractor so that appropriate sized / correctly located cut outs are made (by civil contractor) for installation of grilles / diffusers / return air.

However in case wall openings / cut outs have not been provided for either duct laying, louver fixing, ventilation fan(s) or fresh air fan, the same shall have to be made by the Contractor.



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- e. Minor modifications, alterations in system installation as per customer's specific requirements shall be done without any extra cost to purchaser.

11.4 Exclusions

- i. Receipt of material, Unloading and safe storage of all material/components.
- ii. Supply of Cable trays for laying cables. Installation wherever required is in contractor scope.
- iii. Supply of power and control cables. The bidder shall chose from the BHEL procured cables listed in Annexure-I to this section & furnish quantity and type of cables required complete system in their respective bids. Laying & termination is in contractor scope.
- iv. Various rooms and foundations for locating ventilation equipments.
- v. Supply of GI flat for earthing of equipments.

11.5 OPERATION & MAINTENANCE (O&M) MANUAL

Operation and Maintenance manuals shall be specifically complied for the project by the bidders. The draft O&M manual shall be submitted along with supply of the various items. The O&M manual shall contain the following information:

- a. Description of the system and equipment with design particulars.
- b. Instruction for erection.
- c. Instruction for operation, maintenance and repair.
- d. Recommended inspection practices and inspection schedule.
- e. Ordering information for all replaceable parts.
- f. Recommendation for type of lubricants and frequency of lubrication.

11.6 Handing & Taking Over

It is the responsibility of the contractor to maintain the system till it is handed over. The system/equipment before being handed over shall be subjected to successful run test for a minimum period of one week during which all readings shall be taken and recorded. Any defect noted during the period shall be rectified by the contractor. This running test shall be in addition to the performance tests specified earlier.

11.7 Inspection & Testing

All the equipments shall be inspected prior to dispatch in line with relevant standards, approved GTP/ drawing, technical specification & BHEL/ customer approved QAP.

The contractor shall submit various drawings & documents for Customers /Purchaser's approval after award of contract as mentioned in section 4. Drawing/ document no. shall be chosen from this document list furnished in Sec-4.

12.0 Various Heads to be quoted for

Based on the above input it is recommended that the bidders shall submit their UNIT RATE offers in the prescribed format only as given below:



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TABLE-I

Sl. No.	Item Description	Unit	Qty.	Supply (Ex-works)		ETC	
				Unit Rate	Total Amt.	Unit Rate	Total Amt.
A	VENTILATION SYSTEM – 220 KV GIS BUILDING						
i	Centrifugal fan with Motor – 51,000 CMH capacity	Nos.	2				
ii	Ducting fabricated from GSS having zinc coating complete with hangers, supports, joints/ washers.	Lot	1				
a	24 G	Sq. Mt.	20				
b	22 G	Sq. Mt.	100				
c	20 G	Sq. Mt.	350				
d	18 G	Sq. Mt.	20				
iii	Supply air grill with VCD	Nos.	25				
iv	Fire damper	Sq.Mt	8				
v	Actuator for Fire Damper	Nos.	2				
vi	Pressure relief damper	Nos.	4				
vii	Power Distribution board	No.	1				
B	MANDATORY SPARES (As per Cl. No. 8.1) [Individual Unit rates for each spare to be furnished in BOQ]	Lot	1			NA	
C.	Special Tools as per (As per Cl. No. 8.2)	Set	1			NA	
D.	General Spare Parts as per clause (As per Cl. No. 8.3)	Set	1			NA	

NOTE:

- a. Unit rate for each of the mandatory spare item listed under Cl. no. 8.1 of this section shall be provided by the bidder as a part of this aforesaid BOQ.
- b. The Bill of Quantities shall be read in conjunction with the Instructions to Bidders, General and Special Conditions of Contract, Technical Specifications, and Drawings.
- c. The quantities given in the Bill of Quantities are estimated and provisional, and are given to provide a common basis for bidding. The exact quantity of each items shall be finalized during detailed engineering.
- d. A rate or price shall be entered against each item in the priced Bill of Quantities. The cost of Items against which the Contractor has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities.



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- e. *The whole cost of complying with the provisions of the Contract shall be included in the Items provided in the priced Bill of Quantities, and where no Items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.*
- f. General directions and descriptions of work and materials are not necessarily repeated nor summarized in the Bill of Quantities. References to the relevant sections of the Contract documentation shall be made before entering prices against each item in the priced Bill of Quantities.
- Miscellaneous items like hardware, fixtures etc. shall be deemed to be included under the relevant BOQ items and bidders shall consider the same while quoting for BOQ items.



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ANNEXURE - I**LIST OF THE CABLES PROCURED BY BHEL**

2C x 2.5 sq mm PVC/Copper, Unarmoured
4C x 6 sq mm PVC/Copper, Unarmoured
4C x 4 sq mm PVC/Copper, Unarmoured
5C x 2.5 sq mm PVC/Copper, Unarmoured
7C x 2.5 sq mm PVC/Copper, Unarmoured
19C x 2.5 sq mm PVC/Copper, Unarmoured
12C x 2.5 sq mm PVC/Copper, Unarmoured
4C x 16 sqmm XLPE/Aluminium, Armoured
3.5C x 35 sqmm XLPE/Aluminium, Armoured
3.5C x 70 sqmm XLPE/Aluminium, Armoured
1C x 150 sqmm XLPE/Aluminium, Armoured



PROJECT ; 2X 60MW VYASI HEP
VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

SL No	ITEM	VENDOR
2	CENTRIFUGAL FAN	FLAKT
		KRUGER
		DRAFT AIR
		HYDERABAD POLLUTION CONTROL
		ADVANCE VENTILATION
		PATEL AIR
		NICOTRA
		SK SYSTEM
		MARATHON
		CB DOCTOR
		SARLA
		Comefri
3	FRESH AIR/ SUPPLY/ EXHAUST/ RE UNIT FANS / PROPELLAR	HYDERABAD POLLUTION CONTROL
		SK SYSTEM
		ADVANCE VENTILATION
		KRUGER
		NICOTRA
		MARATHON
		FLAKT
		CB DOCTOR
		SARLA (SITAL)
		PATEL AIR
		KHAITAN

		PROJECT ; 2X 60MW VYASI HEP VENTILATION SYSTEM LIST OF MAKES OF SUB-VENDOR ITEMS	
5	LV MOTORS (FLAME PROOF)	SIEMENS	
		ABB	
		CGL	
		MARATHON	
		KEC	
		BHARAT BIJLEE	
		BHARAT ELECTRIC	
		NGEF	
		JYOTI	
		LHP	
6	LV MOTORS (NON FLAME PROOF)	SIEMENS	
		ABB	
		CGL	
		MARATHON	
		KEC	
		BHARAT BIJLEE	
		BHARAT ELECTRIC	
		NGEF	
		JYOTI	
		LHP	
7	AIR FILTER	PUROLATOR	
		FMI	
		ANFILCO	
		TENACITY	
		JOHN FOWLER	
		SPECTRUM	
		AIR TECH	
		PUROMATIC	
8	INSULTATION MATERIAL	BEARDSHEL	
		K-FLEX	
		PARAMONT	
		ARMAFLEX	
		SUPREME	

PROJECT ; 2X 60MW VYASI HEP
VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

		LLOYDS
		UP TWIGA
		AEROCELL
9	FIRE DAMPER	TSC
		CARRYAIRE
		RAVISTAR (SYSTEM AIR)



PROJECT ; 2X 60MW VYASI HEP
VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

15	Pipes (MS/GI) - ERW	SURYA ROSHNI
		TISCO
15	Pipes (MS/GI) - ERW	DADU PIPES
		INDUS TUBES
		WELSPUN
		TATA
		BST
		JINDAL
		SAIL
		PSL
		LALIT PROFILE
		SAMSHI PIPE INDUSTRIES
		S MUKUT PIPES
		MANN INDUSTRIES
		SURENDRA ENGINEERING
		PRATIBHA PIPES AND STRUCTURES PVT LTD
		JCO GAS PIPES
		NUKAT TANK AND VESSELS
		GOODLUCK TUBES
		ADVANCE STEEL TUBES
		BIHAR TUBES
		HITECH PIPES
		RATNAMANI
		MAHARASHTRA SEAMLESS
16	GI SHEETS FOR DUCTING	TISCO
		INDIAN IRON & STEEL CO
		RASHTRIYA ISPAT NIGAM LIMITED
		ESSAR
		ISPAT INDUSTRIES



**PROJECT ; 2X 60MW VYASI HEP
VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS**

		JSW
		LLOYDS
		Bhushan steels
		TATA
		SAIL
		JINDAL
17	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW
		TSC
		AIR MASTER
		CARRYAIRE
		RAVISTAR (SYSTEM AIR)
20	LOCAL CONTROL PANEL	INDUSTRIAL CONTROL & APPLIANCE
		Pyrotech Electronics Pvt. Ltd.
		Positronics Pvt. Ltd.
		CONTROL & SWITCHGEAR
		SIEMENS
		L&T
		GE POWER
		RITTAL
		HOFFMAN



PROJECT ; 2X 60MW VYASI HEP
VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

NOTES:

1. *Designed by Hyderabad Pollution Control / SK SYSTEM/ ADVANCE VENTILATION / DRAFT AIR/BLUE STAR/ VOLTAS/ STERLING WILSON/ROOTS COOLING SYSTEM/ C DOCTOR/ TAP/ Pack Plast/ Industrial projects and products & fabricated by their approved fabricator.
2. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.
3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.



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**SECTION-2
CUSTOMER SPECIFICATION**

Customer contract document is enclosed as part of this specification. Only equipment specification pertaining to section -1 shall be referred. Regarding quantities and type of Ventilation equipment, section-1 shall be referred. In case of variance between section-1 and section-2, the requirement of Section-1 shall prevail. Customer specification in annexure to section-2 shall be adhered to by the bidder.

22. HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS**22.1. Scope of Work**

Scope of work under this section covers the provision of labour , tools , plants, material and performance of work necessary for the detailed design and engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, transportation, delivery at site, site storage and preservation, erection, testing and commissioning, performance testing, field acceptance testing, training of the Employers personnel, handing over to the Employer and guarantee for two years, of the ventilation systems complete with all accessories and necessary components for making the equipment and the system complete and for warranting a trouble-free and safe operation.

The scope of work shall be a comprehensive functional system covering all supplies and services including but not limited to the following:

22.1.1. Detailed Scope of Supply

- Two (2) air-handling units AHU-1 and AHU-2 for mechanical area each of 100% of required capacity.
- Air duct distribution system for supply and return air of entire air handling and ventilation systems, with necessary galvanized sheet metal ducts (complete plastic ducts, grills etc.), elbows, tees, supports, fixations, including all necessary grills, louvers, outside air louvers, adjusting duct dampers, motorized air dampers, heating and cooling insulations, etc.
- Central control panel for HVAC system complete with all wiring instrumentation and associated accessories etc.
- Local control panels for air handling units, water cooled chilling units, circulation/ cooling water pumps, strainer, exhaust fans etc.

- Necessary pressure, temperature, flow/ humidity, sensing devices/ instruments, meters etc.
- Provision of necessary contacts and/ or ports for integration with plant SCADA system through local control board of common services.
- Items not specified above, but are necessary for satisfactory operation of air conditioning and ventilation systems.
- All specified devices, tools maintenance equipment etc. required for installation, testing, commissioning and maintenance of the air conditioning and ventilation systems.
- Spares.

The quantities of equipment / units mentioned in clause 22.1.1 above are tentative only. The actual quantities may need to be examined and reviewed and shall have to be got approved from the Employer during detailed engineering.

22.3. Basic Dimensions and Ratings

The system design shall be based on criteria, factors, and details recommended or indicated in the ASHRAE handbook.

22.3.1. Indoor Air Conditioners

Rooms as control room, computer room and relay room etc. shall be maintained at temperature of $24^{\circ}\text{C} \pm 1^{\circ}\text{C}$ at relative humidity of $50 \pm 5\%$. During the winter season when the ambient temperature is below 24°C , heating requirement in the control rooms and offices shall be met with the combination of duct heaters and base board heaters. The use of Class I ozone-depleting chemicals including all chlorofluorocarbons, halons, or their mixtures are prohibited.

The HVAC systems shall be designed and erected to guarantee the room conditions according to the design requirements. The internal heat production from electrical and mechanical equipments shall be calculated and submitted by the Contractor. Final calculation depends on the design data of individual manufacturer's equipment.

22.3.2. Air Changes per Hour

For all ventilated and air conditioned rooms, the air changes shall be as per relevant ASHRAE / IEC / IS to provide the desired heat relief and maintain a minimum level of fresh air in the powerhouse. All ventilated and air conditioned area shall be designed to maintain a positive pressure within the powerhouse.

22.3.3. Noise Levels

The noise levels caused by operation of the ventilation and air conditioning systems shall not exceed 55 dB (A) in rooms as in the control rooms, offices, & reception room.

Silencer, as required, shall be provided to guarantee the above sound levels.

22.3.4. Maximum Air Velocities

In main ducts	Maximum 10m/sec
In branch ducts	Maximum 8m/sec
Ducts in the occupied room zones	Maximum 2m/sec

22.3.5. Standards and Codes

All works shall be performed in accordance with the most advanced practice in engineering for each class of equipment and completed in a workmanlike manner following the best modern practice in the manufacture of high-grade equipment. The standards under which the equipment is to be designed, constructed, erected and tested shall be the following:

Indian Standards	IS
International Standard Organization (for machine work tolerances)	ISO
Deutsche Industries-Norm	DIN
American Society for Testing and Material for material	ASTM
International Electro technical Commission (for electric installation)	IEC
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE
Air Moving and Conditioning Association	AMCA
American Society of Refrigerating Engineers	ASRE

22.4. Performance Criteria and Guarantee

The ventilation and air conditioning systems along with all its accessories shall be capable of performing all intended duties and it is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars.

22.5. Design and Construction

22.5.1. Air Handling Units

22.5.1.1. General Description

Unit shall be central station air handler. It shall consist of a fan with the following factory-installed components as indicated on the equipment schedule:

- Heating coil section with Electric coil
- Access and Plenum Section.
- Filter Section
- Mixing box section
- Face and bypass damper sections for
- Exhaust section.
- Multi zone damper section
- Air mixer section
- Return fan section

Units shall be shipped in the number of sections necessary to meet project requirements. All sections shall be flanged and gasketed to allow easy assembly and disassembly.

22.5.1.2. Casing

22.5.1.2.1. Construction

All unit sections shall be supplied with 12-gage G90 galvanized steel structural support rails. Perimeter 10 gage lifting lugs for overhead

rigging shall be provided on each section. Slings of units in lieu of lifting lugs is not acceptable.

Exterior panels (top, sides, and bottom) shall be constructed of G90 galvanized steel, with pre-painted, baked enamel finish. These panels shall be capable of withstanding a 500-hour salt spray test per ASTM Standard B-117.

Interior panels (double wall option) shall be 20-gage G90 galvanized steel.

Casing panels shall be removable for easy access to unit. All panels shall be gasketed to ensure a tight seal.

Fan supports, structural members, panels, or flooring shall not be welded, unless aluminium, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.

Each component section shall have mating flanges for assembly. The flange shall extend around the complete perimeter of each section. Fasteners shall be located no further than 12 in. on centre. The manufacturer shall install closed cell gasket for full perimeter coverage.

The fan section shall have a G90 galvanized steel floor of sufficient size to enable field personnel to service or adjust the motor and drive without damaging the insulation. A double-wall hinged access door shall be provided on both sides of the fan section.

All coil sections shall be constructed of insulated, double-wall, galvanized steel panels. Coil sections shall have coil tracks to facilitate coil removal. Blow-thru coil sections shall have a diffuser plate as an integral part of the coil section if used immediately downstream of the fan section.

Filter sections shall be designed and constructed to house the specific type of filter approved during detail engineering. A double-walled hinged access door shall be provided on both sides of the section.

All mixing boxes and filter-mixing boxes shall have a double-wall hinged access door as specified. Filter-mixing boxes shall have doors on both sides of component. Mixing boxes shall have floors of G90 galvanized steel to protect insulation.

Access sections shall have a double-wall hinged access door on both sides of component. Sections shall have floors of G90 galvanized steel to protect insulation.

22.5.1.2.2. Insulation

Each section shall be factory insulated. Insulation shall have full coverage waterproof adhesive to firmly secure the material to the unit casing. Insulation shall meet the erosion requirements of UL 181. Insulation and insulation adhesive shall comply with NFPA 90A requirements for flame spread and smoke generation.

22.5.1.2.3. Access Doors:

Access doors shall be of double wall construction. Hinge pins shall be non-removable to avoid loss. Use of "drop-in" hinge pins is not acceptable. Sufficient handles shall be provided to assure positive closure. Doors shall be gasketed and shall open outward for negative pressure sections and inward for positive pressure sections. Doors shall be provided on both sides of all access, fan and filter sections. All fan and access sections must have handles on inside and outside of door in compliance with OSHA requirements for confined space access.

22.5.1.3. Fans**22.5.1.3.1. General****Forward-curved fans**

Shall have one double width double inlet (DWDI) fan wheel and scroll. They shall be constructed of heavy gage galvanized steel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have a minimum AMCA Class II rating.

Airfoil fan sections

These sections shall have one DWDI airfoil fan wheel and scroll. Airfoil blades shall be double thickness design. They shall be painted with zinc chromate primer and enamel paint. Fans shall have a minimum AMCA Class II rating.

Plenum fan sections

These sections shall have one single width single inlet (SWSI) airfoil fan wheel. Airfoil blades shall be double thickness design. Wheels shall be painted with zinc chromate primer and enamel paint. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have a minimum AMCA Class II rating.

Fan wheels

Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical, and shall be statically and dynamically balanced as an assembly.

Fan shafts

Fan shafts shall be solid steel, turned, ground, polished and coated with rust preventative oil.

Fan motor

Fan motor shall be mounted within the fan section casing on slide rails equipped with two adjusting screws. Motor shall be of high efficiency, open drip-proof or totally enclosed fan cooled NEMA Design B with size and electrical characteristics as shown on the equipment schedule. Premium efficiency motors shall be available. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All motors shall have a $\pm 10\%$ voltage utilization range and a 1.15 minimum service factor. Motor shall be compliant with EPACT where applicable.

22.5.1.3.2. Performance Ratings

Fan performance shall be rated and certified in accordance with ARI Standard 430.

22.5.1.3.3. Sound Ratings

Manufacturer shall furnish first through eighth octave sound power for fan discharge and casing radiated sound.

22.5.1.3.4. Mounting

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly which shall be isolated from the outer casing with factory-installed 50 mm. deflection spring isolators and vibration absorbent fan discharge seal. The isolation system shall be designed to conform to seismic zone 5 requirements.

22.5.1.3.5. Fan Accessories

Forward curved fans — Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Airfoil fans — Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Plenum fans:

Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Rotor/Fan guard package shall be available as required.

22.5.1.3.7. Filter Sections

Flat filter sections shall accept 1-in, 2-in., or 4-in. width filters in any combination that totals 1,2,3, or 4 inches. Sections shall include side access slide rails. Rails shall be constructed of extruded aluminium for increased rigidity.

Angle filter sections shall accept 2-in. filters of standard sizes, arranged in a horizontal V formation. Filter tracks shall be constructed of extruded aluminium for increased rigidity.

Draw thru bag cartridge filter sections shall be capable of accepting standard size 12-in. deep rigid media or bag filters. For bag filters with lengths longer than 12 in., additional access section(s) shall be available.

Blow thru bag cartridge filter sections shall contain a face loading Farr type 8-filter frame.

22.5.1.3.8. Dampers

Mixing boxes, filter-mixing boxes, and exhaust boxes shall have parallel blades and interconnecting outside-air and return-air dampers. Exhaust ducts in the room containing a fire hazard shall have dampers with automatic and manual mode of operation during fire.

Damper blades shall be constructed of galvanized steel with a double-skin airfoil design. They shall have silicone blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to hex axle rod rotating in stainless steel bearings. To eliminate blade warping, dampers shall be sectionalized to limit blade length to 48 inches maximum. Maximum leakage rate shall be 5 cfm/ft² at 1-inch wg (0.25 kPa) differential pressure.

Face and Bypass Dampers:

Shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with silicone blade seals and stainless steel edge seals. Blades shall be mechanically fastened to hex axle rod rotating in self-lubricating synthetic bearings. To eliminate blade warping, dampers shall be sectionalized to limit blade length to 48 inches maximum. Dampers shall be opposed-acting and arranged to match coil face with top bypass, and external linkage.

Multi-Zone Dampers:

Shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with blade seals and stainless steel edge seals. Axles shall have self-lubricating nylon bearings. Linkage shall have external connections. Number of zones shall vary by size of section.

22.5.1.3.9 Air Mixer

Air Mixer shall be constructed of welded aluminium framing and turbulence. The mixer shall have no moving parts. It shall contain a primary set of direction-changing vanes, a secondary set of turbulence vanes, and a cone design for mixing of air streams.

Unit shall mix two or more air streams of different temperatures (at nominal flow) to within a range of 6° F standard deviation of theoretical mixed-air temperature. It will provide a uniform velocity contour entering a downstream filter or oil bank.

22.5.2. Unit Cabinet

Salient features of the Cabinet will be:

- Frame shall be of heavy-gage galvanized steel members.
- Cabinet shall be galvanized steel casing with a pre-painted finish.
- Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM B-117 standard.

Over 1251 mm	1.25 mm
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The cylindrical spiral ducts shall have the following thickness:

Up to 300 mm	0.63 mm
From 301 mm to 600 mm	0.63mm
From 601 mm to 750 mm	0.63 mm
From 751mm to 1000 mm	0.80 mm
From 1001 mm to 1500	0.80 mm
From 1501 mm to 2250	1.0 mm
Over 2250	1.25 mm

All ducts shall be airtight with opening at suitable locations.

If necessary, the rectangular elbows shall be equipped with aerodynamically formed guiding vanes.

All take-off branches shall be equipped with an adjustable volume extractor, which assists in balancing by directing a regulated amount of air for supply outlets from the main duct.

The ducts shall be supported by straps attached directly to the sides of the duct if the duct size is not more than 400 mm, but larger ducts shall be carried by structural angles, hanging in rods with adjustable nuts, anchored to the ceiling of walls by concrete fastener bolts or anchors. Maximum allowable distance between duct supports is 1500 mm.

22.5.4. Insulations

The fresh air and cooled down supply air ducts shall be insulated to prevent condensation on the duct surfaces.

The insulation material (thickness to be as per detail design) shall be non-hygroscopic, rot-proof, preferably of mineral raw material such as rock wool. The insulation mats or plates shall be fastened on the duct and wrapped with aluminium foils. The insulation material shall be also sufficient to obtain the acoustical guarantee.

The chilled and cooling water piping shall be properly insulated. The mentioned insulations shall be included in the supply.

22.5.5. Grills

The supply air grills shall be used for correct air distribution by horizontal and vertical adjustable bars of sidewall installations.

The return air grills shall be suitable for adjustment from outside and shall be equipped with 45° horizontal fixed fins.

The design has to fit the architectural false ceiling and lighting schemes and the grills be made of aluminium powder coated with high surface finish and the sizes have to correspond to the fixed noise criteria.

Grills for the battery room shall be of acid resistant PVC.

22.5.6. Outside Air Louvers

Outside air louvers of each of the fresh air and exhaust air systems shall prevent the entrance of rain, insects, birds and trash into the ducts.

They shall be stamped and pressed out of one piece of aluminium sheet of at least 2 mm thickness. The frames shall also be made of aluminium.

22.5.7. Louver Dampers

Double acting louvers shall be fabricated with a welded frame of rolled section.

Bearings shall be of the oil retaining porous bronze type and shall be fixed into the frame.

The louver dampers as well as the steel frames shall be hot-dip galvanized after fabrication.

Louvers and dampers shall be equipped with related limit switches to be used in control and interlocking system.

22.5.8. Air Filters

The filter banks shall be composed of panels not bigger than 500 x 500 mm, which can be easily removed by hand. They shall be designed taking care of the recommended velocity of the air passing through an area as per relevant standards/codes in practice. The filters shall be of the viscous impingement type, cleanable, aluminium wire mesh coated with viscous substance such as filter oil or grease. Separation degree may be similar to EU4 (rough air filter), according to EUROVENT or DIN 24185 standards.

The frame structure of the panel cells shall be made of aluminium sections.

A properly positioned pressure gauge of the inclined tube type shall give an indication of the degree of dust loading on the filters for establishing the periods between services.

22.5.9. Fans

Exhaust air fans shall be adjustable axial flow fans. Axial air fans shall be of the multi blade vane type. The vanes shall be adjustable individually at standstill. The hub of the impeller shall be directly coupled to the motor shaft and its diameter adapted to the motor frame. The impeller shall be statically and dynamically balanced.

All bearings shall be pre-lubricated, self-aligning and selected for a minimum of 40000 hour's average life at the maximum design rating. If, however, frequent lubrication is required this should be possible from the outside of the fan casing without disturbing the fan duct assembly.

Bearing supports shall be specially designed for trouble-free bearing service. All fan shafts and wheels shall be designed to operate at their maximum rated speed, which is below the first critical speed.

All motor bases shall be adjustable and V-belt drives selected for 120 percent of motor power.

The steel casing of the air fans shall be made of hot-dip galvanized steel or aluminium.

Where the impeller is accessible in operation, guards shall prevent injuries to maintenance personnel.

Anti-vibration mountings shall be provided for each fan.

22.5.11. Bolts, Nuts and Washers

All bolts, screws and nuts shall be of metric thread standards and have hexagonal heads. The material shall be of stainless steel.

22.5.12. Controls and Electrical Equipment

The HVAC system shall be equipped with operation on fully automatic mode and manual mode.

Automatic Control and Regulation

The HVAC system shall be equipped with a fully independent computerized and automatic control system for efficient operation, which shall be included in the supply. It should automatically shutdown all fans immediately in case of fire detection.

All sensors and instruments (temperature, pressure, humidity, etc.), limit switches, etc. required for automatic regulation and monitoring of proper service of the systems shall be included in the supply.

Manual mode

Individual starting and stopping of equipments by push buttons.

All the necessary cabling between the control panels and the field HVAC components (as fans, sensors, pumps, valves, air dampers, etc.) shall be included in the supply and shall be in accordance with relevant standards/codes in recent practice.

Each of the control systems shall be equipped with the necessary control, interlocking and security devices. Any failure or breakdown in the control system shall be indicated by a signal on the respective control panel, as well as remotely in the main control room. Potential free contacts and terminals for remote indication of the alarms shall be provided in the panels. All necessary protection viz single phasing, IDMT and Instantaneous over current relays, Under voltage relays etc. shall be provided.

Pumps shall be provided with electric motors, anchor bolts and other mounting materials. The pumps shall be with starting unit suitable for 415 V + 10%, 50 HZ + 5% with contacts for remote operation / indication.

22.6. Quality Control and Assurance

The contractor shall follow the quality assurance and testing requirements specified separately in Section XII – Quality Assurance Plan.

22.7. Drawings, Documents and Design Calculations

22.7.1. Drawings and Documents

The Contractor shall submit all the drawings and documents as per clause no. 2 of Section VIII.

22.7.2. Design Calculation

The Contractor is required to submit the design calculation for following to the Engineer for approval during detail engineering.

Sizing of ducts for air distribution

Calculation for selecting the AHU and other fans capacity

Cooling loads, air flow rate and temperature & humidity conditions at all locations/areas

22.8. Shop Tests

The HVAC system shall be type and routine tested as per relevant IEC / IS / Standards. The contractor is required to carry out all type tests on air cooled chiller units and other equipment of one-unit and routine tests on all units and submit the reports to the Employer. At the discretion of the Employer, type test certificates can be accepted in place of type tests.

22.9. Installation and Commissioning

The contractor shall furnish all labour, supervision, tools, supplies, bracing, spiders, shims and supports and all other provisions or materials necessary to assemble, erect, install, test and commission of the equipment in a thorough workman like manner following the best modern practices.

The equipment and all its components shall be placed with great care and accuracy and shall be aligned correctly to provide an installation consistent with the close tolerances used in the erection of modern equipment. The proper elevations and centrelines to which equipment is to be set shall be established by the contractor.

All necessary materials and labour for performing all the above tests shall be provided by the contractor. All test equipment and instruments shall be furnished by the contractor and will remain the contractor's property after the fulfilment of all field tests

All civil work required for foundation shall be carried by "other contractors". The contractor is required to submit all foundation drawings and supporting steels well in advance.

22.10. Field Tests

After installation, the HVAC system shall be field tested for operational tests, visual inspection of complete installations, main air flow rates, performance of heaters, electrical consumption of electrical components, room conditions in all rooms, control system, hydrostatical tests of whole piping systems, air tightness, vibration and noise due to turbulence in the duct assembly etc. The contractor shall prepare and hand over to Employer details of all test results in a report in a mutually agreed format.

22.11. Spare Parts**22.11.1. General Spare Parts**

The Contractor shall supply the general spare parts as per clause number 3.1.1 of Section VIII. The supply of this spares shall be as per the approved list of spares for each component / equipment / item during detail engineering.

22.11.2. Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts as per clause number 3.1.3 of Section VIII.

22.11.3. Specified Spare Parts

The following specified spare parts, as defined in clause number 3.1.2 of Section VIII, which shall comprise the total requirement for HVAC system under this Contract, shall be supplied.

S. No	Description	Qty
1	Filter bank of each type and size	4 sets
2	V- belts of each type and size	2 sets

A set is defined as the total number required for one unit.

22.12. Special Tools

The Contractor shall provide one set of all necessary special tools and maintenance equipment for repair and maintenance of the Air conditioning and Ventilation system as recommended by the manufacturer.

A list of such tools shall be approved during detail engineering.

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6.3 Colour Code

In general, the colour code for electrical Works shall be as described in the Particular Technical Specifications.

The manufacturer's painting systems shall be used to the maximum possible extent, but shall by all means be subject to the approval of the Engineer. Final coats of paint shall be matching adjacent installations, where required.

6.4 Electric Motors**6.4.1 General**

All motors shall be of approved manufacture and shall comply with the requirements of this Chapter. Motors of the same type and size shall be fully interchangeable and shall comply - as far as applicable - to IEC standard motor dimensions.

The general construction shall be stiff and rigid; no light metal alloy casings will be accepted. All precautions shall be taken to avoid any type of corrosion.

All motors shall be fitted with approved types of lifting hooks or eyebolts as suitable.

AC motors shall have squirrel cage type rotors.

Motor Voltages and Power Ratings

The service voltages and corresponding power ratings for electric motors to be used in the Project shall be as follows:

- Motors up to 100 kW
- Service voltage : 3-phase a.c. 415/240 V, 50 HZ
- Mode of starting : direct-on-line up to 50 kW

Above 50 kW with suitable starters

- Motors up to 0.75 kW
- Service voltage : single-phase a.c. 240 V, 50 HZ
- Mode of starting : condenser
- Motors intended to work on the d.c. System
- Service voltage : 220 V D.C.
- Mode of starting : resistor

6.4.2 Rating

The rating of the motors shall be adequate to meet the requirements of its associated equipment. The service factor, being the ratio of the installed motor output to the required power at the shaft of the driven

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machine at its expected maximum power demand, shall be applied as follows:

Power Demand of Driven Machine	Service Factor
Up to 5 kW	1.2
More than 5 kW	1.1

A.C. motors shall be capable of operating continuously under rated output conditions at any frequency between 95% and 105% of the rated frequency and/or with any voltage variation between 90% and 110% of the nominal voltage. A transient over voltage of 130% of the nominal voltage shall as well be sustained.

Further, the motors shall be capable of maintaining stable operation when running at 70% nominal voltage for a period of 10 seconds. The pullout torque for continuously loaded motors shall be at least 160% of the rated torque and for intermittently loaded motors 200% of the rated torque.

D.C. motors shall be capable of operating continuously under rated output conditions at any voltage between 90% and 110% of the nominal voltage with a fixed brush setting for all loads. Unless otherwise approved, the speed drop between no-load and full-load shall not exceed 10% of no-load speed.

6.4.3

Starting

A.C. motors shall be designed for direct on-line starting. They shall be capable of being switched on without damage to an infinite bus bar at 110% of the nominal voltage with an inherent residual voltage of 100% even in phase opposition. For starting the motors from the individual main and auxiliary bus bars, a momentary voltage drop of 20% referred to nominal voltage should be taken into consideration. With 85% of the nominal voltage applied to the motor terminals, each motor shall be capable of accelerating its associated load to full speed with a minimum accelerating torque of 5% of full load torque.

The maximum starting currents (without any tolerance) shall not exceed the following values: -

- - 5 times of rated current for low voltage motors rated 100 kW or above
- - 2 times of rated current for D.C. motors (by means of starting resistors)

Generally, all motors shall be able to withstand three cold starts per hour, equally spaced. In addition, each medium voltage motor shall be capable of enduring two successive starts with the motor initially at operating temperature. Each low voltage motor shall be capable of withstanding three successive starts under the same conditions or once every twenty minutes without detrimental heating.

Motors for frequent automatic starting shall have an adequate rating. In the motor list the Contractor shall state the frequency of starts permitted in compliance with the motor design.

6.4.4 Windings and Insulation Class

The insulation of all motors shall be of class F but will not exceed the temperature limits of class B materials in operation. It shall be suitable for operation in damp locations, for occasional contact with corrosive gases and vapours and for considerable fluctuations in temperature.

The stator winding shall be suitably braced to withstand the forces due to direct-on-line starting and transfer conditions as mentioned before. The winding envelopment and tails shall be non-hygroscopic. The stator winding shall withstand the maximum fault current for the period determined by the associated protective devices.

The rotor winding (if applicable) shall be designed to give trouble-free continuous service including repeated direct-on-line starting. The rotor shall be subjected to a 120% over speed test for 2 minutes without showing any winding dislocation.

6.4.5 Ventilation and Type of Enclosure

All motors shall be of the totally enclosed fan-cooled type, protection class IP 54 according to IEC Recommendation 144. Cable termination points shall be of class IP55.

They shall have a closed internal cooling air circuit re-cooled by an external cooling air circuit drawn from the opposite side of the driving end.

Where motors are installed outdoors, a weatherproof design shall be chosen. L.V. motors of IEC size 132 and above shall be equipped with automatically controlled heating elements for protection against internal condensation of moisture during standstill periods. Such A.C. heater shall be suitably fixed inside the motor casing; the leads shall be led to a separate L.V. terminal box.

Motors installed outdoors and directly subjected to solar radiation shall be rated such as not to exceed a maximum metal temperature of 85°C. Where necessary, such motors shall be provided with sun shields.

Vertical motors shall be provided with a top cover to prevent the ingress of dirt, etc.

6.4.6 Bearings

As far as possible, the motors shall have sealed ball or roller bearings. All motors with ratings of about 1 kW and above shall be equipped with lubricators permitting greasing while the motor is running and for

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preventing over-lubrication. Additionally, the bearings shall be fitted with grease nipples permitting the use of a universal grease gun.

Vertical motors shall have approved thrust bearings.

Where sleeve bearings are being used, they shall be of the self or forced lubricating type. If forced lubrication is required, it shall be arranged common to both the motor and the driven machine and provisions shall be made to ensure lubrication during start-up and shutdown operations without the necessity to start an auxiliary lube oil pump. Self-lubricated bearings shall be equipped with an easily accessible oil reservoir with overflow pipe and oil collecting vessel.

All bearings shall be easily controllable during operation or standstill without dismantling the bearings. The bearings shall further be protected and sealed against dust penetration and oil leakage.

In case of independent bearings, motor and bearing pedestals shall be fitted on a common base plate.

For the transport of motors equipped with ball or roller bearings, special bearing inserts shall be provided to prevent transport damage.

6.4.7 Shafts and Couplings

The motors shall be provided with a free shaft extension of cylindrical shape with key and keyway according to IEC Recommendation 72-1 and with the motor side coupling, which shall be pressed on the motor shaft and be balanced together with it. A coupling guard shall be provided.

6.4.8 Brush gear and Commutators

Brush gear for D.C. motors shall be designed to ensure constant brush pressure. Carbon brushes shall be provided which stand at least 6 months of operation without replacement. Each brush shall be independently adjustable but should not require adjustment throughout its life. A design of brush gear which permits the brush holder to touch the commutator as the brushes wear or which passes current through the pressure fingers will not be accepted.

A sufficient number of brushes, not less than two per pole, shall be fitted to ensure that vibrations do not affect the commutation.

The minimum safe wearing margin of commutators shall not be less than 20 (twenty) per cent of the total thickness of the commutator bars and the minimum safe diameter shall be clearly marked on it.



6.4.9 Terminal Boxes and Earthing

The terminal leads, terminals, terminal boxes and associated equipment shall be suitable for terminating the respective type of cables as specified in these General Technical Specifications and in the Particular Technical Specifications.

The terminal boxes shall be of ample size to enable connections to be made in a satisfactory manner. Supports shall be provided at terminal boxes as required for proper guidance and fixing of the incoming cable.

The terminal boxes with the cables installed shall be suitable for connection to supply systems with the short-circuit current and the fault clearance time determined by the motor protective devices.

A permanently attached connection diagram shall be mounted inside the terminal box cover. If motors are provided for only one direction of rotation, this shall be clearly indicated.

Terminal boxes shall be totally enclosed and designed to prevent the ingress of moisture and dust. All joints shall be flanged with gaskets of neoprene or similar material. For motors above 1 kW, the terminal box shall be sealed from the internal air circuit of the motor.

Depending on the size, the terminal box of L.V. motors shall be fitted either with an approved cable sealing-end or with a gland plate drilled as required and provided with suitable fittings for cable fixing and sealing. Such openings shall be temporarily plugged or sealed during transportation.

For earthing purposes, each motor shall have adequately sized bolts with washers at the lower part of the frame. In addition, each terminal box shall contain one earthing screw. Each equipment/panel shall be earthed by at least two separate earthing strips.

The cable termination philosophy to be adopted shall be such that extensive grouping of signals by a large scale use of field-mounted group. Junction boxes at strategic locations (where large concentration of signals are available, e.g. switchgear) is done. Termination / Junction boxes shall have either maxi- terminal or cage clamp type terminals

6.4.10 Noise-Level and Vibrations

Under all operating conditions, the noise level of motors shall not exceed 85 dB (A).

In order to prevent undue and harmful vibrations, all motors shall be statically and dynamically balanced.

Vibration displacements or velocity shall be measured in accordance with DIN 45 665 for IEC motor sizes 80 to 315. The results for all motors shall be within the "R" (reduced) limits.

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6.4.11 Tests

Each motor shall be factory tested and shall undergo a test at site. The following tests shall be performed under full responsibility of the Contractor.

- Workshop Tests:
 - Measurement of winding resistances
 - No-load and short-circuit measurements
 - Measurement of starting current and torque
 - Efficiency measurement (type test)
 - Heat test run
 - Dielectric test
 - Measurement of insulating resistance
 - Over speed test
- Site Tests:
 - Measurement of insulation resistance
 - Measurement of motor vibrations
 - Measurement of starting time.

6.5 M.V. and L.V. Switchgear, Cubicles and Panels

6.5.1 Starters and contactors

Motor starters and contactors shall be equipped with short circuit protection and local disconnecting devices. Preferably, all starters shall be from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V isolating transformer with primary circuit breaker and secondary fuse. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.

Starters and contactors shall comply with IEC 292.1 or NEMA IC 1 and be suitable for direct on-line starting, uninterrupted electrical duty, and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation and weatherproof enclosures for outdoor installation, unless otherwise approved by the Engineer. The enclosures shall be complete with locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards, etc. as required by the duty of the starter or contactor.

Starters and contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal, at nominal frequency.




Thermal type overload and phase failure relays shall be supplied with starters for motors of 7.5 kW or greater. For motors of less than 7.5 kW, suitable rated 3-phase thermal overloads will be acceptable. Ammeters to read current in one phase shall be provided for motors above 7.5 kW.

Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes plus two spare convertible contacts for Owner's use.

6.5.2 Moulded case circuit breakers

All moulded case circuit breakers shall be of 2 or 3-pole type as required, having thermal time delay and instantaneous trips with "On-Trip-Off", indicating/operating mechanism. Circuit breakers used in combination type motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with applicable section of IEC 157/1 or equivalent standards.

6.5.3 Control relays

Relays used as auxiliary control devices in conjunction with motor starters and magnetic contactors shall be of the type designed for machine tool application featuring contact convertibility. All contacts shall have a minimum thermal current rating of 10A over a range of 6 to 600 V AC.

6.5.4 Pilot devices

Pilot devices such as selector switches, push-button starters and thermostats shall be of heavy duty type and, where mounted outdoors, shall be housed in weather proof enclosures specially designed for the environment.

All electrical contacts for control, alarm and shutdown shall have a thermal current rating of not less than 10 A at 220 V DC.

6.5.5 Terminal blocks

All terminal blocks shall be mounted in an accessible position with the spacing between adjacent blocks not less than 100 mm and space between the bottom blocks and the cable gland plate being a minimum of 200 mm. Sufficient terminals shall be provided to allow for the connection of all incoming and outgoing cables, including spare conductors and drain wires. In addition, 20 percent spare terminals shall be provided. In enclosed cubicles, the terminal blocks shall be inclined toward the door for facilitating terminations.

Terminals shall be of the channel mounting type and shall comprise a system of individual terminals so that terminal blocks can be formed for easy and convenient cabling consistent with the high reliability required of the circuits.

Terminal blocks shall be provided with shorting links and paralleling links where applicable and mounting identification numbers and/or letters.

Terminal blocks shall conform to the applicable standards. The smallest size to be used shall be designated for 2.5-sq. mm wire and not more than two conductors shall be connected under one terminal clamp.

Terminal identification shall be provided corresponding to wire number of connected leads.

Circuit terminals for 415 V AC shall be segregated from other terminals and shall be equipped with nonflammable, transparent covers to prevent contact with live parts. Warning labels with red lettering shall be mounted thereon in a conspicuous position.

6.5.6

Equipment wiring

All wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point.

Splices or tee connections between terminal points are not acceptable. Wire runs shall be neatly dressed inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipments.

Multi conductor cables shall be connected to the terminal blocks in such a manner as to minimise crossovers. Approved claw washers of crimp type connector shall be used to terminate all small wiring. Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilising slip-on ferrules approved by the Engineer.

Markers may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.

Markers must withstand a tropical environment and high humidity and only fungus proof materials will be accepted. Ferrules of adhesive type are not acceptable.

All trip circuits shall employ markers having a red background.

Sensitive control circuits shall be effectively shielded against extraneous signals and interference. A separate terminal shall be provided for termination of individual cable shields, which will be grounded at source end only.

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6.5.7 Cubicles and control panels

Cubicles and control panel enclosures shall be of sheet steel with minimum thickness of 2.5mm, of rigid, self-supporting construction and supplied with channel bases.

Cubicles shall be fitted with close fitting, gaskets, hinges, lift-off doors capable of being opened through 180 deg. The doors shall be provided with integral lock and master key.

Cubicles and panels shall be vermin proof. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances shall the floor/roof plate be used as a gland plate. The cables and wiring shall enter from bottom or top as approved or directed by the Engineer.

The cubicles and panels shall be adequately ventilated, if required, by vents or louvers, and shall be so placed as not to detract from the appearance. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.

Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.

Unless stated otherwise, all cubicles and panels shall be provided with a ground bus with 40mm copper bar extending through out the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120mm².

The standard phase arrangement when facing the front of the motor control centres and switchboard shall be RYB from left to right, from top to bottom and front to back. All instruments, devices, buses and other equipments involving 3 phase circuits shall be arranged and connected in accordance with the standard phase arrangement, where possible. Electrical clearances shall conform to applicable standards and shall not require cutting away of adjacent framework.

All instruments, control knobs and indicating lamps shall be flush mounted on the panels. Relays and other devices sensitive to vibration shall not be installed on doors or hinged panels, and no equipment shall be installed on rear access doors.

The instrument and control wiring, including all electrical interlocks and all interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the manufacturer.

The arrangement of control and protection devices on the panels and the exterior finish of the panels shall be subject to the approval of the Engineer. The interior of all cubicles and panels shall have a mat white finish unless specified otherwise.

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Switched interior light and socket outlets shall be provided for all cubicles and control panels.

All cubicles and control panels shall be provided with lamacoid nameplates, identifying the purpose of the panel and all of its components.

6.5.8 Alarm contacts

Where applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices.

- -Local annunciator
- -Station annunciator
- -Supervisory control and sequence of events / fault recorder system.

All alarm contacts shall be changeover type. Where required, relays shall be provided as contact multiplier.

6.6 Cables

Refer to particular technical specifications Section-IX.

6.7 Earthing System

The contractor of Electro-Mechanical Equipment will make the design calculation and supply the necessary material and install the earthing system during powerhouse construction in co-ordination with civil contractor

6.8 Explosion Proof Works

6.8.1 General

According to the kind of oils and fuels used, explosion in hazardous locations may be caused by standard type electrical works. Therefore, the installation in such locations shall generally be kept to a minimum with said works designed or installed in compliance with the latest issue of IEC recommendation 79 and the appropriate articles of the American National Electric Code (NEC) or the German VDE Standards 0165, 0170 and 0171.

6.8.2 Definition of Hazardous Locations

Hazardous locations shall be defined as follows:

- Class 1, Div. 1 locations are those:
- Where hazardous concentrations of inflammable vapours or gases exist continuously, intermittently, periodically under normal

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3. SPARE PARTS AND TOOLS

3. This specification is for entire power house. Bidder shall refer portions of this specification for the scope applicable for Switchyard or GIS portion of the project as stipulated in Sec-1 of this TS including spares applicable for GIS portion.

Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components. Before issue of the Taking-Over Certificate the spare parts shall be checked at the Site by the Contractor in presence of the Engineer in charge/Employer.

Acceptance of any spare part will not take place before the Contractor has submitted the complete final detailed list of all spare parts and tools.

All spare parts shall be protected against corrosion and shall be marked with identification labels in English. The identification shall be in accordance with the agreed Works Identification System.

All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage.

3.1.1 General Spare Parts

At least the quantity of general spare parts specified below shall be included in the Total Tender Price and consequently in the scope of Works of the Contract.

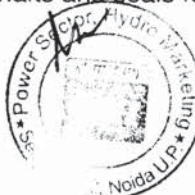
If the same spare parts are listed twice under "General Spare Parts" as well as under "Specified Spare Parts", the quantity listed under "Specified Spare Parts" shall take priority over the quantity stipulated under "General Spare Parts".

- Spare Parts subjected to Wear and Tear.

For each installed assembly such as Servomotors, Pumps, Motors, Main Inlet Valves, Pressure Oil Units, Gates, Valves, Compressors, Cranes, Machine Tools etc. the following general Spare Parts shall be delivered.

Two (2) complete sets of:

- Facing rings of mechanical seals
- Protection sleeves
- Carbon brushes for motors (if applicable)
- Inserts of filters
- Bearing bushings
- Brake liners
- Pickings
- Roller bearing for rotating shafts and seals for rotating shafts



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- Driving belts
- Wearing parts of couplings
- Frequently actuated springs
- Outdoor installed pressure hoses

Wear and tear items shall be defined as such, which require replacement several times during the service life of the assembly.

➤ Customary Spare Parts:

For a number of like and identical assemblies the following spare parts shall be delivered, whereas one set shall be defined as the total quantity for one assembly:

- "X" Complete Sets related to "Identical Assemblies"
- Seals, gaskets and packing
- Thermometer, manometer, flow meter, level indicator (with and without contacts)
- Transducer 4/20 mA for position, pressure, temperature, flow
- Indoor installed pressure hoses
- Lamps, signal lamps, push button and switches
- Fuses, clamps
- Limit switches, auxiliary relays, pressure switches
- Roller bearings, sleeves and bushings for movable parts including for spherical joints
- Ball bearings
- Resistance thermometer without indicator
- Motor-starters, contacts for feeder switches
- Springs
- "X" Complete Valves and Gates:

Related to "Identical Installed Standard Valves and Gates" (manually, hydraulically or electrically driven) including Drive like

- Shut-off valves and cocks
- Globe valves, needle valves or butterfly valves
- Non-return valves
- Pressure relieve valves
- Pressure reducing valves
- All solenoid valves
- Safety valves
- Aeration and venting valves



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Dy. General Manager (E&M Design-I)
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➤ Float controlled valves

The quantity "X" which shall be furnished is a function of the number "N" of supplied "Assemblies" or "Valves and Gates" identical in type and size.

$$N < 3 \quad X = 1$$

$$N < 10 \quad X = 2$$

$$N > 10 \quad X = N/10 + 1, \text{ rounded-up to the next higher whole number}$$

The Contractor shall provide 5%, but at least two pieces of all bolts, screws, nuts, washers, spanner rings and cotters. The quantity may be taken from the surplus handed over to the Employer after completion of the installation as described under 5.2 "Bolts, Screws, Nuts, etc." of this Section.

For all items under this Contract the Contractor shall deliver 5 % of the quantity of painting material, but at least one litre, in new sealed containers, for later repair work other than the Contractor's.

Parts with a special size or properties, as listed below are excluded as General Spare Parts:

- Bolts, screws, nuts, washer, spanner rings and cotters with a nominal diameter of more than 80 mm
- Roller bearings, bearing shells, sleeves and bushings for movable parts including for spherical joints with an inner diameter of more than 200 mm
- All valves and gates with a nominal diameter of more than 600 mm
- Main seals for gates, valves, access doors and openings with a total length of more than 2.40 m in straight length or circumference.

3.1.2 Specified Spare Parts

The required specified spare parts are listed separately in the Particular Technical Specifications. The price for each listed special spare part shall be quoted individually in the Price List; the total price shall be included in the Total Tender Price.

3.1.3 Recommended Spare Parts

If any additional spare parts are recommended by the Contractor, these shall be stated in quantity and description in the Technical Data Sheets for each item.

Orders for recommended spare parts shall be optional to purchase by the Employer for a period of five (5) years after the date of the completion of the project. However optional spare parts will not be considered in tender evaluation.



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Section VIII
General Technical Specifications (GTS)

3.2 Tools and Appliances

The scope of work shall include all customary and special tools, as well as auxiliary devices including lifting devices, ropes, etc. necessary for total assembly and disassembly of all parts of the supplied Works. Furthermore, all accessories for maintenance shall be supplied and included in the Tender. The total price for tools and devices as required by this article shall be included in the Total Tender Price.

The tools, wrenches, etc. shall be unused. Customary tools for erection shall be of the forged and polished chrome-vanadium type. Use of special tools and devices for erection shall be allowed, but shall be approved by the Engineer in each case. Special tools and devices shall be provided with means for ready identification.

All lifting devices and wire ropes slings to be used at site shall be tested at works and test certificate shall be supplied to the Engineer.

Suitable hardwood or steel boards arranged for wall mounting as well as tool carts and/or toolboxes shall be included in the delivery. An itemised list and description of all provided tools, auxiliary devices, storage equipment, etc. shall be included in the Tender. Acceptance of any tool or device shall not take place before the Contractor has submitted the complete final detailed List of Tools and Appliances.

Ropes, slings etc. shall be handed over in new condition. The Employer shall be entitled to take over from the Contractor the entire erection tools, appliances, instruments at mutually agreed conditions.

MOHAMMAD GULFISHAN
Dy. General Manager (E&M Design-I)
NTP Limited, Ganga Bhawan
Yashwantrao Chavan Colony, Dehradun-248001



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SECTION-3

PROJECT DETAIL AND GENERAL SPECIFICATION

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other respective sections and are not exclusive. However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

3.1 PROJECT INFORMATION AND SYSTEM PARAMETERS

a)	Customer/ Purchaser/ Owner	Uttarakhand Jal Vidhyut Nigam Limited
b)	Project Title	220kV switchyard for 2 X 60MW Vyasi HEP
c)	Location	Village Vyasi, 5.0 Km.d/s of Lakhwar, Dehradun
d)	Elevation above MSL	535 m
e)	Transport Facilities	Airport ,Railways at Dehradun, accessible by Road from National Highway NH-123 at Barawala (3 km from Dakpathar).
f)	Postal Address	To follow
SITE CONDITIONS		
a)	Max. temp.	42.8°C
b)	Min. temp.	0.3°C
c)	Design ambient temp.	40°C
d)	Latitude/Longitude	30° 31' 00" N/ 77° 53' 00" E
e)	Maximum Relative humidity	100 %
f)	Minimum Relative humidity	8%
g)	Pollution Severity	Less Polluted
h)	Seismic acceleration	0.18g
i)	Seismic zone	Zone-IV
l)	Wind Velocity & Zone	47 m/s Zone IV

SYSTEM PARAMETERS :

Nominal system voltage	220 kV
Highest system voltage	245 kV
Rated Normal Current at Nominal System Voltage	1600 A
Basic Impulse level	1050 kVP
Power frequency withstand voltage	460 kVrms
Switching Impulse voltage	850 kV
	-

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Maximum Permissible Switching Over Voltage to Earth (kV)	487 kV
Frequency	50 Hz $\pm$ 5%
Rated short time current	50 kA for 1 sec
Creepage distance	25 mm/kV
System Earthing	Solidly Grounded

Note: -

Seismicity: -The project is situated in a seismic zone and falls within Zone IV of the seismic zoning Map of India. Value of peak ground acceleration has been recommended as 0.36g for maximum Credible Earthquake (MCE) and 0.18g for Design Basis Earthquake (DBE).

Wind Load: - The basic wind load as per IS875 (part-3) shall be applied on the vertical projected area, multiplied with the applicable factor for different type of structures.

AUXILIARY POWER SUPPLY

3 phase A.C power supply	415V, 50 Hz, 3-phase 4 wire, solidly earthed with variation in frequency of $\pm$ 5% and variation in voltage $\pm$ 10%.
1 phase A.C power supply	240V, 50 Hz, 1-phase, AC supply with variation in frequency of $\pm$ 5% and variation in voltage $\pm$ 10%.
D.C. power supply	220V (variation under worst condition from 198V to 242V) , 2-wire ungrounded, 50V, 2 wire system (+) earthed , 48V $\pm$ 20%

Transportation Limitations: - For shipments, the Manufacturer shall pack the items to meet size and weight restrictions of the Indian railways and road systems. Shipments from Manufacturer's work (in case of foreign manufacturer) shall travel to the Port of entry in India, from where these will be transported, after necessary port clearances etc., by the Contractor to Dehradun, which shall be the nearest rail head for the Project, and further transported to site. However, in certain cases the Contractor may be required to transport the materials from Point of entry to Dehradun and further to Vyasi HE Project site directly by road transport. However, Indian contractors shall be responsible in all respects for transportation of all materials and equipment up to the project site. Manufacturers shall consult with the concerned authorities of railways and highways to ensure that their packaging will be such as to permit them to transport the plant and equipment within such imposed limits. Manufacturers shall arrange to deliver the maximum size subassemblies consistent with safe and convenient transport. All materials and equipment etc. arrived at Dehradun will be unloaded from rail wagons and reloaded on to road transport for shipment to project site by the Contractor. The roads and bridges en-route shall be made suitable for 70R loading capacity.

3.2 GENERAL TECHNICAL REQUIREMENT

3.2.1 SPECIFIC TECHNICAL REQUIREMENT

As per section-1

3.2.2 TYPE TESTS

For all the items of equipment's, bidder shall furnish copies of Type Tests Certificates for the

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equipment's of the type and ratings similar to those specified. Type Tests Certificates furnished shall be as per the provisions of relevant standards for such equipment's. In case the contractor is not in position to furnish, such type tests certificates or the type tests certificate furnished by him are not as per the relevant standard for such equipment and, therefore, not acceptable to the Employer, Type Test for such items and equipment's will have to be conducted by the contractor at his cost.

All the switchyard equipment's shall be type and routine tested as per relevant IS / IEC- Publication or Type tests certificate shall be furnished to prove that the equipment fulfils all characteristics defined in Specifications. The contractor is required to carry out all type tests on one apparatus of each type and routine tests on all apparatus and submit the reports to the Employer. If approved by the Employer, type test certificates can be accepted in place of type tests in case of the same have been carried out on same type & similar capacity. All equipment/systems to be supplied shall conform to type tests as per relevant standards and proven type.

The Bidder / Contractor shall furnish the reports of all the type tests carried out after **08.05.2007** as listed in relevant clauses in respective electrical specification and relevant standards for all components / equipment / systems. These reports should be for the tests conducted on identical/similar components/equipment/systems to those offered/proposed to be supplied under this contract.

Type tests done in an independent government laboratory or in the presence of representative of State Electricity Board or other reputed public undertakings, the type test reports of the same shall be submitted for scrutiny/approval. If these are found suitable and technically acceptable, conducting of type tests shall be waived off.

In case Contractor is not able to submit report of type test(s) conducted in last ten years, or in case type test report(s) are not found to be meeting the specification/relevant standard requirements, then all such tests shall be conducted by the Bidder free of cost to Employer/Purchaser, and reports shall be submitted for approval. No charges shall be paid under this contract. All acceptance and routine tests as per relevant standards and specification shall be deemed to be included in the bid price.

3.2.3 CODES AND STANDARDS

All materials and equipment shall generally comply in all respect with the latest edition of relevant international electro-technical commission (IEC) or any other internationally accepted standard which ensure equal or better quality or relevant Indian standard(IS) mentioned against each equipment and this specification.

3.3 MATERIAL/WORKMANSHIP

3.3.1 General Requirement

Where the specification does not contain characteristics with reference to workmanship, equipment, materials and components of the covered Equipment it is understood that the same must be new, of

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highest grade of the best quality of their kind conforming to best engineering practice and suitable for the purpose for which they are intended. All design calculations, materials, works, manufacturing and testing shall conform to the latest applicable standards.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from purchaser.

Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be constructed as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, leveling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances and instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacture's limits suitable guards shall be provided for the protection of personal on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purpose. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help purchaser in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

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3.3.2 Provisions For Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air conditioned areas shall also be of same type.

3.4 COLOUR SCHEME AND CODES FOR PIPE SERVICE

The contractor shall propose a color scheme for those equipment/Items for which the colour scheme has not been specified in the specification for the approval of purchaser. The decision of purchaser shall be final. The scheme shall include:

Finishing colour of Indoor equipment
 Finishing colour of Outdoor equipment.
 Finish colour of all cubicles.
 Finishing colour of various auxiliary system equipment including piping
 Finishing colour of various building items.

All steel structures, plates etc shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all electrical equipment in switchyard are painted with shade RAL 7032. All The indoor cubicles shall be of same color scheme and for other miscellaneous items, colour scheme will be approved by the purchaser.

3.5 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves, pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner. Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

3.6 FUNGISTATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on the parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interface with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application to the varnish.

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3.7 SURFACE FINISH

All surfaces that are so indicated on the drawings or those that require machining for their intended function, or those that are usually machined according to good workshop practice shall be machined. Surface finish qualities shall be adequate for the intended use and shall be indicated on the Contractor's Drawings. Suitable measuring device such as scatter meter or other acceptable measuring device will be used to determine compliance with specified surface finish.

All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulating oil as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paints.

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limit specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external painting shall be as per RAL 7032.

Before delivery, all exposed, unfinished metal surfaces shall be cleaned and shop painted. Cleaning and Preparation of steel surfaces shall be in accordance with relevant standards and they shall be given at least one prime coat the same day. Paint shall be in accordance with applicable portions of relevant Indian and International standards. The colours of the paint will be selected at the Employer's option. All interior surfaces of the crane those are accessible for maintenance inspections shall also be completely painted. All other interior surfaces shall be painted with only the 1 coat of primer. The inside of all gear housings shall be painted with 2 coats of oil resisting enamel as recommended by the gear housing manufacturer. A quantity and type of paint equal to 15% of the paint used for the second and third coats shall be provided for field touchup work. Monorail hoists shall be painted with the manufacturer's standard finish. The colour of the paint will be subject to approval of the Employer/Customer.

3.8 GALVANIZING

All structural steel including ladders, platforms, hand rails and the like and all exterior and interior steel surfaces of outdoor Works, as well as bolts and nuts associated with galvanized parts shall be hot-dip galvanized, electrolytic galvanized or serialized, as may be appropriate to the particular case. Galvanizing shall be performed in accordance with VDE Standard 0210 (Verband Deutscher Elektrotechniker) or IS 4795:1996. For galvanizing, only original blast furnace raw zinc shall be applied, which shall have a purity of 98.5%. The thickness of the zinc coat shall be for bolts and nuts, approx. 60 micrometers.

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Conforming to latest version of IS:2629 or any other equivalent authoritative standard. However, hardware less than M12 size shall be electro-galvanized. Minimum weight of zinc coating shall be **610 gms. per square meter** and minimum thickness of coating shall be 85microns for all items thicker than 6mm. For items lower than 6 mm thickness, requirement of coating shall be as per relevant ASTM.

3.9 PACKING

The following details are to be clearly indicated in the material forwarding documents:

- Name and address of the consignee.
- Purchase order number.
- Name of supplier/s.
- Description of equipment / material.
- Net weight.
- Gross weight.

All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the purchaser, the Contractor shall also submit packing details/associated drawing for any equipment material under his scope of supply, to facilitate the purchaser to repack any equipment/ material at a later date, in case the need arises. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost.

The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbol i.e. fragile, handle with care, use no Hooks etc. All electrical parts shall be carefully protected from damage by sand, moisture, heat or humid atmospheric conditions by packing them in high-pressure polyethylene foil.

All the cable shall be supplied on nonreturnable wooden drums with adequate barrel diameter so as to avoid any damage to the cables and to withstand rough handling during transportation and storage. A layer of waterproof paper shall be applied to the surface of the drums and over the outer cable layer.

A circular space of at least 40mm shall be left between the cable and the lagging. Each drum shall carry the name of the manufacturer, the name of the Employer, his address, order number, item number, type, size length of cable, net and gross weight duly stenciled thereon.

3.10 HANDLING, STORING AND INSTALLATION

Contractor may engage manufacturer's Engineers to supervise if required for unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

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Where assemblies are supplied in more than one section, contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning.

Contractor shall be responsible for examining all the shipment immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. Any demurrage, pilferage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. The Contractor shall be fully responsible, for the equipment/material until the same is handed over to the purchaser in an operating condition after commissioning.

The minimum phase to earth, phase to phase and section clearance along-with other technical parameters for the various switchyard voltage levels to be maintained shall be strictly as per the approved drawings.

The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and costs.

3.11 DEGREE OF PROTECTION

The supplier shall propose following Degree of protection for those equipment/Items for which the degree of protection has not been specified in the specification for the approval of BHEL/UJVNL. The decision of BHEL/UJVNL shall be final. The enclosures of the Control Cabinet, Junction boxes and Marshalling boxes panels etc. to be installed shall be provided with degree of protection as detailed here under:

- a) Installed outdoor: IP-55
- b) Installed indoor in air conditioned area: IP-42
- c) Installed in covered area IP: 52
- d) For LT switchgear (AC & DC distribution Boards): IP-54

The degree of protection shall be in accordance with IS: 13947, (Part-1)/IEC-947(Part-1). Type test report/or degree of protection test on each type of the box shall be submitted for approval. If necessary, the cubicles shall be equipped with automatically controlled heating elements for protection against internal condensation and moisture. All panels/cubicles shall have approximately 20% space for mounting of future devices. Door operated interior illuminating lamps, power socket for 240V 5 /15A and communication socket shall be provided in all panels.

3.12 RATING PLATES, NAME PLATES AND LABELS

The switchyard equipment shall have a rating plate with the information required by relevant IEC i.e. at least the following:

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- Manufacturer's name
- Type number
- Serial number
- Rated Voltage
- Rated impulse withstand voltage
- Rated power frequency withstand voltage
- Rated frequency
- Rated current
- Rated short circuit breaking current
- Rated short time current (r.m.s), & duration Each instrument transformer must have its own rating plate with the information as required in IEC 600441 and IEC 60186.

3.13 EARTHING

The operating mechanism housing, control cabinets, support structure etc. shall be provided with two separate earthing terminals suitable for bolted connection to 50x6mm mild steel flat to be provided for connection to station earth mat.

Circuit breakers, LA, Isolator, CVT, CT, BPI shall be provided with two grounding pads suitable for connection to galvanized steel flat of Size 75X12 mm. Control panels, Relay panel, outdoor marshalling boxes, Junction boxes, lighting panels and distribution board shall be provided with two grounding pads, for connection to galvanized steel flat. The two pads shall be provided, one each at the middle of the two opposite sides of the bottom frame of the equipment. Earthing of hinged door shall be done by using a separate earth wire.

The Contractor shall connect all equipment included in the scope of delivery to the grounding system. In addition to the grounding through cable screens, all equipment such as cubicles, motors, etc. shall be connected directly to the grounding system using copper wire of area not less than 50 mm sq. at two different points. In general, all iron parts such as supports, covers, railing, etc. shall be connected to the grounding system. Each conductor shall have its own separate connection point. Pressed on closed shoes shall be used for connections to bars.

3.14 TERMINAL BLOCKS AND WIRING

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be stranded copper and shall be not smaller than 1.5 mm sq. except as otherwise agreed by the Engineer.

Larger size wiring shall be used where needed for the current carrying capacity requirements. Cables shall have at least 1000 V grade PVC insulation except for 110V DC and telemetering or communication system equipment for which 650V and 300 V ratings respectively may be acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 2.5mm sq. Wiring shall terminate at terminal blocks at one side only. Where

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tap connections are required, they shall be made on terminal blocks. Wiring shall be neatly arranged and laid in plastic conduits accessible from the front door. The conduits shall not be filled more than 70 %.

Each cubicle shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

The terminal blocks shall be located to allow a neat and easy connection work and shall be safely accessible while the equipment is in service. Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks. Power terminal blocks shall be rated in accordance with applicable standards and shall be provided with covers. Control wiring terminal shall be equipped with facilities for opening the circuit. It shall be possible to interchange a single terminal block for a new one without dismantling a whole row. Current transformer terminal blocks shall have provisions for short-circuiting and disconnecting. Not more than two wires shall be connected to any one terminal. Terminal blocks using screws acting directly on the wire will not be accepted. At least **20%** spare terminals shall be provided. Terminals shall be marked with printed labels.

Terminal blocks shall be 1100 V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece complete with insulated barriers stud type terminals, washers nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wedge or equivalent. The Insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, fluorocarbons etc.

Terminal block for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. At least 20 % spare

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terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be a minimum clearance of 250mm between the first bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm. The Supplier shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connection (where applicable) as well as between phases and common terminal boxes or control cabinets.

All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The supplier shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

3.15 CONTROL CABINETS, JUNCTION BOXES, TERMINALS BOXES AND MARSHALLING BOXES FOR OUTDOOR EQUIPMENTS

All types of boxes, cabinets etc. shall generally conform to and be tested in accordance with IS-5039, IS-8623 or IEC-439, as applicable and the clause given below.

Control cabinet, Junction boxes, marshalling boxes & Terminal boxes shall be made of sheet steel or aluminium and shall be dust, water and vermin proof. Sheet used shall be least 2.0 mm cold rolled or 2.5mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet of specified thickness. Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.

Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be provided with suitable gasket and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins. Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness. Disconnecting (sliding) type terminal blocks shall be provided, to facilitate testing & maintenance without disconnecting the cables.

Multi block terminal board of 15 A, 500 V rating shall be provided to form in assembly of number of terminal block. Assembly may be secured with only two screws on the surface. There shall be provision on the strips to add more terminal in case of further requirement.

Cabinet /boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of gaskets shall be such that it does not get damaged/cracked during the operation of the equipment.

All door, removable covers and plates shall be gasketed all around with suitably profiled EPDM

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gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged /cracked during the years of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth, straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting atleast 150 mm above from the base of the Marshalling Kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required

3.16 SPACE HEATERS

The space heaters shall be suitable for single phase 50 Hz AC supply from an independent source, which should automatically switch off before starting of unit. However, once the dehumidification unit is switched ON, it shall be controlled automatically with a thermostat. The dehumidification unit shall be designed to avoid hot spot. The heater shall be suitable for continuous operation at 240 V AC supply voltage and shall be provided with on – off switch and fuse shall be provided for heater.

One or more adequately rated, thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heater shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heater to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and air and shall consist of coiled resistance wire centered in metal sheath and completely encased in a highly compacted powder of Magnesium Oxide or other material having equal heat conduction and electrical insulation properties, or they shall consist of a resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and air. Alternatively, they shall consist of resistance wire mounted into a tubular ceramic body built into an envelope of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in glaze the surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments

3.17 QUALITY

BHEL quality plan to be followed subject to TBEM / customer's approval.

3.18 GUARANTEE:

The supplier shall guarantee that the goods under the Contract are new, unused of the most recent or

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current models and incorporated all recent improvements in design and materials unless provided otherwise in the Contract. The supplier shall further guarantee that the goods supplied under this Contract shall have no defects arising from design, materials or workmanship, installation and erection, if that may develop under normal use of the supplied goods. The supplier shall also guarantee the performance of the works executed by him including the performance of all the materials/goods supplied by him.

BHEL shall promptly notify supplier in writing of any claims arising under guarantee in respect of goods. Upon receipt of such notice, the supplier shall, with all reasonable speed, repair or replace the defective works or parts thereof, free of cost at site. All the expenses towards transportation of defective parts to supplier's works and of repaired/replaced parts to site shall be borne by the Supplier.

If the Supplier, having been notified, fails to remedy the defects within 14 days, the BHEL will proceed to take such remedial action as may be necessary, at the supplier's risk and expenses. All expenses in this regard will be recovered from Supplier.

3.19 DOCUMENTATION

3.19.1 LIST OF DOCUMENTS

The bidder shall submit a detailed list of drawings / documents along with the bid proposal which he intends to submit to the Employer after award of the contract.

The supplier shall necessarily submit all the drawings / documents unless anything is waived. All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under this specification shall be performed in strict conformity, unless otherwise expressly requested by the employer in Writing.

3.19.2 DRAWINGS

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, the dimensions required for installation and interconnections with other equipment's and materials, clearances and spaces required for installation and interconnection between various portions of equipment's and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, name of consultant, the unit designation, contract no., and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

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Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Employer if so required.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

3.19.3 APPROVAL PROCEDURE

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Employer would be discussed and finalized at the time of award. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer.

The contractor may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings.

3.19.4 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

3.20 DOCUMENTATION SCHEDULE

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
			Prints	Prints	CDs
1	Drawings and Data Sheets	1	10	13	-
2	Drawings "As Built "	-	-	13	05
3	Type Test Reports	1	05	13	-
3	Erection Manuals	-	11	13	-
4	Operation and Maintenance Manuals	-	11	13	-
5	Manufacturing Quality Plan	1	11	13	-
6	Field Quality Plan	1	11	13	-

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7	.	Inspection Test Reports	-	-	13	-
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Drawings will also be submitted in mini cartridges in AUTOCAD Release -14 package or any other CAD package along with conversion files for all major items.

Final Documentation shall be submitted in bound volumes with Customer & Project etc. written on top.



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**SECTION-4
LIST OF DRAWINGS & DOCUMENTS**

Bidder shall submit the drawings & data sheets as per the following list:

DRAWING NO.	DRAWING NAME
TBDG-398-553-05	Ventilation Ducting Layout for GIS Building
TBDG-398-553-06	Ventilation Fan Room Layout for GIS Building
TBDG-398-553-07	Drawing of PDB for Ventilation system
DATA SHEETS	DATA SHEETS NAME
TBDS-398-553-01	TDS For GI Duct/Supply & Return diffuser/ Fire Damper/PRD/ Pre-fine filter/Instruments
TBDS-398-553-02	TDS For Supply Air Fans/ Exhaust Fans
TBDS-398-553-03	TDS of Centrifugal fan & motor for GIS Ventilation system



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SECTION-5
ENCLOSURES TO SPECIFICATION

SCHEDULES TO BE FILLED UP BY THE BIDDER

- Schedule 1 **Schedules of Deviations**
- Schedule 2 **Details of contact persons (technical & commercial)**
- Schedule 3 **Enclosures to Specification (Drawings)**

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SCHEDULE-1**SCHEDULE OF TECHNICAL DEVIATION**

The following are the deviations / variations / exceptions from the specification:

Section	Clause No. / Page No.	Statement of deviation/ Variations/Exceptions
---------	--------------------------	--

- 1) **In case, this schedule is not submitted, it will be presumed that the equipment /material to be supplied under this contract are deemed to be in compliance with the specification.**
- 2) If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**
- 3) Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

Place

Signature of the authorized representative of Bidder

Name -----

Date

Designation-----

Company seal-----



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SCHEDULE-2**DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL**

Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Signature of the authorized representative of Bidder

Date

Name-----

Designation-----

Company seal -----

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.



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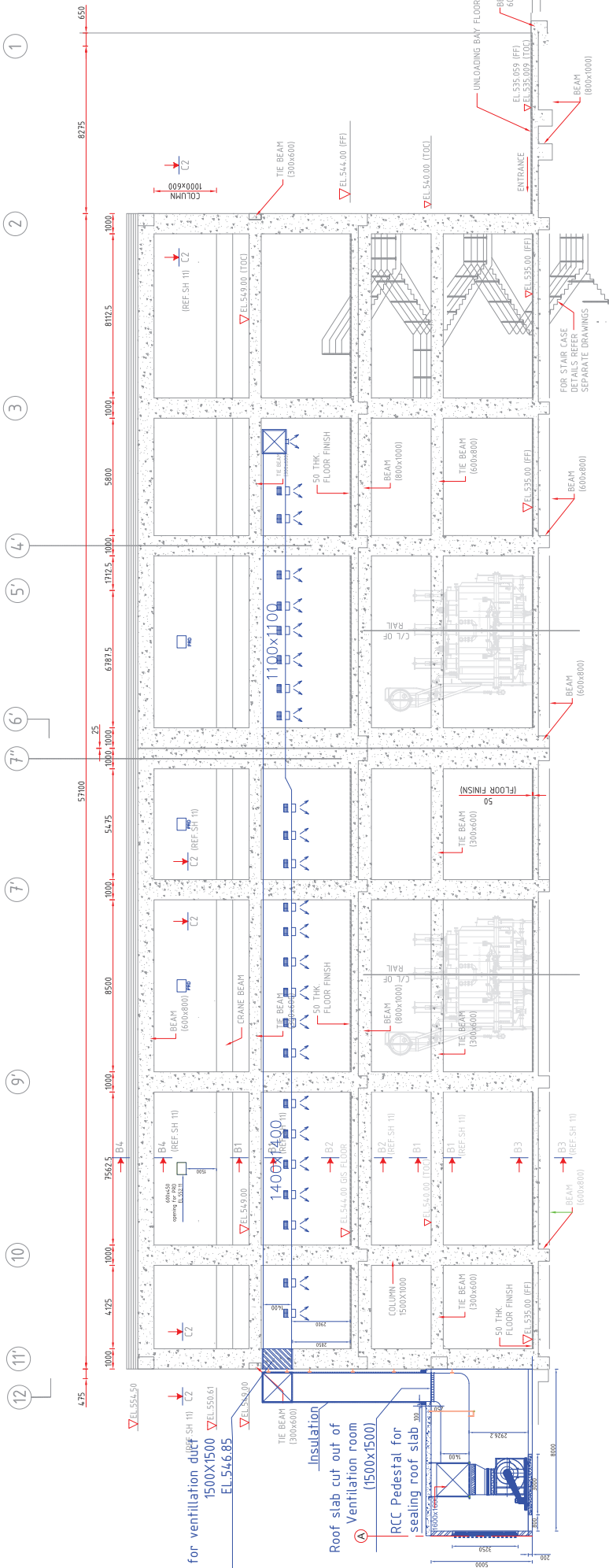
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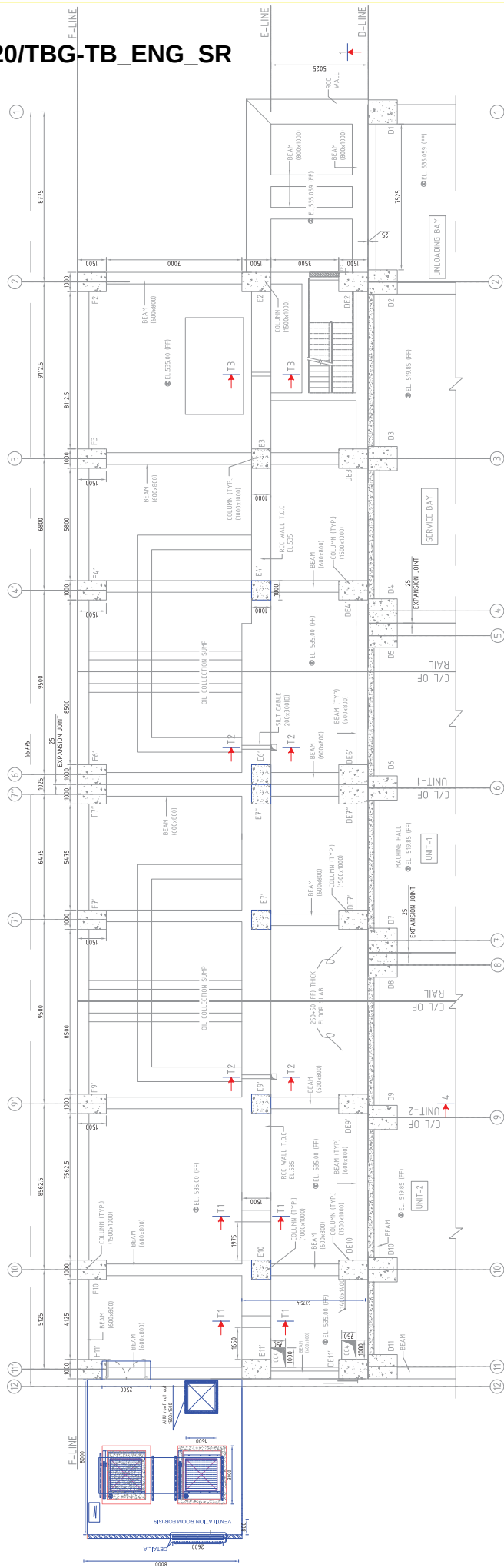
SCHEDULE –3**ENCLOSURES TO SPECIFICATION****(ANNEXURE-A)****DRAWINGS**

1. Ventilation Duct Layout (Elevation)
DRG. NO. TB-DG-398-553-331
2. Ventilation Room (Plan at EL. 535)
DRG. NO. TB-DG-398-553-332
3. Ventilation Duct Layout (Plan at EL. 549)
DRG. NO. TB-DG-398-553-333
4. Ventilation Duct Layout (Section)
DRG. NO. TB-DG-398-553-334



Notes:

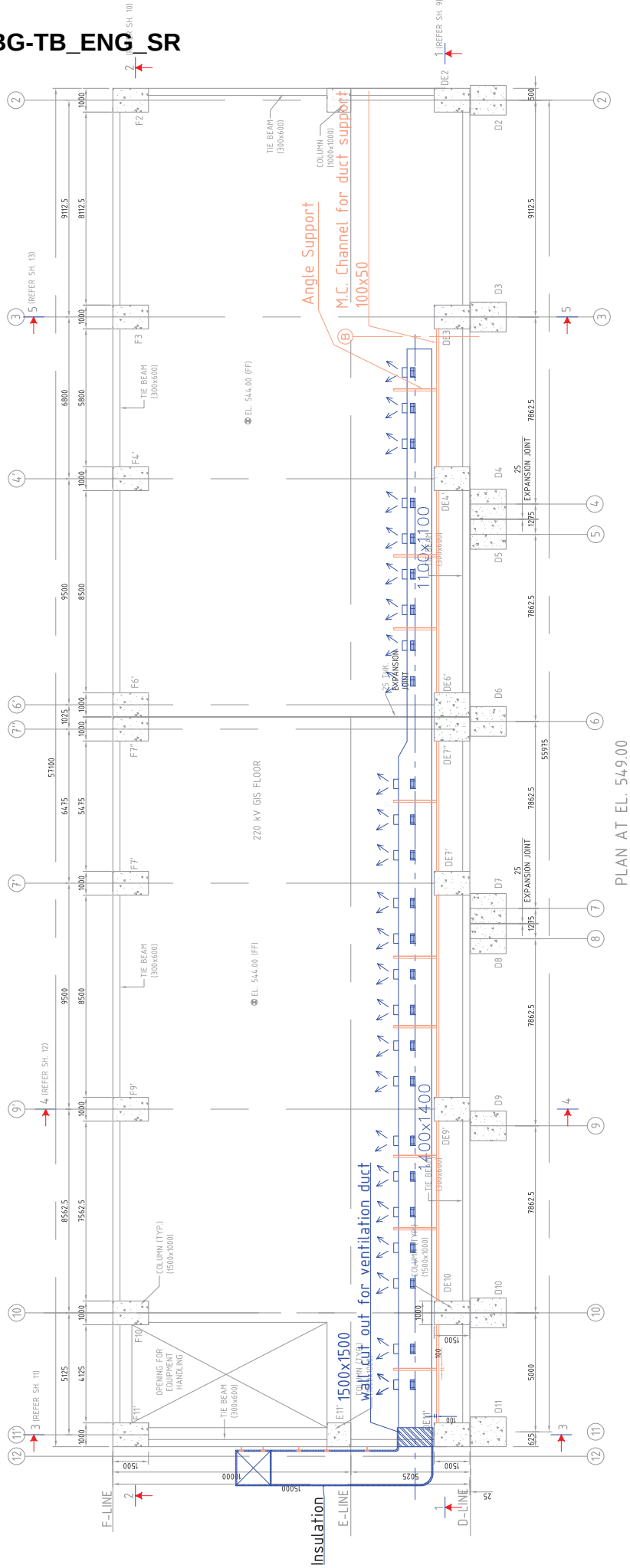
- 1. Ventilation room door size 2500x2500 opening outwards.
- 2. All dimensions are tentative, final dimensions may vary during detailed engineering.
- 3. All dimensions in mm.



PLAN AT EL. 535.00
(T.O.C EL. 534.95)
LAYOUT OF TRANSFORMER AND TRENCHES INDICATIVE ONLY.
FOR LAYOUT AND DETAILS REFER SEPARATE DRAWINGS

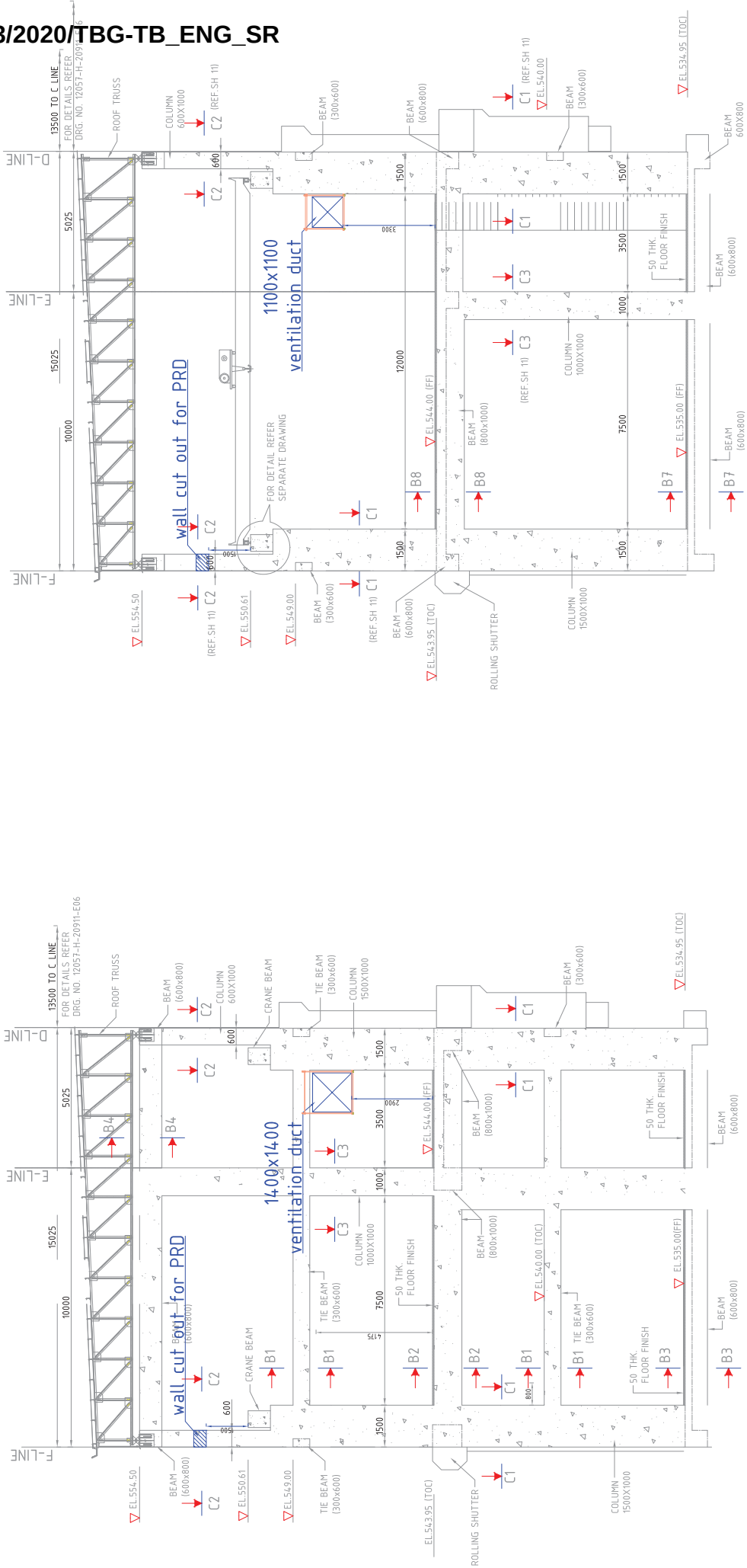
Notes:

1. Ventilation room door size 2500x2500 opening outwards.
2. All dimensions are tentative, final dimensions may vary during detailed engineering.
3. All dimensions in mm.



Notes:

1. All dimensions are tentative, final dimensions may vary during detailed engineering.
2. All dimensions in mm.



Notes:

1. All dimensions are tentative, final dimensions may vary during detailed engineering.
2. All dimensions in mm.