

**TAMILNADU GENERATION & DISTRIBUTION CORPORATION
LIMITED**

**1x800 MW TANGEDCO NORTH CHENNAI TPP (FGD
SYSTEM)**

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-485- (571-13000-A)-A002 (REV-0)



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
BHEL SADAN
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA**

**TITLE:****1X800 MW TANGEDCO NORTH CHENNAI TPP–
(FGD SYSTEM)****SPECIFICATION No: PE-TS-485- (571-13000-A)-A002 (REV-0)****SECTION****REV. 00****SHEET: 1 OF 2****CONTENTS****This Technical specification consists of two sections:****SECTION - I**

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TITLE:

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**1x800 MW TANGEDCO NORTH CHENNAI
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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION



**1x800 MW TANGEDCO NORTH CHENNAI
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1.0 INTENT OF SPECIFICATION

- 1.1 The specification covers design (i.e. preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants, chemicals, reagents and consumables required for pre-commissioning, commissioning , performance testing, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation, storage & preservation at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil and structural work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site, training of customer/client O&M staff, handing over and handover in flawless condition to BHEL's customer of **HVAC SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **1x800 MW TANGEDCO NORTH CHENNAI TPP– (FGD SYSTEM)**.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **HVAC SYSTEM**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all terms required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.



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- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under section II of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.
- 1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the format attached with GCC (Annexure-II Deviation sheet (Cost of withdraw), otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section - C shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please referred relevant clause of NIT.



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PROJECT INFORMATION

**ANNEX - 1.1**
PROJECT INFORMATION

1.0	General		
1.1	Project Title	:	1 x 800 MW North Chennai Coal Based Super Critical Thermal Power Project Stage III.
1.2	Plant capacity	:	800 MW
1.3	Type of project	:	Brown field
1.4	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
1.5	Plant site location	:	In the premises of North Chennai Thermal Power Station (NCTPS)
1.6	Location co-ordinates	:	80° 19' E to 80° 20' E Longitude 13° 13' N to 13° 18' N Latitude
1.7	Nearest Village	:	Ennore & Puzhuthivakkam Village
1.8	Nearest Town & City	:	Chennai (35 Km)
1.9	State Capital	:	Chennai (35 Km)
1.1	Nearest Railway Station	:	Athipattu Pudunagar (~ 5 Km) on Chennai – Vijayawada Line
1.11	Nearest Airport	:	Chennai (~ 60 Km)
1.12	Nearest Seaport	:	Ennore (~ 3 Km)
1.13	Nearest Road access	:	All weather road from Pattamandri on the Thiruvottiyur – Ponneri highway
2.0	Meteorological Condition		
2.1	Climate	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind
2.2	Site Elevation	:	(+) 10.0 Meter above Mean Sea Level
2.3	Ambient Temperature		
a.	Annual Maximum Mean Temperature	:	45 °C
b.	Annual Minimum Mean Temperature	:	15 °C
c.	Design ambient temperature	:	30 °C
2.4	Relative Humidity		
a.	Maximum	:	90%
b.	Minimum	:	36%
c.	Design	:	75%
2.5	Annual Rainfall		



	Maximum	:	2540 mm
	Average	:	1600 mm
	Minimum	:	1175 mm
2.6	Basic Design Wind Pressure	:	As per IS: 875 (Latest Edition)
2.7	Wind Speed	:	11.8 kmph (Avg), 50 m/s (max)
2.7	Seismic zone	:	Zone: III as defined in IS:1893-2002
2.8	Design ambient temperature for Electrical equipment	:	50 °C



ANNEX- 1.3

SERVICE WATER ANALYSIS

The Service water (make-up water) water quality is mentioned below:

Sr. No.	Parameter	Unit	Result
1	Temperature	°C	35
2	pH	-	7.5 – 8.2
3	LSI		0 -0.2
4	Alkalinity		< 100 PPM of Ca CO ₃
5	Hardness		< 80 PPM
6	Chloride		< 350 PPM
7	Sodium		< 170 PPM



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SPECIFIC TECHNICAL REQUIREMENT



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1. FUNCTION

The purpose of the system is to provide HVAC for different areas of 1x800 TANGEDCO NORTH CHENNAI TPP-FGD under the scope of this tender.

SYSTEM DESCRIPTION

The basic engineering of the Air Conditioning (AC) system, including heat load calculations, P&IDs, equipment capacities, and equipment layouts, has been approved and finalized with the Customer. Accordingly, all Civil, Electrical, and C&I inputs associated with these finalized engineering documents shall be deemed frozen. Equipment selection shall be based strictly on these approved inputs, and no deviations from these parameters shall be permitted.

Equipment/Layout drawings corresponding to the specific makes of the respective equipment (as listed in Table below) have also been finalized and are enclosed under Sub-Section 7 (Appendix 1) of this Specification. In the event that the Bidder offers the same makes/models as specified, submission of these drawings/documents afresh shall not be required. However, during the detailed engineering stage, the Bidder shall formally endorse the documents enclosed in Sub-Section 7 (Appendix 1).

The Bidder may alternatively propose equipment makes other than those for which drawings/documents have been included in this Specification, provided such makes are selected from the approved list of sub-vendors specified under approved Sub Vendor List. In such cases, the Bidder shall submit complete engineering documents for the proposed equipment, consistent with the scope and level of detail provided in the corresponding equipment General Arrangement (GA) drawings/documents enclosed in Appendix 1.

Notwithstanding the above, any information that is proprietary in nature, forms part of the OEM's standard design for the offered model, or is not specifically stipulated in this Tender Specification for the respective equipment, may be suitably updated or modified, provided such changes do not alter the approved basic engineering philosophy, interfaces, functional requirements, capacities, layouts, or frozen Civil, Electrical, and C&I inputs.



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Equipment/Item	Approved Make
Air Handling Unit	Waves Aircon (Wolter)
Air Cooled Dx Condensing Unit	Voltas
Unitary Filtration Unit	Air Movement and Control System
Pump	SAM TURBO
Pot Strainer	D. S. Engineering
Valves	Sant Valves
Axial Fan	Air Movement and Control System
Split/ Cassette ACs	Voltas
Insulation	Supreme/Twiga
Pressure/Temperature Gauge	Gauges Bourden
Air/Water Flow/Differential/Level Switch	D. K. Instruments
Temperature Cum RH Sensor	Honeywell
Air Differential Pressure Switch	Kasturba Udyog (Now Orion)
Ahu Fan Pressure Switch	Kasturba Udyog (Now Orion)
Junction Box	Pustron

Scope of Supplies

- **DX Type Air-Cooled Condensing Unit of minimum 60 TR actual cooling capacity** for the FGD Control Room, complete with matching Air Handling Units (AHUs), electric heater, humidifier, controls, refrigerant piping, accessories, and all associated components required for a complete, fully functional, and satisfactory HVAC system
- Air conditioning units as per the approved heat load calculations, complete with all associated equipment, piping, controls, and accessories required for a complete installation.
 - **Cassette Type Air Conditioners** for the Conference Room in the FGD Control Room Building.
 - **Hi-Wall Split Air Conditioners** for the C&I Staff Room, Shift In-Charge Room, O&M Room, Log Record Room, and other designated rooms in the FGD Control Building.
 - **Hi-Wall Split Air Conditioners** for the SO₂ Analyser Room
 - **Hi-Wall/Cassette type Split Air Conditioners** as per requirement for any other smaller areas which are away from the Air-Cooled Conditioning units, require air conditioning

Split AC shall be supplied along isolation switch (MCB of suitable rating with MCB box), voltage stabilizer, ISI-marked power accessories for each single-phase Split AC (1 No. 5-pin power socket of min. 20A rating, 1 No. 3-pin power plug of min. 20A rating, and 1 No. MCB with MCB box) cabling, all supporting structure, refrigerant piping to suite actual site condition, drain piping up to nearest drain etc.



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- **Modular type UAF units of 90,000 CMH** capacity for non-air-conditioned area of FGD control room building considering design philosophy for evaporative type ventilation system.
- **Axial flow fans** as per approved ventilation fan schedule for Non-AC areas/buildings

Other items/equipment as are mentioned in any part of tender document or is required for completion of system.

2. DESIGN CRITERIA:

The outside design conditions considered are as follows: -

	Summer	Monsoon	Winter
DBT (°C)	46.5	15.6	29.4
WBT (°C)	24.7	11.1	27.2

The inside design conditions to be maintained are as follows:

2.1. For Air Conditioning System

- 22°C ± 1°C & RH 50% ± 5% for Air-Conditioned Areas of FGD Control Building
- For winter heating load calculation, 50% of combined light load and eqpt. /Panel load as available in the room shall be considered.
- Fresh air requirement shall be minimum 1.5 air change per hour for control room areas or 35 m³ per hour per person whichever is higher. For other areas like office, Fresh air shall be considered as per ISHRAE
- A margin of 10% shall be considered for the capacity of equipment like Condensing Units, AHUs etc.
- Lighting load, minimum 2 W / Sq ft. or actual whichever is higher shall be considered
- The Occupancy shall be considered as One (1) person in 10 sq.m in general, and One (1) person in 25 sq.m in control room, CER etc. or (actual).
- Necessary Heater and Humidifier shall be provided
- Air and water velocity for Air Conditioning System –

1.	Main Ducts	7.5 m/sec
2.	Branch Duct	6.0 m/sec



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3.	Grill/Diffuser	2.0 m/sec
4.	Louvers for Air inlet	2.5 m/sec
5.	Water velocity in piping	2.5 m/sec
6.	Water velocity in piping (gravity flow/pump section)	1.5 m/sec
7.	AHU (face Velocity)	2.5 m/sec

- i) Air Curtains to be provided at each entrance of FGD Control Room.
- j) For other design parameters refer relevant clauses of section C2-A, customer specifications.

2.2. For Ventilation System

- a) Air Changes per Hour shall be as follows: -

• For all evaporative type ventilation system	8
• DG Set	45
• Electrical Room like M.C.C room, Switchgear Room	15
• Battery Room Areas	30
• General Areas	20
• Toilets	30

- b) Inside temperature shall be kept 3° C below the design ambient temperature during summer for ventilated areas of Control Room Building.
- c) In dry type forced (mechanical) Ventilation System where the ambient air is drawn and distributed inside the building/room and then exhausted, the average design condition inside the space to be ventilated is to be restricted 5°C higher than the ambient (outside) dry-bulb temperature. Higher of the air quantities obtained by the Air Change Method and Heat Load Calculation Method shall be selected.
- d) All equipment shall be designed for continuous duty.
- e) Air and water velocity –

For Ventilation System –

1.	Main Ducts	12 m/sec
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2.	Branch Duct	9.0 m/sec
3.	Grills	3.75 m/sec
4.	Backdraft dampers	6.0 m/sec
5.	Water velocity in piping	2.5 m/sec
6.	Water velocity in piping (gravity flow/pump section)	1.5 m/sec
7.	UAF (face velocity)	2.0 m/sec

f) Ventilation philosophy for all ventilated areas shall be as follows -

S. No.	Area	Type of Ventilation
1	Non-AC area of FGD Control Room Building	Modular type UAF units of suitable capacity (1x100%) with exhaust through gravity damper
2	General area like pump house, building etc.	Mechanical dry type ventilation through Combination of supply air fan & exhaust air fans
3	MCCs and Switchgear room etc.	Mechanical dry type ventilation through combination of wall mounted axial flow Supply air fan & back draft dampers
4	Battery rooms & Oil rooms and fumes / door generates	Mechanical dry type ventilation through Combination of intake louvers & Exhaust air / roof extractor fans motors shall be flame proof
5	Toilet / pantry etc.	Propeller type exhaust air fan.

Any other building to be ventilated shall be provided by combination of wall mounted axial flow supply fans with gravity dampers or wall mounted axial flow exhaust fan with inlet louvers. For other design parameters refer relevant clauses of section C2-A, customer specifications.

3. EQUIPMENT AND SERVICES TO BE PROVIDED FOR AIR CONDITIONING SYSTEM

3.1. AIR COOLED CONDENSING UNIT (DX TYPE)

Refer to relevant clauses of section C2-A, customer specifications.



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3.2. AIR HANDLING UNIT

Refer to relevant clauses of section C2-A, customer specifications.

3.3. HI-WALL SPLIT/CASSETTE AIR-CONDITIONERS

- a) Areas like C&I Staff room, Shift- Incharge Room and O&M, Logs Record Room etc. shall be provided with sufficient capacity of Non Ductable split Air conditioner with 100% redundancy.
- b) Air conditioning requirement of Conference Room shall be catered by Cassette Air conditioners of sufficient capacity with (100%) redundancy.
- c) For other details refer to relevant clauses of section C2-A, customer specifications

3.4. STRIP HEATER PACKAGE AND HUMIDIFICATION PACKAGE

- a) One common set of electrical strip heaters package of approved capacity complete with contactor, air-stat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat, mounted inside the AC plenum/duct for AHU Room.
- b) One No. Pan humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc for each AHU Room.
- c) Temp gauge, temp element, RH and temp sensor shall also be provided and the same shall be hooked with DDCMIS system.
- d) Refer to relevant clause of section C2-A, customer specifications

3.5. SHEET METAL WORK

- a) GSS supply and return air Ducting (as per IS-277) with 275 gms/sqm of zinc coating complete with vanes, damper, hangers / supports etc. Insulation of supply air AC duct and return air duct, piping, fitting etc. shall be provided as per relevant clause of customer technical specification.
- b) Supply air diffusers / grilles (Frame and Louvers of Diffuser/Grilles shall be of extruded aluminum of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no Volume Control Damper.
- c) Other details shall be as per customer technical specification

3.6. INSULATION

Refer to relevant clauses of section C2-A, customer specifications.



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3.7. PIPING VALVES ETC.

Refer to relevant clauses of section C2-A, customer specifications

3.8. FRESH AIR FAN

Fresh air fan with pre-filter & fine filter in all AHU Rooms.

Other details shall be as relevant clauses of section C2-A, customer specification

3.9. Air Curtain

- a) Industrial Grade and fully automatically controlled (with on/Off control with door switch, Heat On/ Off control with room thermostat and Fan speed control with two phase thermostat). Air Curtains shall be designed in accordance to ISO 27327
- b) Self-supporting casing construction along with filter at inlet supply of air shall be provided
- c) Air curtain shall be with Low noise.



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4. EQUIPMENT AND SERVICES TO BE PROVIDED FOR VENTILATION SYSTEM.:

4.1. UNITARY AIR FILTRATION

Each UAF shall comprise of –

- a) One (1) No. (100% duty) Centrifugal fan backward inclined, DIDW type, complete with electric drive motor, drive Pulleys, V-belt, belt guards, slide rails and other accessories etc as per relevant clauses of section C2-A, customer specifications
- b) Centrifugal type pump for circulation of water relevant clauses of section C2-A, customer specifications.
- c) Other details shall be as per relevant clause of section C-2, Customer specification.

4.2. WALL MOUNTED AXIAL FLOW FAN

Each wall mounted axial flow fan shall be complete with

- a) Electric drive motor with coupling if any, including motor brackets.
- b) Other details shall be as per relevant clause of section C-2, Customer specification.

4.3. INSULATION

- a) Thermal insulation shall be provided for the duct exposed to sun / rain.
- b) Please also refer to other relevant clauses of Customer technical specification section C-2A for detail construction of insulation.

4.4. FIRE DAMPAERS

- a) For fire damper refer to relevant clauses of section C2-A, customer specifications

5. SPECIFIC REQUIREMENTS: -

- a) The system shall be designed to maintain specified inside design conditions during peak summer under design outdoor condition.
- b) All ventilation system shall operate on 100% fresh air.
- c) The fire damper shall close the air flow inside the duct on receiving fire alarm signal from FPS. Also, respective fan shall trip once the fire damper is closed.



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- d) The name plate rating of all motors at 50deg C shall have at least 10% margin over the input power requirement of the driven equipment at rated duty point.
- e) RE / wall mounted fans shall be selected so as to have motor rating and wall / slab opening as under. Feeder suitable for following ratings only shall be provided by BHEL.

1.	Roof extractor units with 15 mmwc static pressure.		
	Capacity	Motor rating	Roof / Slab opening
a.	50,000 CMH	5.5 KW	1320 mm
b.	40,000 CMH	5.5 KW	1320mm
c.	20,000 CMH	2.2 KW	1140mm
2	Axial flow supply fans with 30 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	2.2 KW	800mmx800mm
b.	7,500 CMH	1.5 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	500mmx500mm
3	Axial flow supply fans with 20 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	600mmx600mm



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4	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	2.2 KW	900mmx900mm
b.	10,000 CMH	1.5 KW	800mmx800mm
c.	7,500 CMH	1.1 KW	700mmx700mm
d.	4,000 CMH	0.75 KW	600mmx600mm
e.	2,000 CMH	0.55 KW	500mmx500mm
5	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	4,000 CMH	0.55 KW	600mmx600mm
f.	2,000 CMH	0.37 KW	500mmx500mm
6	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1200 CMH	100 W	330 mm circular



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6. CONTROL PHILOSOPHY

A common DCS based control system shall be provided for both Air conditioning and Ventilation System

Refer to clause of section, C-4 of specification.

7. ACCEPTANCE TEST

7.1. For Air Conditioning System

Room condition test shall consist of taking the reading of dry bulb and wet bulb temp at different locations points to be mutually decided at site in the areas which are air-conditioned by the respective system/plant. Room condition test shall be done after stabilization of the system. The dry and wet bulb temp shall be measured by sling psychrometer which will have accuracy of $\pm 0.5\%$ with a least count of 0.5 degC. This will be carried out for 24 hrs continuously and readings will be taken every one-hour interval. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer during summer season when the dry bulb temp is generally high. Relative humidity shall be determined from psychometric chart.

Noise and Vibration measurement of various equipment shall be done at site

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

7.2. For Ventilation System

Air flow measurement of fans for ventilation system shall be done at supplier's works only

Noise and Vibration measurement of various equipment shall be done at site.



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8. GENERAL

- 1) Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.
- 2) Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.
- 3) The bidder shall be responsible for providing necessary storage facilities for materials supplied.
- 4) All commissioning spares & consumables for trouble free operation till handing over, shall be provided.
- 5) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage. Standard QP format is enclosed in the technical specification.
- 6) Indicative list of makes is enclosed as per Annexure-I however this equipment / items shall be subject to Customer & BHEL approval during detail engineering Stage.
- 7) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.
- 8) Fixing frame works for diffusers and grilles in the scope of Vendor.
- 9) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.
- 10) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipment etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.

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11)

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

12)

Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.

13)

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

14)

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

15)

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

16)

Instrument for testing shall be calibrated by vendor/supplier before taking up testing.

17)

Pressure gauges shall have provision for air venting. Three-way valves shall be used which shall have air venting provision.

18)

Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied (as per attached instrumentation installation diagram)

19)

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

20)

The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of air conditioning and ventilation system.

➤

Performance test of the Air conditioning system shall be carried out at site after proper installation. The site test shall include performance testing of equipment for minimum 72 continuous hours in summer or monsoon and minimum 24 continuous hours in winter. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.

➤

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.

21)

For group of motorized fire damper / 3 Way valve actuators / motorised valves, single phase power supply shall be provided by BHEL in AHU room. Suitable transformer shall be provided

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by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

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

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

24) 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.

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

26) 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. Standard QP format is enclosed in the technical specification.

27) Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

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

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

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30)

Supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

31)

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.

32)

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

33)

The bidder’s proposal shall be for equipment in accordance with the tech. Specification.

34)

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

35)

All openings required in brick wall for installing the axial supply and exhaust fans, propeller fans, duct opening, louvers and damper openings etc shall be done by BHEL as per opening sizes indicated under clause number 7. Any opening requirement on account of change in size of equipment over and above the opening size indicated under clause number 7, same shall be done by vendor along with finishing of opening and painting as per finished wall. Grouting of fans along with anchor fasteners shall be done by vendor. The openings shall be finished properly. In case openings are done once the wall has been painted, repainting, to match with the existing wall paint shall also be done by the vendor. Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Ventilation system vendor.

36)

All codes and standards shall be as per contract specifications

9. SCOPE OF SERVICES

Scope of services by bidder will include but not necessarily limited to the following:

a)

Unloading, Storage, handling and transportation at site

b)

Erection & Commissioning of AC & Ventilation System

c)

Necessary supports and structures / frames etc. as required for supporting the duct /piping equipment etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.

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- d) Foundations for HVAC Equipment: Plain Cement Concrete (PCC) / Reinforced Cement Concrete (RCC) foundations for all HVAC equipment shall be provided as per approved foundation drawings. However, the Bidder shall be responsible for ensuring the adequacy of foundation dimensions and locations based on the final equipment selection and vendor drawings. Any modifications required to suit the equipment shall be carried out at no extra cost to the BHEL.
- e) Pockets / Openings / Embedded Inserts: The Bidder shall provide all necessary pockets, sleeves, embedded inserts, and openings in the foundation required for anchoring, grouting, or fixing of HVAC equipment. The Bidder shall furnish the details such as size, location, and quantity of anchor bolts, pockets, and inserts to the BHEL well in advance to facilitate timely incorporation during foundation casting.
- f) Minor civil work like chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself including special type of grouting like GPX2 etc, making opening to suit / finishing of opening after completion of AC Equipment erection, sealing of duct / pipe opening etc.
- g) Making Good / Repairing / replacement of and damaged done by bidder to adjacent structure, pipes etc. while erecting equipment's related to AC & Ventilation System
- h) Drain piping up to the drain point to be provided by the Vendor.
- i) Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation like refrigerant, grease, lubricants, anemometer, tachometer, ammeter, voltmeter etc. for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.
- j) Inspection & testing, Performance Requirements and Performance Guarantees as per the specification.
- k) Painting of equipment's, valves, pipes and other accessories within scope of supply
- l) Electrical scope as per enclosure elsewhere in the specification
- m) Training of plant Owner's personnel O&M operators' personnel on plant operation and maintenance as per Customer specification
- n) Relevant requirements as per GTR, GCC & SCC
- o) Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.
- p) For motorized fire damper / 3 Way valve actuators / motorized valves, power supply shall be derived by vendor from respective control panels. Suitable transformer shall be provided by



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bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

- q) Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to DCS / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.
- r) Supports required for supporting the fan and/or filter section for Axial fans shall be under bidder's scope.
- s) Local push button station shall be provided for local operation of the Unitary Air Filter (UAF). In case multiple AHU's or UAF are kept in a room or in vicinity, common Local Push Button Station shall be provided for local operation of all the AHU / UAF in the room or located in vicinity.

10.EXCLUSIONS

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

- a) Construction of AHU room, foundations for HVAC equipment's.
- b) False ceiling, drop ceiling.
- c) Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers. However minor civil work like making opening to suit / finishing of opening, sealing of duct opening, grouting of foundation bolts including special type of grouting like GPX2 etc. are in the scope of HVAC system vendor.
- d) Various cable & pipe trenches, pipe pedestals, drains, sumps, insert plates for pedestals for pipe supports.
- e) DCS Control panel for Operation and control of AC System and Ventilation System. However, all logic for implementation of control and monitoring from DCS shall be provided by successful bidder during detail engineering.
- f) For Electrical scope, refer Electrical scope matrix sheet.

11.Codes and Standards

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below:

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IS-659: Safety code for air-conditioning

IS-660: Safety code for mechanical refrigeration

ASHRAE-23: Standard method of testing and rating [67 Standards] air conditioner.

ARI-450-6: Standards for water cooled refrigerant Condenser.

ASME Sec. VII: Unfired pressure vessels

IS-4503: Shell and tube type heat exchanger.

ASHRAE 22-72: Method of testing for rating water cooled refrigerant condenser.

ASHRAE-15-2007: Safe Standard for Refrigeration System

ASHRAE-30-1995: Method of testing liquid chilling packages

ANSI-8-31.5: Refrigeration piping.

ANSI-8-9.: Safety code for mechanical refrigeration.

AR1-410 : Standard for air cooling and air heating coils.

AR1-210: Standard for unitary air conditioning equipment.

IS-3588: Specification for electrical axial flow fans.

AMCA-210: Methods of performance test for fans.

BS-2831: Methods of test for air filters used in AC and general ventilation.

IS-4671: Expanded polystyrene for thermal insulation purpose.

IS-702: Industrial bitumen

IS-1239: Heavy class Pipes for sizes up to 150 mm dia.

IS-8188: For Water conditioning

IS-325: 3 phase induction motors

IS-4029: Guide line for testing 3 phase induction motor

IS-210: Specification grey iron casting

IS-2062: Structural steel

AMCA - Bulletin: Standard code of testing centrifugal and axial No. 210 flow fans

IS-2825: Code of practice for welding mild steel



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IS-2676: Dimensions for wrought aluminium and aluminium alloy sheets and strips.

ASHRAE Code: For various filter

ASHRAE-62-2004: Ventilation rates

IS-655: Specification for metal air ducts

Pump design and testing should correspond to the procedure mentioned in IS-1520

10 Operation and Maintenance Services

The bidder scope also covers the Operation and Maintenance (O&M) services for Preventive and Breakdown maintenance from the date of successful commissioning of HVAC System to end customer. However, actual date of start of O&M services shall be communicated to successful bidder by BHEL site personnel.

Bidder to note that the spares and consumables required for maintenance of the equipment during this O&M period shall be in bidder's scope of supply. Bidder shall use only genuine parts as mentioned in O&M Manual. Any damage or malfunction caused by the use of unauthentic parts or unqualified personnel shall be responsibility of bidder and as a consequence of above bidder is required to replenish the unauthorised part and abridge the qualified person without any commercial implication to BHEL.

O&M Services scope also covers all regular maintenance by certified and trained service engineers and supply of genuine parts and lubricants as per the original equipment manufacturer's recommendations in a pro-active manner.

For the purpose of Operation of HVAC System, One-day shall be considered as 24 hours i.e. 3 shifts of 8 hours each. The HVAC System (along with related accessories) shall be operated on Round-the-clock basis on all the days of the year including Sundays and Public Holidays

O & M Personnel should be acquainted with local language. Governmental / Statutory approval w.r.t. O&M service as applicable shall be in bidder's scope.

Total duration of the Operation and Maintenance services by Bidder can be increased or decreased as per requirement and payment in such case shall be made on pro-rata basis.

Depending on start of O&M services, there is a possibility that some period of O&M services and Warranty period may overlap. However, it is clarified that any maintenance required or any spare of HVAC System required to be replaced during Warranty period (as part of warranty clause requirement) shall not be made part of O&M Services. Bidder may take care of this fact while working out the prices of O&M services.

Wherever AC system has been written in O&M Service Specification, the same shall be deemed as complete HVAC System.

The vendor shall deploy following minimum manpower for Operation of HVAC System.

One qualified and experienced AC operator per shift on "Round the Clock" basis throughout the year for all days of the year including Sundays & Public Holidays. There must be minimum 30 minutes overlapping between two shift operators to get familiarize with the status of HVAC System. Under normal circumstances one shift shall not be more than 8 hours.

One Helper per shift on " Round the Clock" basis throughout the year for all the days of the year including Sundays and Public Holidays. The helper shall assist the HVAC System Operator in day to day operation of HVAC System and accessories and shall assist him for keeping HVAC System equipment's in neat and tidy condition. Under normal circumstances one shift shall not be more than 8 hours

10.1 Responsibility of HVAC System Operator

- i. HVAC System operator shall be responsible for proper sequential operation of HVAC System (AC and Ventilation System) including operation of standby equipment in a predefined sequence and stopping the same (when necessary) as per the procedural practice. In case of any abnormality (like non availability of power supply at in-comer of HVAC System), he shall immediately report the matter to BHEL site Engineer for further action. Similarly, any malfunctioning in the system shall be immediately reported by him to BHEL site Engineer for suitable corrective action irrespective of time of occurrence of malfunctioning / abnormality in the system. A log book of all such outrages shall be maintained by HVAC system operator, which shall be shared with BHEL site engineer on periodic basis.

- ii. HVAC System operator shall take hourly readings of all the parameters of HVAC System / Equipment's including reading on main electrical panel of HVAC System. Temperature & RH readings inside all AC areas shall be taken at least once in a day. All the readings shall be recorded in a logbook register.

10.2 Responsibility of Helper.

- i. The HVAC System helper shall assist HVAC System operator for day to day smooth operation of HVAC System, like leaning of AHU filters and other filters etc. as and when required. He shall be responsible for keeping all the equipment's of HVAC System including DX Unit & AHU rooms in clean and tidy condition. He shall also carry out general cleaning of all AC equipment's including Electrical Panels (Part of AC System), AHU's etc. on regular basis.
- ii. The helper shall work under the control of HVAC System operator and shall always ensure that unusable junk materials are not allowed to be kept in HVAC System room or AHU rooms. Under such eventuality, he will report the matter to Plant Operator, who in turn will take suitable action including reporting the matter to BHEL site Engineer.

10.3 All the log book registers shall be arranged by vendor. Log book register duly paged and bounded will be maintained in good condition by vendor.

10.4 All the necessary tools and other materials, required for operation of HVAC System shall be kept by vendor under the control of HVAC System operator. Required testing instruments like refrigerant leak detector, Multi Meter (for Electrical portion of HVAC System), Sling psychrometer, Line Tester, Tool Kit, Torch etc. should also be always available with Plant Operator.

10.5 In case of any operator / helper being on leave, vendor shall immediately take advance action and provide substitution so that minimum manpower as indicated above is not reduced on any day. In case a particular shift duty A/C Operator or helper does not turn up due to any reasons, the earlier duty person shall continue to make sure that HVAC System never remains unattended.

11 Maintenance of HVAC System

- i. Maintenance work under scope of the vendor shall broadly include but in no way limited to the following:

- a) Preventive maintenance of the plant.
- b) Servicing of the plant at regular interval including cleaning of AHU filters etc.
- c) Attending to complaints.
- d) Replacement of worn out or defective components
- e) Replacing of refrigerant gas and oil as and when required.

No consumable or any other items of HVAC system shall be arranged by Customer and no extra payment shall be made by customer in this regard.

- ii. Vendor shall be responsible at all time, during the entire period of contract for satisfactory performance of HVAC system (including accessories) with zero down time. During emergency or breakdown, vendor's Engineer along with related technicians shall be available immediately even though it may be beyond normal working hours or on public holidays till the HVAC System is restored back into normal satisfactory condition. Response time for attending breakdown complaints shall not exceed 2 hours.
- iii. Defective / worn out components shall be replaced only by genuine and original parts. OEM or its authorized dealer's invoice shall be submitted as proof of using genuine parts. All common spares required for HVAC system shall normally be kept available in the plant by the vendor. However, for critical spares, the same shall be made available in not more than 72 hours from the time of break-down requiring such spare.
- iv. Preventive Maintenance, servicing of HVAC System equipment's and accessories etc. shall be done by vendor in a planned manner in consultation with concerned customer's engineer. Preventive maintenance and service should be done as per the recommendations / guidelines of various OEMs
- v. Major servicing & over handling of equipment's like compressors, evaporators, condensers, pumps, AHU's, piping / ducting works, valves etc. shall be done by vendor once in a year.
- vi. Painting of all equipment's including base frames & accessories like piping, electrical panel boards etc. shall be done once in two years.
- vii. In case any repair/services of particular equipment of system like chiller unit is to be carried out by vendor through OEM (or their authorized dealer), all the arrangements including tools, O&M spares etc. shall be the total responsibility of vendor.

- viii. Vendor shall arrange and maintain separate logbook register for services / maintenance of HVAC System. Record of work done for services/maintenance repairs etc. shall be recorded by vendor's engineer in this register. This register shall always be with updated records & shall be produced to customer's engineer on weekly basis or as & when required by him.
- ix. Vendor shall arrange and maintain sufficient stock of spares and consumable at site (HVAC room). Similarly, all necessary tools & instruments required for the purpose of servicing / maintenance / routine testing etc. shall also be arranged by vendor and should be available at site at all times.
- x. Repairs / servicing works shall normally be done by vendor at site up to maximum possible extent. However, in case any equipment or accessories is essentially required to be taken by vendor out of the plant premises for repairing / servicing, all necessary arrangements including to and fro transportation shall be the responsibility of vendor. Vendor shall also inform concerned customer's engineer for doing procedural formalities (like issue of gate pass etc.), prior to taking out the materials out of Plant premises.
- xi. In case bidder fails to supply the spares required for maintenance of the equipment, same shall be provided by BHEL at Bidders risk and cost.
- xii. Vendor shall be fully responsible for safety of his personal at all times. Vendor shall also be responsible for taking all safety precautions at all the times, especially during servicing / preventive maintenance and repairs of HVAC System equipment's etc.
- xiii. All the safety controls of AC Plant such as HP, LP, OP, Water pressure switch, inter locking etc. shall be positively checked at least once a month and same shall be recorded by vendor engineer
- xiv. Technicians & helpers engaged by the vendor shall wear uniform with nameplate for easy identification, while being within plant premises
- xv. Vendor's engineer shall be focal point for customer. He shall report to customer engineer on daily basis, for taking necessary instructions and to update the status of AC system
- xvi. If any damage to the equipment and its accessories has happened due to improper maintenance by bidder shall be recovered from the bidder.
- xvii. Bidder is to arrange all the safety gears like helmets, air plugs, safety shoes etc. during the maintenance for the O&M Staff.



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TPP– (FGD SYSTEM)
HVAC SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**

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SECTION : I

SUB-SECTION : C-2

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CUSTOMER SPECIFICATION



VOLUME – II

SUB-SECTION 2.7

AIR CONDITIONING & VENTILATION SYSTEM

1.0.0 INTRODUCTION

This section covers minimum requirements for design, engineering, fabrication, manufacture & assembly, inspection, erection, testing and commissioning of complete air conditioning and ventilation system for FGD plant buildings, equipment and entire FGD area.

2.0.0 CODES AND STANDARDS

Design, Manufacture, inspection and testing of equipment covered under this specification for HVAC 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 confirm the latest applicable Indian/British/American standards. Some of the applicable standards are listed below.

ASHRAE	
ISHRAE	
IS 325	Three phase induction motors
IS 655	Metal Air ducts
IS 2312	Propeller type AC ventilation fans
IS 3588	Electric axial fans
IS 4894	Centrifugal fans
UL 555	Fire dampers

3.0.0 AREAS TO BE AIR CONDITIONED

3.1.0 The areas to be air-conditioned shall be as follows:

- a) Air cooled condensing units (Dx type) type air conditioners with AHU of suitable capacity with 100% redundancy (as per approved heat load calculation) shall be provided for FGD Control room building.
- b) Cassette and Hi-wall Air-conditioners for Other auxiliary control room /control room buildings is also covered in the scope of Bidder.

4.0.0 AREAS TO BE VENTILATED

- 4.1.0 (i) Modular type UAF units of suitable capacity (1x100%) shall be provided for non-air-conditioned area of FGD control room building considering design philosophy for evaporative type ventilation system. All non-air-conditioned area of FGD control room building (cable gallery & MCC room shall be positively ventilated and exhaust shall be through gravity damper.
- (ii) Mechanical Ventilation (using Roof extractors/ Supply and/or Exhaust fans) shall be provided for various other areas/buildings in the scope of bidder as under:
 - a) Grinding system building
 - b) Gypsum dewatering building
 - c) Recirculation pump & Oxidation blower/compressor building.



- (iii) Toilets in above building (i) & (ii). Any other area not listed above but covered in the scope of Bidder.
- (iv) For other miscellaneous areas/ buildings not listed above but covered in the scope of Bidder, mechanical type ventilation system using Supply and/or exhaust air fans/ roof exhausters shall be provided.

4.2.0 All non-air-conditioned areas covered under this package shall be ventilated by a combination of supply/exhaust fans and fresh air in-take back draft louvers as detailed below

Sl. No.	Area	Type of Ventilation System
(i)	General area like pump house, building etc.	Combination of supply air fan & exhaust air fans
(ii)	MCCs and Switchgear room etc.	Supply air fan & back draft dampers
(iii)	Battery rooms & Oil rooms and fumes / door generates	Combination of intake louvers & Exhaust air / roof extractor fans motors shall be flame proof
(iv)	Toilet / pantry etc.	Propeller type exhaust air fan.

5.0.0 DESIGN CRITERIA

5.1.0 Outdoor Design Conditions:

Season	Dry Bulb Temp. (°C)	Wet Bulb Temp. (°C)
Summer	46.5	24.7
Winter	15.6	11.1
Monsoon	29.4	27.2

I. Air-conditioning system

a) Indoor Design Conditions:

Dry bulb temperature : $22^{\circ}\text{C} \pm 1^{\circ}\text{C}$

Relative humidity : $50 \pm 10\%$.

- b) For fresh air quantity, number of air changes per hour shall be min.1.5 or 35 CMH/person or suitable to maintain over pressure of 2 mmWC, whichever is higher.
- c) Lighting load - 2 watts/ft² or actual whichever is higher shall be considered for heat load calculations.
- d) The occupancy for general area shall be minimum one person per 10m². In the control rooms, control equipment rooms the occupancy shall be considered one person per 25m² (Minimum) or part thereof.



- e) Minimum design margin of 12.5% on sensible heat, 10% on latent heat and 10% margins for overall heat respectively shall be considered while calculating heat load.
- f) Heat dissipation of panels shall be considered in the equipment sizing calculation for summer and monsoon season. 50% of equipment load shall be considered for winter load calculations.
- g) To reduce the air conditioning load, the exposed roof slabs (Including beams and column etc.) of air conditioning control room shall be insulated with 50 mm thickness fiber glass insulation of density 48 kg/m³ finished with 26 swg aluminum cladding.
- h) Noise level within the air conditioned space shall be restricted to 35-45 NC level with suitable acoustic attenuation (with duct silencer / acoustic insulation etc.).

II. Ventilation system

- a) The ventilation system shall be designed to maintain the dry bulb temperature not exceeding 5°C above design ambient summer temperature (heat load basis) or based on number of air changes per hour, whichever is higher.
- b) No. of air changes per for switchgear room as follows,

Area description	Air changes/hour
Switchgear/MCC room	15
Pump house	20
Toilets	30
Battery room/Areas where gaseous fumes/vapors are generated	30

- c) All the equipment of ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day, all indoor and outdoor installed units.
- d) A minimum 10% margin shall be considered while sizing the equipment capacity.
- e) All ventilation system shall operate on 100% fresh air. All mechanically ventilated areas shall be positively ventilated by means of supply air fans fitted with filters and/or gravity operated back draft dampers and exhaust fans. MCC room, electrical equipment room etc. shall necessarily be pressurized condition. Supply air fan catering for electrical areas shall be provided with fine filters and for other areas, supply air fans shall be provided with pre-filters only.
- f) Supply air fans, exhaust air fans for ventilations of each area shall be provided with local starter panels.
- g) The openings required for fan fixing and duct crossing shall be 50 mm larger than the fan fixing frame and duct size respectively including insulation.



5.2.0 Equipment Description - Air Conditioning System

Air-Cooled D-X type

Type	: Air cooled scroll type
Vibration isolators	: Steel spring / Neoprene rubber cushy foot type with isolation efficiency not less than 85%.
Compressor	
Type	: The Compressor shall be scroll, serviceable, either hermetic type or semi-hermetic type with automatic capacity control (minimum 3 steps).
Type of drive	: Motor driven, direct or through V-belt.
Refrigerant	: The refrigerant shall be R-134a/ R-410AIR-407C or any other environment friendly refrigerant.
Accessories	: High/Low pressure cutouts, oil pressure switches, relief valves, pressure gauges at each stage, lube oil and control oil pressure gauges, suction & discharge stop valves, Muffler, Crank case heaters, oil filters, magnetic oil separators, temperature indicators for lube oil/heaters, oil level indicators, safety thermostat for crank case heater, vibration isolators, etc.
Motor Rating	: 10% more than the power required by the compressor at 50 deg C design ambient temperature.
Capacity	: Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated

5.2.1 Air Handling Unit (AHU)

5.2.1.1 Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti-vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs shall be provided.

5.2.1.2 The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24g) galvanized steel sheet (thickness of galvanization as per manufacturer's standard), with 25mm thick polyurethane foam insulation of minimum 38 Kg/Cum density in between. Suitable reinforcements shall be provided to give structural strength to prevent any deformation/buckling.



5.2.1.3 Sloping condensate drain pan shall be made of minimum 1.2 mm thick Stainless Sheet Steel. It shall be isolated from bottom floor panel through 25mm thick heavy duty treated for Fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.

5.2.1.4 Cooling coil (min. 4 row deep) shall be made of seamless copper tubes with aluminum fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.

5.2.1.5 All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.

5.2.1.6 Centrifugal fan for AHU

- | | | |
|----------------------|---|---|
| a) Fan Type | : | Double Width Double Inlet (DWDI) Centrifugal Type |
| b) Fan impeller | : | Backward curved blades |
| c) Casing material | : | GI /Mild steel with minimum thickness of 3 mm. |
| d) Impeller material | : | Carbon steel |
| e) Shaft | : | EN 8 Steel |
| f) Fan bearings | : | Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours. |
| g) Critical speed | : | First critical speed of rotating assembly shall be at least 25% above the operating speed. |
| h) Drive | : | Motor driven with removable belt guard. Motor driven with removable belt guard. Motor rating (at 50 deg.C ambient) shall be atleast fifteen percent (15%) above the maximum load demand of drives at the design duty point. |
| i) Fans | : | For AHUs of capacity 50,000 CMH and above, Bidder may offer two (2) Nos. centrifugal fans of equal capacity for each AHU provided all such AHUs are accommodated within the space identified by the Employer. |

5.2.1.7 Mixing Box:

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU. Further, wherever return air is led back directly to AHU room, no mixing box is required.

5.2.1.8 Pan Humidifier:

Pan humidifier shall be made of 22 gauge SS 304 tank, duly insulated with 25 mm thick resin bonded fiber glass insulation (min. 24 Kg/m³ density) with 0.5 mm GSS cladding. The humidifier shall be complete with stainless steel immersion heaters, safety thermostat, float valve with stainless steel ball, sight glass, overflow and drain connections, steam outlet nozzle and float switch. Step controller shall be provided for switching on/off heater banks as per system requirement.



5.2.2 HI-Wall Split/Cassette Air-Conditioners

5.2.2.1 Hi-wall Split/cassette air conditioners shall in general consists of the following:

- i) Casing
- ii) Hermetically sealed rotary/scroll Compressor
- iii) Condenser and condenser cooling fan
- iv) Evaporator along with fan
- v) Cooling coil
- vi) Filters
- vii) Piping, valves, refrigerant strainer, etc.
- viii) Controls, instruments, control panel/starter panels.
- ix) Vibration isolator pads, etc as required.
- x) Refrigerant as per manufacturer practice.

5.2.2.2 Indoor unit of Ceiling Mounted Cassette Type Unit (Multi Flow Type):

The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

Unit shall have four way supply air grills on sides and return air grill in center. Each unit shall have high lift drain pump and very low operating sound.

5.2.3 Split/Packaged Air Conditioners

5.2.3.1 Split/package air conditioners shall in general consist of following:

- i) Casing
- ii) Compressor
- iii) Condenser
- iv) Evaporator and condenser cooling fan
- v) Cooling Coil
- vi) Filters
- vii) Piping, Valves, refrigerant strainer etc.
- viii) Control, instruments, control panel/starter panels.
- ix) Vibration isolator pads, ducting (if applicable) etc. as required.

5.3.0 Equipment Description -Ventilation System

5.3.1 Unitary Air Filtration

5.3.1.1 Each modular unitary air filtration shall consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

5.3.1.2 The housing/ casing of air washer unit shall be double skin construction. Double skin panels shall be made of 22G galvanized sheet on outer side and 20G galvanized sheet inside with 25mm thick polyurethane foam insulation of minimum 38 kg/cum density. Frame work for section shall be joined together with soft rubber gasket in between to make the joints air tight. The entire fan section shall be mounted on rolled formed GSS channel frame work.



- 5.3.1.3 The unitary air filtration tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the tank shall be spray galvanized (**minimum 60 microns DFT**). Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.
- 5.3.1.4 The distribution plate shall be fabricated out of 18G galvanized steel sheets & galvanized steel angle supports with minimum 50% free area.
- 5.3.1.5 Unitary air filtration shall be one-bank construction. All header and stand pipes shall be galvanized. Cat walks of suitable width shall be provided for maintenance of nozzle, filter etc.
- 5.3.1.6 The spray nozzles shall be of brass or bronze with chrome plating and shall be self-cleaning type. The nozzle shall be designed to produce fine atomized spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm².
- 5.3.1.7 The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilized using Titanium di-oxide and shall withstand the weathering test as per IS: 4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray and drain pipe.
- 5.3.1.8 Air tight inspection doors of suitable size shall be provided for suction chamber. Spray chamber and fan suction for easy accessibility and maintenance and a water marine light to be provided for each unitary air filtration.
- 5.3.1.9 Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement.
- 5.3.1.10 The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for UAF unit.
- 5.3.1.11 Saturation efficiency of Unitary Air Filtration units shall be minimum 60%.

5.3.2 Centrifugal Fan

- 5.3.2.1 The casing shall be of welded construction fabricated with heavy gauge galvanized sheet steel or MS sheet with spray galvanization (minimum 60 micron OFT). The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required.

The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristic of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts.



- 5.3.2.2 The bearing shall be self-aligning, heavy duty ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.
- 5.3.2.3 Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.
- 5.3.2.4 Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 85% efficiency.
- 5.3.2.5 The first critical speed of the rotating assembly shall be at least 25% above the opening speed.
- 5.3.2.6 The fans shall be provided with V-belts and sheaves. All belts shall be sized for 150% rated HP. All V-belt shall be equipped with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. Motor rating (at 50 deg C ambient) shall be at least fifteen percent (15%) above the maximum load demand of drives at the design duty point.

5.3.3 Roof Ventilators (If applicable)

- 5.3.3.1 The roof extractors shall be "COWL" type.
- 5.3.3.2 Impeller shall be of axial flow type, cast Aluminum in one piece and dynamically balanced. Casing shall be heavy gauge sheet steel construction of 3 mm thick for impeller up to 750 mm diameter and 5 mm for fans with impeller of diameter 750 and above. In casing, access door with locking arrangement be provided.
- 5.3.3.3 The cowl shall be designed for weather protection of the fan also inside of the roof on which the extractor is installed. Galvanized bird screen of 15 mm Square be provided with the cowl. All accessories, steel supports as required will be provided.
- 5.3.3.4 The speed of the fan shall be limited as per limitation given above for axial fans.
- 5.3.3.5 All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required shall be provided.
- 5.3.3.6 The vibration level for fans shall be as per ISO: 14694.

5.3.4 Centrifugal Pumps

- | | | |
|-----------------------------|---|--|
| a) Type | : | Horizontal Centrifugal, Axial or radial split type casing pump or end suction, top discharge horizontal centrifugal pump |
| b) Impeller | : | Closed type |
| c) Material of Construction | | |
| i) Casing | : | 2% Ni Cast Iron IS: 210 Gr. FG-260 |
| ii) Impeller | : | Bronze IS: 318 Gr-2 |
| iii) Wearing rings | : | Bronze |
| iv) Shaft | : | SS 316 |



- | | | |
|------------------|---|------------------------------|
| v) Shaft sleeve | : | SS 316 |
| vi) Lantern ring | : | Brass / Bronze |
| vii) Packing | : | Asbestos free |
| viii) Base Plate | : | Carbon steel as per IS:2 062 |
| ix) Speed | : | Maximum 1500 rpm |

5.3.5 Axial Fans

5.3.5.1 These fans shall have fixed/variable pitch cast aluminum blades of aero foil design.

5.3.5.2 The fan casing shall be of heavy gauge sheet steel construction.

5.3.5.3 Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

5.3.5.4 The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be at least 25% above the operating speed.

5.3.5.5 All other accessories like supporting structure etc. as required shall be provided.

5.3.5.6 Fans of capacity 1000 cum/hr & lower shall be of propeller exhaust type.

6.0.0 BALANCE EQUIPMENT SPECIFICATION

6.1.0 Material of Construction for Piping & Fittings

- | | | |
|-----------------------|---|--|
| a) Piping for Chilled | : | Heavy grade-IS:1239 or Equivalent upto150 NB and Condenser and IS:3589 or Equivalent for pipes beyond 200 water lines NB |
| b) Refrigerant piping | : | Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade). |
| c) Drain piping | : | Same as (a) above & galvanized as per IS: 4736. |
| c) Fittings | : | 1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 or equivalent for sizes 65 NB and above.

2) For sizes 50 NB and below, the material shall conform to ASTM A-105. |



- 3) All steel flanges shall be of slip on type and shall conform to ANSI 16.5
- 4) For pipe sizes above 350 NB, fabricated fittings of adequate thickness may be used. The bend radius in case of miter bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534.
- 5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI 831.5

6.2.0 Valves

- 6.2.1 Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.
- 6.2.2 Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
- 6.2.3 All safety /relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- 6.2.4 Valves shall be furnished with back seating arrangement for repacking while working under full working pressure.
- 6.2.5 Manual gear operators to be provided for valves of size 200 NB and above.
- 6.2.6 All valves shall be supplied with companion flanges, nut, bolts & washers, etc.
- 6.2.7 The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.
- 6.2.8 Gate valves shall be of Cast Iron body (confirming to IS: 210 Gr FG 220/equivalent) for sizes 65 NB and above conforming to IS: 14846. Gun Metal construction for sizes less than 65NB shall be as per IS: 778. Butterfly valves shall conform to latest revision of BS: 5155 or equivalent standard of required class/rating.

6.3.0 Air Filters

6.3.1 Pre Filter

- 1) Type : Flange / Cassette
- 2) Pre-filter shall contain washable non-woven synthetic fiber or High density Polyethylene (HDPE) media having 18G GSS or 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminum expanded metal on exit side or G.I. wire mesh on both sides.
- 3) Other requirements : (as applicable)
 - a) Suitable aluminum spacers be provided for uniform air flow;



- b) Casing shall be provided with neoprene sponge rubber sealing.
 - c) Capable of being cleaned by water flushing.
 - d) Density of filter medium shall increase in the direction of air flow in case of metallic filter.
 - e) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
- 4) Efficiency:
- Average arrestance of 65 - 80 % when tested in accordance with BS:65401ASHRAE-52-76 1 EN-779.
- 5) Minimum thickness : 50mm
 - 6) Face Velocity : Not more than 2.5 rn/sec.
 - 7) Pressure drop : Initial pressure drop - Not to exceed 5.0 mm WC at rated flow.
: Final pressure drop- Up to 7.5 mm WC.
 - 8) Location : a) At the suction of each AHUs
b) At the suction of each Fresh air fan

6.3.2 Fine Filters (Micro-vee type)

- 1) Type : Flange/Cassette
- 2) Fine filter shall contain washable non-woven synthetic fiber or High density Polyethylene (HDPE) media having 18G GSS or 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminum expanded metal on exit side or GI wire mesh on both sides.
- 3) Other requirements : a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
b) Capable of being cleaned by air or water flushing.
c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
- 4) Efficiency : Average arrestance > 90% when tested in accordance with BS:6540\ASHRAE-52-76 / EN-779.
- 4) Minimum thickness : 150 mm or 300 mm.
- 6) Face Velocity : Not more than 1.2 rn/sec for 150 mm and not more than 2.4 rn/sec. for 300 mm.
- 7) Pressure drop : Initial pressure drop - Not to exceed 10 mm we at rated flow
Final pressure drop-Up to 25 mm WC.



- 8) Location : i) At the discharge of each individual AHU.
ii) At the discharge of each Fresh air fan.

6.4.0 Low Pressure Air Distribution System

6.4.1 Material of air distribution system shall be through galvanized steel sheet (Conforming to Class 275 of IS :277) or Aluminum alloy (grade 19000 / SIC or 3100 I NS3 of IS:737). GI Sheets should be galvanized and galvanizing shall be of 275 gms/sq.m. (total coating on both sides) both for site fabricated and factory fabricated ducts.

6.4.2 Thickness of rectangular ducts shall be as follows:

Larger Dimension of duct (mm) GI sheet (mm)	Thickness of sheet (mm)	Thickness of Al sheet (mm)
up to 750 mm	0.63 (24 G)	0.80
751 to 1500	0.80 (22 G)	1.00
1501 to 2250	1.00 (20 G)	1.50
2251 & above	1.25 (18 G)	1.80

6.4.3 Thickness of round ducts shall be as follows:

Diameter of Round duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet (mm)
150 to 500	0.63	0.80
501 to 750	0.80	1.00
751 to 1000	0.80	1.00
1001 to 1250	1.00	1.50
1251 & above	1.25	1.80

6.4.4 Duct Fabrication and Supports:

- Duct fabrication shall be as per the latest relevant BIS/SMACNA standard.
- Ducts for A/C system may be site fabricated or factory fabricated.
- The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns with provision of necessary auxiliary or special steel members or by



hooks or can be provided by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder. Where ever ducts are running outside the building and or at locations where it is not possible to support the ducts from ceiling/floor due to non-availability of the same, the base steel frame/truss work and other auxiliary steel members, hooks, rods, etc. for supporting the duct work shall also be provided by the Bidder.

- d) Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass.
- e) All curves, bends, off-sets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.
- f) Wherever duct passes through a wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space.
- g) Wherever pipe hangers or rods pass through the ducts, light and streamline easement around the same shall be provided to maintain smooth flow of air.
- h) Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.

6.4.5 Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control of system. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.

6.4.6 Factory fabricated ducts:

- i) All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I.
- ii) Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)
- iii) All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply:
 - a) Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.



- b) All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
- c) All edges to be machine treated using lock formers, flangers and roll-bending for turning up edges.
- d) Sealant dispensing equipment should be used for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for the ducts over 2" w.g. static pressure
- iv) All transverse connectors shall be 4-bolt slip-on flange system with built-in sealant, if any. To avoid any leakage additional sealant shall be used.
- v) Factory fabricated ducts shall have the thickness of the sheet as follows:

Sl.No.	Size of Duct	Sheet thickness
i)	Upto 750 mm	0.63 mm
ii)	751 mm to 1500 mm	0.80 mm
iii)	1502 mm to 2250 mm	1.00 mm
iv)	2251 mm and above	1.25 mm

6.5.0 Diffusers, Grills & Dampers

- 6.5.1 Supply air diffusers/grills with factory fitted volume control dampers be provided for all air-conditioned areas.
- 6.5.2 Return air diffusers of air-conditioned areas shall be without volume control dampers.
- 6.5.3 The diffusers/grills shall be of extruded Aluminum of minimum 1.2 mm thick with powder coating. The colour of power coating shall be as per the interior decor.
- 6.5.4 Supply air grills shall be of double deflection type and return air grills shall be of single deflection type.
- 6.5.5 All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.
- 6.5.6 The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.
- 6.5.7 Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of Baffles wherever required shall also be provided.
- 6.5.8 Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.
- 6.5.9 All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames.



6.5.10 All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.

6.6.0 Thermal and Acoustic Insulation

6.6.1 A) Application with Glass Wool / Rockwool

- (i) All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products I Loid bond 83 or Equivalent) be applied@ 1.5 Kg /Sqm on the surface.
- (ii) Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber I Rockwool) shall be struck to the surface. All the joints shall be sealed with bitumen.
- (iii) Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side or alternatively aluminum foil can be used which can come as lamination over insulation.
- (iv) Insulation Finish of types specified under shall be provided thereafter..

B) Application with Nitrile Rubber

- (i) All surfaces to be insulated shall be properly cleaned.
- (ii) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces.
- (iii) Insulating material shall then be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within.
- (iv) Two layers of Glass Cloth with a suitable adhesive as SR 998 or equivalent shall be then applied over the insulating material to avoid surface weathering.

C) Application with Polyurethane Foam & Polyisocyanurate Foam

- i) All surfaces to be insulated shall be cleaned.
- ii) A suitable adhesive such as CPRX or Loid Bond 83 or equivalent shall be applied over the surface to be insulated and insulation material surfaces.
- iii) Insulating material with aluminum foil lamination shall then be pasted onto the surface in a manner to avoid stretching and any air entrapment within.
- iv) Two layers of Glass Cloth with a suitable adhesive as Loid Bond 130 shall be then applied over the insulating material, to avoid surface weathering.
- v) Insulation Finish of types specified under shall be provided thereafter.

**6.6.2 Type of Insulation & Finish**

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
1	Supply & return air duct of AC System	Resin bonded glass wool o4	Roll /Slab	50	F-3
		Closed Cell Elastomeric Nitrile Rubber	sheet	19	As per manufacturer std.
		or Polyisocyanurate Slab Foam	Slab	30	F-3
2.	Refrigerant (Suction and liquid lines)	Closed Cell tube Elastomeric Nitrile Rubber	Tube	19	As per manufacturer std.
		or Rigid Polyurethane Foam	Pipe Section	50	F-1 (a)
3.	AHU drain pipe	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
		or Rigid Polyurethane Foam	Pipe Section	50	F-1 (a)
4.	AHU condensate pan (insulation if required)	Mineral wool or resin bonded glass wool	Slab	25	As per manufacturer std.
5	Acoustic insulation of duct	Resin bonded glass wool	Roll /Slab	25	As per manufacturer std. specifications
6	Exposed air duct	Resin bonded Glass wool/Rockwool	Roll/Slab	50	F-4
		or Polyisocyanurate Foam	Slab	50	F-4(a)



6.6.3 Specification for insulation shall be as follows: -

Insulation Material	Code	Thermal conductivity (w/rn/°C)	Density Kg/m3
Resin bonded glass wool	IS:8183	0.049 at 50°C 0.043 at 50°C	i) 24 (For Glass wool) ii) 48 (For Rockwool) iii) 48(For acoustic insulation)
Mineral wool pipe section. Min.Gr.2	IS:9842	0.043 at 50°C	144
Closed Cell Elastomeric Nitrile Rubber		0.036 at 20°C	40-60
Polyurethane Foam Polyisocyanurate Foam	IS12436	0.03 at 50°C 0.03 at 50°C	34 ± 2 34 ± 2
Note : Insulation used for HVAC application shall be CFC/HCFC free			

6.6.4 The specification for various finishes shall be as follows

a)	Finish F-1 (with Resin Bonded Glass Wool/Resin Bonded Mineral Wool) Step-1 Wrapping of Poly-Bonded Hessain (PBH - to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.
	Step-2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.
	Step-3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.
aa)	Finish F-1 (a) (With Polyurethane Foam & Polyisocyanurate Foam) Wrapping of two layers of 7 mil 10 x 10 mesh glass cloth dipped in suitable adhesive such as SR 998 or Loid Bond 130 equivalent
b)	Finish F-2 Step-1 Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX/ Loid Bond 83 or Equivalent compound.
	Step-2 Same as Step-2 of Finish F-1 above.
	Step-3 Same as Step-3 of Finish F-1 above.
c)	Finish F-3 Step-1 Same as Step-1 of Finish F-2 above



	Step-2	The polythene shall be covered with 26 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.
d)	Finish F-4	
	Step-1	Same as Step-1 of Finish F-1 above.
	Step-2	Same as Step-2 of Finish F-1 above.
	Step-3	Same as Step-3 of Finish F-1 above.
	Step-4	Application of 3 mm thick coat of suitable water proofing compound and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound over the RP tissue
	Step-5	After the above treatment, 22G Aluminium sheet cladding, properly stiched at all joints shall be provided over the external surface.
dd)	Finish F-4(a) (With FR Closed Cell Chemically Cross Linked Polyethylene)	
		Application of aluminium sheet 22G cladding to be provided over the XLPE insulating material. Cladding sheet is held in position with SDST screws @ 150 mm C/c over tongue-in-groove joints applied with a felt for sealing joint against water ingress. All sheet joints to be done in a manner to shed water

6.6.5 For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm and above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation by encasing the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is to be maintained.

6.6.6 Acoustic Insulation

- a) All ducts up to a distance of 5 meters from AHU shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M. density and 30 gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre-to-centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.
- b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be inline with the requirements specified above.

7.0.0 PLANT CONTROL

7.1.0 Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from employer. The descriptions in the sub-sections of the control & instrument sections shall also be referred to.

7.2.0 Control Scheme for Air-Conditioning System

Contractor shall provide microprocessor/PLC/GIU based control system for control and monitoring of air conditioning and ventilation system as per manufacturer's standard practice. Control and monitoring of air conditioning and ventilation system from FGD control system is also acceptable.

7.3.0 Air Handling Unit

- a) Humidity sensor and gysenstat located in the return air duct shall actuate the PAN humidifier to obtain the desired degree of humidification.



- b) Humidity and temp. sensor shall be provided and interlocked in steps with winter heater/re-heater/strip heaters for monsoon and winter re-heating or heating as the case may be.
- c) Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (airstat - located in front of the each heater in the supply air duct).
- d) AHU shall be started either locally or from the main control room of AC system by means of Remote/Manual selection facility.
- e) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Fire Detection System.

7.4.0 Cassette /Hi-wall Split Air Conditioners

Control and interlocks for these type of units shall be as per manufacturer's standard practice.

7.5.0 Miscellaneous Control Requirements

- a) The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.
- b) Relative humidity and temperature measurement of all control rooms and all major air-conditioned areas shall made be available in FGD control system.

8.0.0 PAINTING

- 8.1.0 All the equipments shall be protected against external corrosion by providing suitable painting.
- 8.2.0 The surfaces of stainless steel, Galvanized steel, Gunmetal, brass, bronze and non- metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting, etc. as per the agreed procedure.
- 8.3.0 For all the steel surfaces (external) exposed to atmosphere (outdoor installation), one(1) coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied.
- 8.4.0 For all the steel surfaces inside the building (indoor installation), One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat shall be applied.
- 8.5.0 For centrifugal fans - Casing shall have hot dip/ spray galvanization (minimum 60 micron DFT).
- 8.6.0 However, for all parts coming in contact with acid fumes (in Battery rooms), a coat of epoxy resin based zinc phosphate primer of minimum thickness 30 to 35 microns followed up with undercoat of epoxy resin based paint pigmented with Titanium dioxide of minimum thickness of 25 microns shall be applied and a top coat consisting of one coat of epoxy paint of approved shade and colour with glossy finish of minimum thickness of 25 microns.



9.0.0 CODES & STANDARDS

The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

10.0.0 PIPING THICKNESS

Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The thickness as mentioned below are the minimum specified nominal thickness as per IS: 3589. Tolerance as code shall be applicable.

Nominal pipe Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)
200 NB	219.1	4.5
250 NB	273	5
300 NB	323.9	5.6
350 NB	355.6	5.6
400 NB	406.4	6.3
450 NB	457	6.3
500 NB	508	6.3
600 NB	610	6.3



**1x800 MW TANGEDCO NORTH CHENNAI
TPP– (FGD SYSTEM)
HVAC SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**

SPECIFICATION No: PE-TS-485- (571-13000-A)-A001 (REV-0)

SECTION : I

SUB-SECTION : C-3

REV. 00

SECTION: I

SUB-SECTION: C3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

**TAMILNADU GENERATION AND DISTRIBUTION
CORPORATION LIMITED**

**1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III
(FGD SYSTEM AND AUXILIARIES)**

**AIR CONDITIONING SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT,
NOIDA, U.P., INDIA**



TITLE:	SPECIFICATION NO.	
	VOLUME NO. :	II-B
	SECTION:	I
	REV NO.:	00 DATE: 06.07.22
	SHEET: 1	OF 1

**TECHNICAL SPECIFICATION
FOR
AIR CONDITIONING SYSTEM
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

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The requirements mentioned in Section-I shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section-II.



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
AIR CONDITIONING SYSTEM
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

SPECIFICATION NO.

VOLUME NO.: **II-B**

SECTION: **I**

REV NO.: **00** DATE: 06.07.22

SHEET : 1 OF 1

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
 - d) Electrical load requirement for **AIR CONDITIONING SYSTEM** (all AC & DC load at different voltage levels like 415V AC, 240 V AC, 220 V DC etc).
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “both end equipment in vendor’s scope” shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 The electrical specification without any deviation from the technical/ quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/ No deviation certificate.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
AIR CONDITIONING SYSTEM
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

SPECIFICATION NO.

VOLUME NO.: **II-B**

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4.0 LIST OF ENCLOSURES

- 4.1 Electrical Scope Between BHEL & Vendor (Annexure-I).
- 4.2 Electrical Load Data Format (Annexure-II).
- 4.3 Cable Schedule Format (Annexure-III).
- 4.4 Technical Requirements-Motors.
- 4.5 Data Sheet-A & C
- 4.6 Standard Quality Plan.
- 4.7 Technical Requirements –Earthing & Lightning Protection System
- 4.8 Technical Requirements- Cabling Accessories
- 4.9 Motor Sub Vendor List

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR**PACKAGES : HVAC SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III (FGD SYSTEM & AUXILIARIES)**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR**PACKAGES : HVAC SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III (FGD SYSTEM & AUXILIARIES)**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

ANNEXURE III SECTION-I

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Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES



SECTION-I

SECTION : 3.1- MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT and LT Motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes, especially the Indian Statutory Regulation, except where modified and /or supplemented by this specification.

- a) IS: 325 Three phase induction motors
- b) IS: 12615 Energy efficient induction motors
- c) IS: 900 Code of practice for installation and maintenance of induction motors
- d) IS: 996 Single-phase AC induction motor for general purpose
- e) IS: 1231 Dimensions of three-phase foot-mounted induction motors
- f) IS: 2223 Dimensions of flange mounted AC induction motors
- g) IS: 4029 Guide for testing three-phase induction motors
- h) IS: 8789 Values of performance characteristics for three-phase induction motors
- i) IS: 13555 Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
- j) IS: 5571 Guide for selection of electrical equipment for hazardous areas
- k) IS: 12065 Permissible limits of noise level for rotating electrical machines
- l) IS: 12075 Mechanical vibration of rotating electrical machines
- m) IS: 9334 Electrical motor operated actuators
- n) IS 60034-5 Degree of protection provided by Integral design of rotating electrical machines
- o) IS 60034-8 Terminal marking and direction of rotation
- p) IS 60079-1 Equipment protection by flame proof enclosure
- q) IS 60034-1 Rotating electrical machines.
- r) IS 60079 Explosive atmospheres
- s) IS/IEC 60529 Degrees of protection provided by enclosures (IP code)
- t) IEC 60034 Rotating electrical machines.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits. The equipment shall operate in highly polluted environment.

3.2.0 Supply voltage

Motors rated up to and including 415V are termed as LT motors and the motors rated higher than 415V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.



- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 10%
- Combined variation of voltage and frequency : 10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

3.3.0 System Parameters

Sl. No.	Description	HT System	LT System
1.	Voltage level	11 KV Above 2000 KW 6.6KV above 200KW & upto 2000KW	240 V : up to 0.2 KW 415 V : >0.2 KW and up to 200KW .
2.	System earthing	Earthed through resistance. Earth fault current : 300 Amps	415V: Solidly grounded.
3.	System fault level	50 KA for 3 sec for 11KV 40KA for 1sec for 6.6KV	50 KA for 1 second
4.	Fault withstand rating of motor terminal box (Breaker operated)	50 KA for 0.25 sec for 11KV 40KA for 0.25 sec for 6.6KV	50 KA for 0.25 second

3.4.0 Type

- AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and fly ash or any dusty chemical handling area.
- All LV motors above 10KW shall be with S1 duty.

3.6.0 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- The motor name plate rating shall have 15% margin over duty point input (or) 10% margin over the maximum demand of driven equipment whichever is higher considering highest system frequency.
- The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
- Service shall be considered as 1.0 only.



3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load.
- HT Motors will be controlled through vacuum circuit breaker.
- LT motors rated less than 90KW will be controlled through MPCB/MCCB and contactor. LT motors rated 90 KW and above will be controlled through air circuit breaker (ACB).

3.8.0 Efficiency

All the continuous duty motors shall be energy efficient type. For LT motors, it shall be IE3 class as per IS 12615. For HT motors, efficiency shall be more than 95%.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

- a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on line starting, without exceeding specified winding temperatures.
 - HT Motors : 85% of rated voltage
 - LT motors : 80% of rated voltage
- b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage will be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.
- c) The motor shall be capable of operating at full load at a supply voltage of 80% of the rated voltage for 5 minutes.
- d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage two (2) second duration

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).



3.12.0 Starting current

- Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. No further tolerances are applicable on starting current specified above for HT motors.
- For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater.
- For the LT motors having starting time upto 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage
- All motors shall be so designed that maximum in rush currents and locked rotor and pull out torque developed by them at extreme voltage and frequency variation do not endanger the motor & driven equipment.

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.
- The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.15.0 Enclosure

- a) All motor enclosures shall conform to the degree of protection IP 55 unless otherwise specified. Motor for outdoor or semi outdoor service shall be of weather proof construction.
- b) For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard.



3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type.
- Motors rated >3000KW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
 - Hot and cold air temperatures of the closed air circuit for CACA motors.
 - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 5A at 240 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high Dv/dt . Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240V AC, 50 Hz supply shall be provided for motors rated 30KW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand 1.2/50 microsec impulse Voltage wave of 4U+5 KV (U=Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3msec surge of 32KVp and 12KVp for 11KV & 6.6KV system respectively, followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

Temperature Detectors

- All 11KV motors shall be provided with six (6) nos. duplex, or twelve (12) nos. simplex type winding temperature detectors, i.e. two (2) nos. duplex or four (4) nos. Simplex per phase.
- 11KV motor bearing shall be provided with duplex type temperature detectors.
- The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.
- Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS/PLC connectivity.
- Five number of Temperature detectors / thermistors shall be provided for L.T. motors above 90 KW (3 numbers winding temperatures & 2 numbers bearing temperatures)



3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30KW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors and motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

3.19.0 Terminal Boxes

- For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.25 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.



- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fibre glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 numbers CT for mounting on switchgear side shall be in bidder's scope. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later to the successful bidder. The CT details shall be finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.
- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.

The grounding connection shall be suitable for accommodation of ground conductors as follows :

Above 100 to 200 KW	: 75x10 mm GS flat
Above 55 KW to 100 KW	: 50x6 mm GS flat
Above 22 KW to 55 KW	: 50x6 mm GS flat
Above 5.5 KW to 22 KW	: 25x6 mm GS flat
Fractional HP LV Motors	: 8 SWG GS Wire

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065. Noise level for all motors shall be limited to 85db (A).
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors. Motors shall withstand vibration produced by driven equipment.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

In addition to the minimum information required by IEC/IS, the following information shall be shown on motor rating plate:

- Temperature rise in °C under rated condition and method of measurement.



- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Drain plug

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

3.24.0 Lifting provision

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

3.25.0 Dowel pins

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment

4.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

5.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Paint Shade for the Motor shall be RAL 7032 (Siemens Grey). Sufficient quantity of touch-up paint shall be furnished for application at site.

6.0.0 TESTING AND INSPECTION

- 6.1.0 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.
- 6.2.0 Routine and Type Tests are to be conducted for all HT motors and for LT motors above 60 KW rating in presence of customer's representative as per IS:325, IS:4722, IS:9283 and required copies of test certificates are to be furnished for approval.
- 6.3.0 Test certificates for Routine tests conducted as per IS:325, IS:4722, IS:9283 for motors of rating 60 KW and below shall be submitted for TANGEDCO review, approval and dispatch clearance.
- 6.4.0 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out
 - i) Measurement of vibration.
 - ii) Measurement of insulation resistance and polarization index
 - iii) Measurement of full load current.
 - iv) Test running of the motors, checking the temperature rise and identifying the hot spot etc.



7.0.0 OTHERS

- 7.1.0 The responsibility of co-ordination with electrical agencies and obtaining all necessary clearances shall be the contractor.
- 7.2.0 Canopy shall be provided for outdoor motors.
- 7.3.0 Contractor shall provide fully compatible electrical system, equipment, accessories and services.

8.0.0 SPECIFIC REQUIREMENTS

- 8.1.0 The following shall be considered for control & protection of motors.
- a) Motors below 18.5 KW: MPCB incomers
 - b) Above 18.5 KW but below 90 KW: contactor controlled with MCCB
 - c) 90 KW and above but 160 KW & below: ACB controlled with numerical relays
 - d) HT Motors shall have vacuum breakers
 - e) HV motors 1000KW above shall have differential protection
 - f) For motors 1000KW & above, neutral CT of CI. PS shall be provided as each box on separate terminal box
 - g) Key phasor arrangement shall be provided for all motors
 - h) All motors shall be provided with an emergency stop PB near motor as per Indian Statutory regularity.
 - i) Spacious platform shall be provided around motor area with min. of 300mm below the level of motor base plate.
 - j) Capillary type temp. Gauge cum shall be provided for DE/NDE of HV motors
 - k) After erection of electrical equipment at site, corrosion proof paint touch up to be done before test & commissioning of equipment.



SECTION-I

2.3.0 MOTORS

Item/ Components/ Sub-system	Tests/ Checks														
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing	All tests as per IS:325/ IS:4722/ IS:9283
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y						
Shaft	Y	Y	Y	Y	Y	Y			Y						
Magnetic material	Y	Y	Y	Y	Y		Y			Y		Y			
Rotor copper/ Aluminium	Y	Y	Y	Y		Y	Y		Y						
Stator copper	Y	Y	Y	Y			Y		Y			Y			
SC ring	Y	Y	Y	Y	Y	Y	Y	Y	Y						
Insulating material	Y		Y	Y			Y					Y			
Tubes for cooler	Y	Y	Y	Y	Y				Y		Y				
Sleeve bearing	Y	Y	Y	Y	Y				Y		Y				
Stator, Rotor coils	Y	Y	Y				Y	Y							
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y							
Fabrication and machining of stator, rotor, terminal box	Y	Y			Y				Y						
Wound stator	Y	Y					Y	Y							
Rotor complete	Y	Y					Y						Y	Y	



Item/ Components/ Sub-system	Tests/ Checks													
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing
Stator, Rotor, Terminal Box assembly	Y	Y					Y							
Accessories, RTD, BTD, CT, Brushes, Diodes, space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y											
Complete motor (IS: 325/ IS:4722/ IS:9283)	Y	Y	Y										Y	Y
Y = Test applicable, Y1 = for 11kV and 3.3kV motors only														
Note														
This is an indicative list of tests/ checks. The manufacture is to furnish the detailed Quality Plan indicating the practices and procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for 415V motors upto 50 KW.														

Site Tests :

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out

- Measurement of vibration.
- Measurement of insulation resistance and polarization index
- Measurement of full load current.
- Test running of the motors, checking the temperature rise and identifying the hot spot etc.

	TITLE LV MOTORS <u>DATA SHEET-A</u>		SPECIFICATION NO.	
			VOLUME	II B
			SECTION	II
			REV NO. 00	DATE 28.09.2021
			SHEET 1	OF 1
1.0	Design ambient temperature	:	50 °C	
2.0	Maximum acceptable kW rating of LV motor	:	Upto 200KW	
3.0	Installation (Indoors/ Outdoors)	:	As required	
4.0	Degree Of Protection	:	IP55 (INDOOR), IPW55(OUTDOOR)	
5.0	Cooling	:	TEFC	
6.0	Details of supply system			
	a) Rated voltage (with variation)	:	415V ± 10%	
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% To –5%)	
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)	
	d) System fault level at rated voltage	:	50 kA for 1 sec	
	e) Short time rating for terminal box	:	50 kA for 0.25 sec	
	f) LV System grounding	:	Solidly	
7.0	Class of insulation	:	Class 'F', with temp rise limited to class B.	
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage	
9.0	Power cables data	:	Shall be given during Detailed engg.	
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.	
11.0	Space heater supply (30KW & ABOVE)	:	240 V, 1Φ , 50 Hz	
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 Kw	
13.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL	
14.0	Locked rotor current			
	a) Limit as percentage of FLC	:	As per IS 12615	
	b) Permissible tolerance, if any	:		
15.0	Additional tests	:	As per QP	
16.0	Flame-proof motor			
	a) Enclosure suitable (As per IS:2148)	:	As per requirement	
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement	
	c) Degree of protection	:	IP65	
17.0	Makes	:	AS PER ANNEXURE-I	
19.0	Paint shade	:	RAL 7032 (Siemens Grey).	
20.0	Efficiency class	:	IE3	
NOTE :1. Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec				

7.0

Class of insulation

:

Class 'F', with temp rise limited to class B.

8.0

Minimum voltage for starting
(As percentage of rated voltage)

:

80% of rated voltage

9.0

Power cables data

:

Shall be given during Detailed engg.

10.0

Earth Conductor Size & Material

:

Shall be given during Detailed engg.

11.0

Space heater supply (**30KW & ABOVE**)

:

240 V, 1 Φ , 50 Hz

12.0

Rating up to which Single phase motor

:

Acceptable upto 0.20 Kw

13.0

TYPE OF STARTER PROVIDED IN MCC

:

DOL

14.0

Locked rotor current

a)

Limit as percentage of FLC

:

As per IS 12615

b)

Permissible tolerance, if any

:

15.0

Additional tests

:

As per QP

16.0

Flame-proof motor

a)

Enclosure suitable (As per IS:2148)

:

As per requirement

b)

Classification of Hazardous area
(As per IS: 5572 part-I)

:

As per requirement

c)

Degree of protection

:

IP65

17.0

Makes

:

AS PER ANNEXURE-I

19.0

Paint shade

:

RAL 7032 (Siemens Grey).

20.0

Efficiency class

:

IE3

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME _____ II B
		SECTION II
		REV NO. 00 DATE
		SHEET 1 OF 2

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB)		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.
	LV MOTOR DATA SHEET - C	VOLUME _____ II B
		SECTION II
		REV NO. 00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55KW$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			



TITLE :
GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.
PE-SS-999-506-E101
VOLUME NO. : **II-B**
SECTION : **II**
REV NO. : **00** DATE : 29/08/2005
SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : II
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 1 OF 4

1.0

INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0

CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0

DESIGN REQUIREMENTS

3.1

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2

Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3

Starting Requirements

3.3.1

Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2

Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.



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The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

- i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.
- ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)
- iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor

3.4 Running Requirements

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 Stress During bus Transfer

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 CONSTRUCTIONAL FEATURES

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

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4.4. 4.5 4.6 4.7 4.7.1 4.7.2 4.7.3 4.7.4 4.7.5 4.7.6 4.7.7 4.7.8. 4.7.9 4.8 4.9	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors. Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point. In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C. Terminals and Terminal Boxes Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A". unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end. Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively. Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation. Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A. Degree of protection for terminal boxes shall be IP 55 as per IS 4691. Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors. Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type. Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal. General	

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : II
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 4 OF 4
4.9.1 Motors provided for similar drives shall be interchangeable. 4.9.2 Suitable foundation bolts are to be supplied alongwith the motors. 4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above. 4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956. 4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz. 4.9.6 Name plate with all particulars as per IS: 325 shall be provided 4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions. 5.0 INSPECTION AND TESTING 5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied. 5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser. 5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan. 5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A. 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT a) OGA drawing showing the position of terminal boxes, earthing connections etc. b) Arrangement drawing of terminal boxes. c) Characteristic curves: (To be given for motor above 55 kW unless otherwise specified in Data Sheet). i) Current vs. time at rated voltage and minimum starting voltage. ii) Speed vs. time at rated voltage and minimum starting voltage. iii) Torque vs. speed at rated voltage and minimum voltage. For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling. iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.		

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS		
1	2	3	4	5	6		7	8	9				
					M	C/ N							
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK	P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK	P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK	P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

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		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:

1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,

P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI:** MINOR, **CR:** CRITICAL

D: DOCUMENTATION

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL			Approved by:			

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		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		SECTION: II

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	P	-	-		
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK	P	-	-		
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT	P/V	-			
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT	P	-	-		
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC	P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR	
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	P/V	-			
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC	P/V	-		HEAT NO. SHALL BE VERIFIED	
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK	P/V	-			
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK	P/V	-			

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Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO. :		DATE:17.04.2020 SHEET 2 OF 9
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✓	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

BHEL					
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		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		SECTION: II

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

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SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY		
1	2	3	4	5	6		7	8	9	.	..		
					M	C/N				D	M	C	N
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-
		1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-
		3.TEMP WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG/ SPECS.	LOG BOOK		P	-	-
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-

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SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ASTM-E165	MANUFACTURER'S STD./APPROVED DATASHEET.	LOG BOOK	✓	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:	SECTION: II

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✓	P	V	-	THREE DIPS TO BE GIVEN

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
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	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO.:	DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
		PROJECT:		PO NO.:	
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:	SECTION: II

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION 1.COMPACTNESS & CLEANLINESS	MA MA	PROCESS CHECK VISUAL	CONTINUOUS 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK LOG BOOK	✓ -	P P	V -	- -	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS 2.SOUNDNESS	CR CR	VISUAL MALLET TEST & UT	100% 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK TEST/INSPC. REPORT	- ✓	P P	- V	- -	
2.9	COMPLETE ROTOR ASSEMBLY	3.HV 1.RESIDUAL UNBALANCE	MA CR	ELECT. TEST DYN. BALANCE	100% 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S STANDARD MANUFACTURER'S DWG.	TEST/INSPC. REPORT LOG BOOK	✓ -	P P	V -	- -	
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING 1.ALIGNMENT 2.WORKMANSHIP 3.AXIAL PLAY 4.DIMENSIONS 5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE 6. RTD, BTD & SPACE HEATER MOUNTING.	CR MA MA MA MA MA	ELECT. (GROWLER TEST) MEAS. VISUAL MEAS. MEAS. VISUAL	100% 100% 100% 100% 100%	- - - - -	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	TEST/INSPC. REPORT LOG BOOK LOG BOOK LOG BOOK LOG BOOK	✓ - - ✓ -	P P P P P	V - - V -	- - - - -	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
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Seal	

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO.:		DATE: 17.04.2020 SHEET 8 OF 9
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325//IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325//IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	√ ^s	-	^s NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✓	P	√ ^s	-	^s NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✓	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5//IS-12615	APPROVED DATASHEET	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1//IS: 12802	IS-325//IS-12615//IEC-60034 PART-1//IS: 12802	TC	✓	P	√ ^s	-	^s NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TC	✓	P	√ ^s	-	^s NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✓	P	√ ^s	-	^s NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✓	P	W\$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY ^s NOTE - 2

BHEL					
ENGINEERING			QUALITY		
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Reviewed by:	 PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	 R K JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
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Seal	

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1	2	3	4	5	6		7	8	9	.	..		
					M	C/N				D	M	C	N
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✓	P	W	-

NOTES:

- 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.
- 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.
- 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.
- 4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.
- 5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.
- 6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
- 7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
- 8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.
- 9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.
- 10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
 ** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,
P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI:** MINOR, **CR:** CRITICAL
D: DOCUMENT

BHEL					
ENGINEERING			QUALITY		
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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Approved by:			



SECTION-3.17: CABLING ACCESSORIES

1.0.0 INTENT OF SPECIFICATION

SECTION-II

This section covers the requirements of cabling accessories. List of major items shall include the following:

- Cable joints & terminations
- Cable glands
- Cable lugs
- Camps
- Tags
- Conduits & Pipes
- Junction boxes

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards except where modified and /or supplemented by this specification.

- a) VDE 0278 : Joints and Terminations
- b) IS: 13573 : Joints and Terminations for polymeric cables for working voltages from 6.6 KV up to and including 33 KV-Performance requirements and type tests.
- c) BS:6121 : Mechanical cable glands (Part 1 –Specification for metallic glands)
- d) IS: 12943 : Brass Glands for PVC Cables
- e) IS:8309 : Specification for compression type tubular terminal ends for aluminium conductors of insulated cables.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Joints & terminations

3.1.1 Termination and jointing kits shall be of proven design and make which have already been extensively used and fully type tested. Kits shall be complete with all accessories and consumables required for complete termination or jointing. Copper cable lugs & jointing ferrules for straight through joints shall form part of the kit.

3.1.2 Termination and jointing kits shall be suitable for the following types of cables as per IS.

- 11 KV unearthed grade cable
- 1.1 KV grade power cables

3.1.3 Termination kits shall be 'elastimold' or 'Push on type' or 'heat shrinkable type'. Jointing kits shall be 'Tapex type' or 'heat shrinkable type'.

3.1.4 Straight through joint and termination shall be capable of withstanding the fault level of 44KA for HT Cables.

3.1.5 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.



3.2.0 Cable glands

Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. Cable glands shall be double compression type for armoured cables. For flame proof equipment cable glands shall be of flame proof type.

3.3.0 Cable lugs

3.3.1 Cable lugs shall be of aluminium for aluminium cables and tinned copper for copper cables. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solderless crimping type.

3.3.2 Cable lugs for conductors of power cables shall be "heavy duty" type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.

3.3.3 Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ ring type/U Type to suit the terminals provided in the panels.

3.3.4 Type of cable lugs shall be as follows:

- Power cables with aluminium conductor : Aluminium crimping type.
- Power cables with copper conductor : Copper crimping type.
- Control Cables : Copper pin type /Copper screw type
- Special cables : pin type / maxi-termi type

3.4.0 Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.
- Clamps shall be of suitable sizes to firmly hold the cables of various outer diameters including tolerance in OD.
- Clamps should have been type tested for Short Circuit Withstand Test .
- For Trefoil clamps run spacing shall be 2000 mm and Axial spacing shall be Double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

3.5.0 Omega Cable clamps

- Omega clamps shall be of galvanized mild steel and shall be used to fasten the individual multi-core cables.
- Clamps shall be of simple construction, made of 2mm thick, 25mm wide strip of omega shape and suitable for clamping on the rungs / perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different outer diameters of cables. Omega cable clamps shall be used for individual cables above 35mm outer diameter.
- Steel clamps shall be hot dip galvanized. Weight of zinc not less than 610 gms. per sq. metre
- For cables of above 35 mm OD, cables shall be individually clamped at 5000 mm interval for Horizontal runs and shall be individually clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.



- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

3.6.0 Strip Cable Clamps

- Strip clamps shall be of galvanized mild steel and shall be used to fasten the group of multi-core cables up to 35mm diameter only on a full or part of the tray width.
- Clamps shall be of simple construction, made of 3mm thick Steel, 25mm wide strip to cover the entire width up to 300mm wide tray and part of the tray for more than 300mm wide trays. Strip shall have two right angle bends at each end for fixing on to the rung/ perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different sizes of tray width. However, the maximum size of clamp shall be 300mm and for cable trays of greater width, two clamps shall be used.
- Clamps shall be hot dip galvanized. Weight of zinc not less than 610 gms. per sq. metre

3.7.0 Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Type test certificates to ascertain the strength of clamps shall be submitted for Owner's approval.
- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.
- Clamp length shall be selected such that not more than 80% of lockable length is utilized for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for Individual multicore clamping (above 35mm OD up to 55mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for Individual multicore clamping (above 55mm OD) shall be 7 mm having Tensile strength 60 kg.

3.8.0 Tags

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of aluminium.
- Cable numbers shall be engraved type
- Tags shall be of durable quality of size 60mm x 12mm with a tie hole at each end.
- Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

3.9.0 Junction Boxes

- 3.9.1 Junction box with IP 55 degree of protection, shall comprise of a case with hinged door constructed from FRP material. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.



- 3.9.2 Terminal blocks shall be of 650V grade, rated for 10A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2C $\times$ 2.5mm² cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.
- 3.9.3 The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.

The list of approved make of the LT Motors are as mentioned below:

S. NO.	LIST OF MOTORS	
1	NON FLAME PROOF	ABB
2		BHARAT BIJLEE LTD.
3		CROMPTON GREAVES
4		GE-POWER
5		KIRLOSKAR ELECTRIC CO LTD.
6		LAXMI HYDRAULICS PVT. LTD
7		MARATHON
8		NGEF
9		RAJINDRA ELECT INDUSTRIES
10		SIEMENS
11	FLAME PROOF	RAJINDRA ELECT INDUSTRIES

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

The list of make of CABLE LUGS & CABLE GLANDS are as mentioned below:	
CABLE LUGS	
1	DOWELLS
2	UNIVERSAL MACHINES LTD.
CABLE GLANDS	
1	ALLIED TRADERS & EXPORTERS
2	ARUP ENGG & FOUNDRY WORKS
3	BALIGA LIGHTING EQPT.PVT.LTD.
4	COMMET BRASS PRODUCTS
5	DOWELLS
6	ELECTROMAC INDUSTRIES
7	INCAB

However, the final list of makes for the CABLE LUGS & CABLE GLANDS are subjected to BHEL/Customer approval, during contract stage, without any commercial implications.



**1x800 MW TANGEDCO NORTH CHENNAI
TPP– (FGD SYSTEM)
HVAC SYSTEM
TECHNICAL SPECIFICATION
(C&I PORTION)**

SPECIFICATION No: PE-TS-485- (571-13000-A)-A001 (REV-0)

SECTION : I

SUB-SECTION : C-4

REV. 00

SECTION: I

**SUB-SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)**

TECHNICAL SPECIFICATION (CONTROL AND INSTRUMENTATION) FOR HVAC SYSTEM

				
	FGD FOR NORTH CHENNAI TPP STAGE-III (1 X 800 MW)		DESG	BC
	JOB NO: 485		CHKD	CM
	REV. NO. 00	DATE: 21.07.2022	APPD	SSB

INDEX

S. No.	DESCRIPTION
1	TITLE SHEET
2	INDEX SHEET
3	SPECIFIC C&I TECHNICAL REQUIREMENT
4	GENERAL TECHNICAL REQUIREMENTS
5	LIST OF DELIVERABLES
6	FIELD AND MEASURING INSTRUMENTS
7	PROCESS CONNECTION AND PIPING
8	LOCAL CONTROL PANEL AND DATA SHEET
9	INSTRUMENTATION CABLE, CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY
10	SIGNAL EXCHANGE BETWEEN DRIVES AND DCS
11	QUALITY ASSURANCE/CHECK LIST
12	INSTRUMENT HOOK UP DRAWINGS
13	MANDATORY SPARES
14	SUB VENDOR LIST
15	KKS NUMBERING PHILOSOPHY

GENERAL TECHNICAL REQUIREMENTS

	SPECIFICATION FOR CONTROL & INSTRUMENTATION FOR AUX PACKAGES	SPECIFICATION NO.:	
		VOLUME	
		SUB SECTION	
		REV. NO.	DATE :
		SHEET	OF

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0 The quantity of instruments for auxiliary system shall be as per tender P & ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.

5.0 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

SPECIFIC TECHNICAL REQUIREMENTS

- 1.0** Air Conditioning and Ventilation System shall be operated from FGD DCS (FGD DCS is in BHEL's scope) for areas/buildings indicated elsewhere in the specification.
- 2.0** Interface of MCC, field Equipment, Actuators etc. with FGD DCS based control system shall be as per Signal interface between drives and FGD DCS enclosed in specification.
- 3.0** Microprocessor based controls of Air cooled condensing unit (D-X type), PAC (if applicable) etc. shall be provided with local display along with facilities to Soft link & Hardwired interface with FGD DCS and to meet the requirement of all system operations and controls. Soft link communication between Microprocessor (MP) based control panels & FGD DCS shall be redundant Bi-directional via TCP/IP on OPC or MODBUS with RS485 link. Bidder shall include required hardware at MP end.
- 4.0** Time synchronization of MP with FGD DCS is to be carried out. Necessary hardware & software for same at MP end to be provided by Bidder.
- 5.0** Complete C&I system for Air Conditioning and Ventilation System is in bidder's scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder without any commercial implication.
- 6.0** The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire Air Conditioning and Ventilation System. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre-bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.
- 7.0** The quantity of instruments for the system shall be as per tender P&ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.
- 8.0** Bidder to supply all the instruments required for the package along with necessary fittings, accessories and valve manifold etc. for control monitoring

and operation of HVAC system. All instruments shall be provided with durable epoxy coating for housing and all exposed surfaces of the instruments.

- 9.0** Earthing of all I&C equipments, control panels, Instruments, Junction boxes and cable trays including above ground panel / below ground / redundant electronic earthing. Bidder shall note that all electronic earthing shall be redundant.
- 10.0** All the Electronic Transmitter for Pressure, Temperature, Differential Pressure and DP based Flow /Level measurements shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART).
- 11.0** All the transmitters/transducers supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply.
- 12.0** For all instruments envisaged for seawater applications, they shall be provided with wetted parts of Super duplex SS.
- 13.0** All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection. All limit switches shall be conforming to IEC-60947-5-1.
- 14.0** DPG, DPT & DPS across the filters/strainers shall be provided.
- 15.0** Instrument should be in easy reach of maintenance person, there should be separate platform for unreachable instruments. Easy access should be provided to all the tapping points of instruments used for measurement & control.
- 16.0** Instrument installation and accessories required for the same shall be in Bidder's scope and shall be subject to customer/BHEL's approval during detailed engineering.
- 17.0** All Temperature sensors shall be Duplex type. Temperature transmitter shall be provided for all temperature measurement applications. Bidder to provide temperature transmitter along with compensating cable, JB/Rack & other erection hardware.
- 18.0** Analyser and instrument, which are used for protection, shall be 2 out of 3 and interlock controls shall be 1 out of 2, for monitoring panel single shall be considered.
- 19.0** Use of process actuated switch shall be avoided unless unavoidable.
- 20.0** All switches shall be provided with Double action snap type (DPDT) contacts and shall be equipped with plug in type connections for terminating field wiring.

- 21.0** Switch actuation point shall be field adjustable with a calibration scale to indicate the set point. Switches shall have capacity of 5.0 amps at 240V AC or 0.5 amps at 220V DC. Level switches for general service shall be float type. Float material shall be stainless steel SS316.
- 22.0** All transmitters shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIEs) in case of open areas of the plant and (ii) In Local Instrument Racks (LIRs) in case of covered areas.
- 23.0** All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.
- 24.0** Canopy/Enclosure shall be provided for field instruments like transmitters, switches & flow meters, etc and any other equipment to protect from direct sun light, lightning & rain.
- 25.0** All field instruments enclosure shall be IP65, local panel/cabinet enclosure shall be IP 55, unless otherwise specified.
- 26.0** Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
- 27.0** All instruments and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.
- 28.0** AHU shall be started either locally or from the main Control room by means of Remote / Manual selection facility.
- 29.0** Local control panel (if applicable) shall be in bidder scope and shall have the provision of command (start/stop) & feedback interface with FGD DCS.
- 30.0** Relative humidity and temperature measurement of all control rooms and all major air-conditioned areas shall be made available in Control system.
- 31.0** VFD panels (if applicable) for drives are in Bidders scope. Typical signal exchange with FGD DCS has been indicated in the specification elsewhere.
- 32.0** Drive control philosophy/signal exchange list attached elsewhere in the specification are Tentative and shall be finalized during detailed engineering.

- 33.0** Bidder to include IO from fire protection system (supplied by others) for closing the dampers in the event of fire, the no of IO & other specifications in this regard shall be finalized during detail engineering.
- 34.0** Bidder to furnish electrical load/UPS load data during detailed Engineering.
- 35.0** 415V AC/ 230V UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board, changeover circuit in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Bidder to submit the power requirement along with the bid.
- 36.0** Power supply derived for contact interrogation, interposing relay and solenoid shall generally be ungrounded 24 V D.C. only.
- 37.0** The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.
- 38.0** The make of the items shall be from sub-vendor list. However, the make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
- 39.0** The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards.
- 40.0** Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in Tests for I&C equipment included elsewhere in specification will have to be performed by Bidder without any cost implication.
- 41.0** The scope of cable shall be referred in Electrical scope split sheet in Electrical portion of the specification.
- 42.0** Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB