NEYVELI LIGNITE CORPORATION LTD

2X500 MW NEW NEYVELI TPP

VOLUME II B & III

TECHNICAL SPECIFICATION
FOR
VENTILATION SYSTEM

Specification No. PE-TS-400 & 402-554-A001 Rev 00

NOVEMBER 2014

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERIING MANAGEMENT
NEW DELHI

VOLUME – IIB

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VOLUME II B

SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification is intended to cover Engineering, design, manufacturing, inspection & Testing at manufacturer's/subvendor's works, Painting at manufactures works, duly packed for transportation, delivery to site, unloading, storage & handling at site, fabrication, erection and commissioning, performance and guarantee testing, submission of as built drawing, carrying out acceptance tests at site, minor civil work as required , final painting and handing over of complete Ventilation system on turnkey basis as per details in different sections / volumes of this specification for **2X500 MW NEW NEYVELI.**

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 of **VENTILATION 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 high 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.

1.5 The general term and conditions, instructions to tenderer 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.

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

requirements shall be binding on the successful bidder without any commercial & delivery implication.

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

1.8 Deviations, if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.

1.9 Any commercial documents / deviations shall not be considered during technical evaluation. Moreover any technical deviations included in commercial deviation either explicit or implicit shall be considered null and void even if agreed by BHEL during commercial evaluation stage.

1.10 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.

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

1.12 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or NNTP including their consultant as interpreted by BHEL in the relevant context.

SECTION: B

PROJECT INFORMATION

SECTION - 2

2 GENERAL PROJECT INFORMATION

2.1 Introduction

The project site at Neyveli has distinct location advantages, being at pit-head distance from the source of lignite supply from Mines, making it convenient for transportation of lignite by belt conveyor. Water source is readily available from the nearby mines lake. Besides, other infrastructure such as access road, railway connection etc, already exist.

2.2 Power Plant Site

The power plant site is located at Neyveli, opposite to the now defunct Fertilizer and Briquetting & Carbonization Plant, near TPS-1 Expansion and TPS-II.

2.3 Project & Site Information

(i).	Owner/Purchaser	:	Neyveli Lignite Corporation Limited (NLC Ltd), Neyveli, Cuddalore District, Tamil Nadu State, India
(ii).	Consultant	:	Lahmeyer International (India) Pvt. Ltd (LII), Gurgaon, NCR, India.
(iii).	Project Title	:	2x500 MW Neyveli New Thermal Power Station (NNTPS)
(iv).	Location	:	200 kms south of Chennai and 50 kms south-west of Cuddalore
(v).	Latitude	:	11° 34′ 00″ N to 11° 35′ 00″ N
(vi).	Longitude	:	79° 26′ 00″ E to 79° 27′ 00″ E
(vii).	Elevation above MSL	:	+67 m
(viii).	Nearest Railway Station	:	Neyveli,
(ix).	Nearest Sea Port	:	Chennai, at a distance of 200 km
(x).	Nearest Airport	:	Chennai, at a distance of 200 km
(xi).	Road Access/Approach to Site	:	Connected by Chennai-Thanjavur NH 45C road and state highway connecting Cuddalore – Virudhachalam via Neyveli. Both NH and state high way roads are well connected to NLC township roads.The approach road is approximately 15 kms from Chennai–Thanjavur NH – 45C road
(xii).	**Site Meteorological Data**		
	• Max ambient temperature	:	42.8° C

•	Min Ambient Temperature	:	26.9° C
•	Wet bulb temp	:	29° C
•	Max. Relative Humidity	:	92 % in the month of September
•	Min. Relative Humidity	:	23 % in the month of May
•	Rainfall	:	About 1265.7 mm annually (average)
•	Wind direction	:	South West to North East direction
•	Wind Speed	:	97.2 km/hr (maximum recorded) 4.3 km/hr (average wind speed)
•	Seismicity	:	As per IS: 1893 (part 4) (Zone-II) Importance factor: 1.75.
(xiii).	Languages spoken in the region	:	English, Tamil

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SECTION: C

TECHNICAL SPECIFICATIONS

SECTION: C1

SPECIFIC TECHNICAL REQUIREMENT

1. INTRODUCTION

1.1.1 The purpose of the system is to provide Ventilation for different areas of 2x500 MW NEW NEYVELI under the scope of BHEL.

2. SYSTEM DESCRIPTION

2.1.1 The Ventilation System is provided in the following locations within the Power House by Air washers. Coursing of air in desired direction / areas shall be made by using roof extractors.

2.1.1.1. TG bay (ground, mezzanine and operating floor), HP/LP heater area, condenser area, Boiler feed pump area.

2.1.1.2. MCC Rooms

2.1.1.3. Cable galleries

2.1.1.4. Switchgear Rooms

2.1.2 Ventilation provision for Auxiliary Buildings in various location is envisaged as follows:

a)	AC Plant Rooms	Mechanical Exhaust fans
b)	Transformer rooms, Battery rooms, elevator machine rooms.	Mechanical Exhaust fans
c)	DG bld.	Mechanical Exhaust fans
d)	ACW and all other pump house,	Mechanical Exhaust fans
e)	CPU regeneration bld.	Mechanical Exhaust fans
f)	MCC, switchgear room	Mechanical supply fans
g)	Fuel oil pump house, air compressor room, bunker bay bld., chemical feed station and stores.	Mechanical Exhaust fans
h)	Toilets	Mechanical Exhaust fans

*In addition to above mechanical ventilation for other auxiliary buildings under BHEL scope shall also be provided.

2.1.3 Evaporative cooling system by adopting Air Washer Unit (AWU) shall be provided for the ventilation of turbine building. Cooled and filtered air from Air Washer Unit shall be distributed by means of ducting to the TG building near various heat sources like turbo-generator, switch gear room etc. The hot air from the hall shall than be exhausted by means of roof extractors. The quantity of air exhausted shall be kept lower than the quantity of air supplied in such a way that a little overpressure is maintained inside the hall. This will reduce infiltration of outside hot and dusty air.

2.1.4 The supply air quantity for **each unit** is supplied from four (4) AWU each of 200000 CMH capacity - two (2) nos. being placed outside A-Row at 8.5 M level of TG building and two (2) nos. being placed in B-C bay at 24.0 M floor level, such division and location area decided to achieve effective air distribution with less amount of ductwork and less pressure drop in fans with no crossover of ducting along A-B bay.

2.1.5 The Air Washer Units primarily serve TG hall and the electrical areas like MCC Room, Switchgear Room, galleries. The washed air supplied to MCC / Switchgear/Cable Spreader Rooms shall be allowed to return to TG bay through gravity dampers. Fire dampers are provided in the supply air ducting leading to all electrical rooms (MCC, Switchgear etc.).

2.1.6 The supplied air in the lower level of TG hall after taking the heat load of TG bay rises through different openings to the upper floors and is then finally exhausted by means of roof exhausters placed over the roof of TG Hall. Some quantity of air leaks out through various leakage areas thus maintaining slight positive pressure inside w.r.t. outside.

2.1.7 Various auxiliary buildings such as Pump house etc. are provided with mechanical ventilation. Non-AC area of ESP Bldg. washed and filtered air supply is provided by means of UAF unit.

3. DES IGN CRITERIA:

System Design Criteria:

3.1.1 The outside design conditions considered are as follows:

Su	mmer	Monsoon W	inter
DBT (°C)	43.0	31.1	10
WBT (°C)	25.6	26.6	6.1

3.1.2 The inside design conditions:-

Evaporative Cooled Areas:

Average Inside temperature shall be kept below the design ambient temperature during summer (3^0 C below ambient temperature).

Mechanically ventilated areas:

Average Temperature rise above outside ambient shall be maximum 5^0 C during summer.

Higher number of air changes/higher quantity of airflow of either of condition shall be selected.

No. of air changes per hour shall be as follows: -

Sl. No	Area	No. of Air changes/hour
1	TG hall (for evaporative cooling)	8
2	Switch gear rooms of TG bld.(for evaporative cooling)	10
3	Cable galleries (for evaporative cooling)	6
4	AC plant room, Transformer rooms, Battery rooms, elevator machine rooms, DG bld., ACW pump house, CPU regeneration bld. ,toilets, switchgear & cable galleries.(for mechanical ventilation)	20

3.1.3 All equipment shall be designed for continuous duty and shall be located indoor.

3.1.4 Fire Dampers (Motorised type electrically operated) shall be provided in the duct / Fan opening of Switch Gear Room, cable galleries etc. The operation of these automatic dampers shall be interlocked suitably with fire alarm system and shall also possible from control panel room remote location.

3.1.5 Insulation:-

Please Refer clause no 13.5.1.5 viii & ix of NTA-2 section C-2and other relevant clause of customer specification section C-2.

3.1.6 For other information please Refer clauses mentioned under section C-2 (customer specification).

4. EQUIPMENT AN D SERVICES T O BE PR OVIDED F OR V ENTILATION SYSTEM. :

4.1 AI R-WASHERS:

4.1.1 Four (4) Nos. sheet metal type Air washer units (AWU) having capacity 2,00,000 CMH each having 75 mmwc static pressure for T.G. Hall for each unit # 1&2.

4.1.2 Each air washer comprises of:

4.1.2.1. Please refer clause nos. 13.5.1, 13.5.1.1 of NTA-2 section C-2 and other relevant clause of customer specification section C-2.

4.2 UAF:

4.2.1 One (1) Nos. Sheet metal type Unitary Air Filtration system (UAF) having cap. 75,000 CMH at 50 mmwc static pressure for each unit ESP building shall be placed at roof of the ESP bldg..

4.2.2 One (1) no. UAF comprises of:

4.2.2.1. Please refer clause nos. 12.7.2, 12.7.3 of NTA-1 Section C-2 and other relevant clause of customer specification section C-2.

4.3 CENTRIFUGAL FAN UNITS:

Each centrifugal fan shall be complete with

4.3.1 Please Refer clause no 12.7.14 of NTA-1, 13.5.1.2 of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

These fans shall cater to the areas as indicated in the fan schedule of ventilation system.

4.4 WALL MOUNTED AXIAL FLOW FAN:

Each wall mounted axial flow fan shall be complete with

4.4.1 Please Refer clause no 12.7.18 of NTA-1, 13.5.1.3 of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

These fans shall cater to the areas as indicated in the fan schedule of ventilation system.

4.4.2 RE / wall mounted fans shall be selected so as to have motor rating as under:

1.	Roof extractor units with 15 mmwc static pressure.	
	Capacity	Motor rating
	50,000 CMH	5.5 KW
	40,000 CMH	5.5 KW
	20,000 CMH	2.2 KW
2	Axial flow supply fans with 30 mmwc static pressure.	

	Capacity	Motor rating
	10,000 CMH	2.2 KW
	7,500 CMH	1.5 KW
	6,000 CMH	1.1 KW
	4,000 CMH	0.75 KW
3	Axial flow supply fans with 20 mmwc static pressure.	
	Capacity	Motor rating
	10,000 CMH	1.5 KW
	7,500 CMH	1.1 KW
	6,000 CMH	1.1 KW
	4,000 CMH	0.75 KW
4	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.	
	Capacity	Motor rating
	15,000 CMH	2.2 KW
	10,000 CMH	1.5 KW
	7,500 CMH	1.1 KW
	2,000 CMH	0.55 KW
5	Axial flow exhaust fans with 10 mmwc static pressure.	
	Capacity	Motor rating
	15,000 CMH	1.1 KW
	10,000 CMH	0.75 KW
	7,500 CMH	0.55 KW
	6,000 CMH	0.55 KW
	2,000 CMH	0.37 KW
6	Exhaust fan (propeller type) with 5 mmwc static pressure.	
	Capacity	Motor rating
	1200 CMH	100 W

4.5 ROOF EXTRACTOR UNIT:

Each wall roof extractor unit shall be complete with

4.5.1 Please Refer clause no 13.5.1.4 of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

These fans shall cater to the areas as indicated in the fan schedule of ventilation system.

4.6 AI R DISTRIBUTION SYSTEM

4.6.1 Please Refer clause no 12.7.21, 12.7.23 of NTA-1, 13.5.1.5 (v) & (vi) of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

4.7 DIFFUSERS, GRILLS & DAMPERS

4.7.1 Manually adjustable/back draft type/Gravity type exhaust air dampers.

4.7.2 Fire Dampers (Motorised type electrically operated) shall be provided with open and close status limit switches).

4.7.3 Please Refer clause no 12.7.22 of NTA-1, 13.5.1.5 (vii) of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

4.8 W ATER PUMP SETS

4.8.1 Each circulating water pump set for air washer shall comprise of the following

4.8.1.1. Centrifugal pump Horizontal split casing type, adequate capacity to match the system requirement for Air washer.

4.8.1.2. One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply.

4.8.1.3. One no. Pot type strainer at inlet complete with screen, drain arrangement etc.

4.8.1.4. 150 mm dia. Dial Type pressure gauges one each at suction & discharge side of the pump set and pressure transmitter & temperature gauge on discharge side.

4.8.1.5. Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.

4.8.1.6. One no. non-return (check) valve at discharge side of each pump set.

4.8.1.7. One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.

4.8.1.8. For other information please Refer clause no 12.7.19 of NTA-1, 13.5.1.5 (i) of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

4.8.2 Each circulating water pump set for UAF shall comprise of the following

4.8.2.1. Split casing type centrifugal pump of adequate capacity to match the system requirement for UAF.

4.8.2.2. One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply.

4.8.2.3. One no. Pot type strainer at inlet complete with screen, drain arrangement etc.

4.8.2.4. 150 mm dia. Dial Type pressure gauges one each at suction & discharge side of the pump set and pressure transmitter & temperature gauge on discharge side.

4.8.2.5. Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.

4.8.2.6. One no. non-return (check) valve at discharge side of each pump set.

4.8.2.7. One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.

4.8.2.8. For other information please Refer clause no 12.7.19 of NTA-1, 13.5.1.5 (i) of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

4.9 PI PING AND FITTINGS:-

4.9.1 Please Refer clause no 13.5.1.5 (ii) of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

4.10 VAL VES:-

4.10.1 Please Refer clause no 13.5.1.5 (iii) of NTA-2 section C-2 and other relevant clauses of section C-2 (customer specification).

5. CONT ROL PHILOSOPHY

5.1.1 Remote I/O Panel for Air-washer / UAF unit:

The Control system shall comprise of PLC based control panel, common for both AC & Ventilation system, kept in AC plant room and shall be supplied by AC-Plant supplier (AC Bidder's scope) with remote I/O panel for four (4) nos. air-washers room in power house bldg. and two (2) nos. remote I/O panel for UAF of ESP control room, hook-up with serial link to main plant DCS for monitoring. Remote I/O panel for Air-washer and UAF have been excluded from the scope of ventilation package and is included as part of supply from the AC Plant supplier. However all the instruments required for hook up with PLC shall be supplied by ventilation system vendor.

The communication cable between PLC to remote I/O rack shall be hot-redundant armoured cable. However, all local instruments for operation & control monitoring of ventilation system are within scope of ventilation system supplier.

Following Audio-Visual Annunciations are to be provided for Air-washers and UAFs.

1. Motor Overload Centrifugal Fan
2. Motor Overload Pump - 1
3. Motor Overload Pump - 2
4. Fan Running.
5. Fan Stop.
6. Pump – 1 Running.
7. Pump – 1 Stop.
8. Pump – 2 Running.
9. Pump – 2 Stop.

5.1.2 OTHER CONTROLS - VENTILATION SYSTEM

ON/OFF controls of each drive and equipment like air washer pumps, air washer fans etc located in air washer room shall be provided in local I/O panel located in air washer room. ON/OFF indication shall also be provided on this panel. Emergency stop push button shall be provided for all drives in air washer rooms. Air Washers pumps shall be interlocked with Humidistat. All other drives associated with ventilation system like fresh air supply fans, exhaust fans, roof extractor etc. shall be fed from respective MCC

6. GEN ERAL

6.1.1 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.

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

6.1.3 Vendor to include the Back wash arrangement of pot strainer with gate valve, piping etc for the Air Washer.

6.1.4 Vendor to include level gauge & level switch for each Air-washer tank for alarm & trip of the pumps. Also include one no. Pressure switch for each air washer pump

6.1.5 All drawings and documents shall be computer based.

6.1.6 All commissioning spares & consumables for trouble free operation shall be provided.

6.1.7 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.

6.1.8 Indicative list of makes is enclosed as per **Annexure-I** however these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.

6.1.9 Minor civil works like making openings to suit/finishing of opening, sealing of duct opening, grouting of foundation / foundation bolts etc. are in the scope of Vendor.

6.1.10 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.

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

6.1.12 Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

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

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

6.1.15 Vendor to furnish schedule of power and control cables indicating quantity of cables required to enable procurement of the same by purchaser. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.

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

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

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

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

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

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

6.1.22 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%.

6.1.23 Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.

6.1.24 The performance tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system:-

Design dry bulb temperature and relative humidity of conditioned air, Auxiliary power consumption, Vibration and noise level etc.

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

6.1.26 Motorized fire damper will be installed at supply and return air duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply and return air duct will be closed on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi sensor detectors in the return air duct for all air conditioned areas. Also respective Air washers/UAFs shall trip on receiving fire signal from fire protection system

6.1.27 Vendor to furnish drawings/documents as per the drgs. /documents submission schedule given in the contract.

6.1.28 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.

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

6.1.30 The bidder's proposal shall be for equipment in accordance with the Tech. Specification.

6.1.31 Tender drawings enclosed form the part of specification and the bidder shall check the space requirements.

6.1.32 Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only these items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification (C3).

6.1.33 Single supply feeder shall be provided by BHEL for a combination of fire dampers/valves. Further distribution through junction box/distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/valves.

6.1.34 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.

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

6.1.36 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.

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

6.1.38 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 vendor. Grouting of fans along with anchor fasteners shall also be done by vendor. The openings shall be finished properly. In case openings are done once the wall

have been painted, repainting, to match with the existing wall paint shall also be done by the vendor

7. EXCL USIONS

Items of works listed below are excluded from scope of the Vendor.

7.1.1 Masonry work including construction of ventilation plant rooms, foundations for Ventilation equipment (Air Washers, Centrifugal Fans, RE Units only).

7.1.2 Slab cut out for running ducts, pipes, cables, fixing grilles/dampers. Underground masonry trenches and masonry risers including their covering & water proofing for ducts, pipes, cables etc.

7.1.3 Provision of drain traps / points.

7.1.4 Lighting of Ventilation plant rooms/areas. For further clarity, bidder to note the electrical scope between BHEL and Vendor enclosed elsewhere in the specification.

7.1.5 Lifting & Handling arrangement for ventilation plant for maintenance purpose.

7.1.6 Structure for running the ventilation ducting header outside 'A'- Row, however required inputs shall be provided by the vendor.

SECTION: C2

CUSTOMER TECHNICAL SPECIFICATION

VOLUME IIA
SECTION – XIII
VENTILATION SYSTEM

TABLE OF CONTENTS

13 VENTILATION SYSTEM

13.1 General

This section of specification covers details of system specifications, detailing the areas to be ventilated, basis of design, brief description of the system, equipment and services to be furnished by Contractor.

Evaporative type ventilation system will be provided for TG building for both the units Filtered and Cooled air from each air washer unit will be distributed to various areas through diffusers. The TG building will be provided with adequate number of roof extractors.

For other miscellaneous areas mechanical type ventilation system using Supply and/or exhaust air fans/ roof exhausters will be provided.

13.2 CODES AND STANDARDS

All materials and equipments provided will comply with the following Indian standards

S.No	Code	Description
1	IS 277	Galvanised steel sheets
2	IS 325	Three phase induction motors
3	IS 655	Metal air ducts
4	IS 7613	Method of testing panel type air filters for air conditioning and ventilation process
5	IS 2312	Propeller type AC ventilation fans
6	IS 3588	Electric axial fans
7	IS 4894	Centrifugal fans
8	UL 555	Fire dampers
9	IS 7098 Part – 1	Power Cables
10	IS 1554 Part – 1	Control Cables
11	IS 4237	MCC
12	IS 6875	PB Stations

Control panel Individual electrical components conform to respective IS standards.

13.3 DESIGN CRITERIA

The following are the areas proposed to be ventilated:

Sl. No.	Area	Design condition to be maintained	Type of ventilation system to be provided	Minimum number of air changes / hour
1	Turbo generator hall of Main Power Plant building.	Not more than ambient temp.	Washed air supply system & mechanical exhaust from roof.	8
2	Switch gear rooms of TG building in A-B, B-C,C-D and D-E bays	Not more than ambient temp. with pressurization 2 – 3 mm WC	Washed air supply system	10
3	Cable galleries in A-B, B-C, C-D and D-E bays	Not more than ambient temp. with pressurization 2 – 3 mm WC	Washed air supply system for those areas which are a part of Main power plant building	6
4	A.C. plant room	General air exchange ventilation	Mechanical Exhaust	20
5	Transformer rooms, Battery rooms, Elevator machine room.	General air exchange ventilation	Mechanical exhaust	20
6	DG Building	Exhaust ventilation	Mechanical exhaust.	20
7	ACW Pump house	Exhaust ventilation	Mechanical exhaust.	20
8.	CPU regeneration building	Exhaust ventilation	Mechanical exhaust.	20
9	Toilets	Exhaust ventilation	Mechanical exhaust.	20

13.3.1 Design Input

i. Outdoor Design Conditions

The outdoor design conditions considered for the site as per ISHRAE Hand book are as follows:

Season	Dry Bulb Temp. (°C)	Wet Bulb Temp. (°C)
Summer	43	25.6
Winter	10	6.1

Monsoon	31.1	26.6

ii. Inside design conditions:

- Turbine hall

  Inside dry bulb temperature will be designed not more than the ambient temperature during summer, when TG is generating full load. For HT, LT switch gear room and cable spreader room in station building will be designed to limit not more than ambient temperature with pressurization during summer.

- Mechanically ventilated areas

  Inside dry bulb temperature will be not exceeding ambient summer temperature or based on number of air changes/hr, whichever results in higher air flow rate will be selected.

13.3.2 Sizing Criteria

The Ventilation air flow rate will be estimated considering the following major loads as follows:

i) Lighting load (kW)

ii) Equipment heat load including steam piping as well as the dissipated heat, solar transmission through the building wall and glass, and any other sources of heat. (kW)

iii) Human load (kw)

iv) Air change per hour (ACPH) as per design basis requirement

v) For the Summer ambient conditions as furnished to be considered

vi) The Saturation Efficiency of air-washer will be 90% with two banks opposed type spray system.

The design methodology will be in-line with ASHRAE / ISHRAE guidelines / norms and mass and energy balance.However the following velocities may also be considered while designing the system

.

i) Dry panel filter (Face velocity)	-	2.0 m/sec (maxm.)
ii) Main ducts	-	8 – 10 m/sec
iii) Branch duct	-	6 – 8 m/sec
iv) Supply air grills	-	3 – 4 m/sec
v) Louvers for air inlet	-	1.5 m/sec (maxm.)
vi) Centrifugal fan at inlet/outlet	-	8 – 10 m/sec

vii) Water velocity in piping - 1.5m/sec. (maxm.)

The equipment will have at least 10% reserve capacity.

The other inputs like, ambient condition, inside design condition and Heat load details are indicated in Volume-I

13.4 SCOPE

The scope of equipment to be furnished and installed under this specification will cover all the equipment detailed hereunder:

The scope of Specification is indicative and are minimum requirements for the basic Ventilation system specified, any other items, needed to make the system complete, safe and sound in operation will be included under the scope of work by the Contractor at no extra cost to the Employer.

Ventilation Schedule

Different areas of Power House Building and Service Building will be ventilated using systems as indicated in Clause 4.0 above. Schedule of equipment for Ventilation system is furnished below. If the system/rooms offered by the Contractor are different, same will be indicated and provided.

Sl. No	Function / Location	Type	Qty. of fans for 2 x 500 MW (Minimum)
1	Supplying washed air to TG Hall in AB, BC and upto EF Bay of TG building.	Backward curved centrifugal DIDW fan	4
2	Supplying washed air to switch gear rooms and cable galleries, in TG Building	Backward curved centrifugal DIDW fan	4
3	Exhausting air from TG Hall roof monitor	Roof mounted axial flow fan exhauster fan	20
4	Exhausting acid fume laden air from Battery Room of Service Building	Wall mounted bifurcated, axial flow fan of spark proof construction.	1 W + 1 S
5	Exhausting acid fume laden air from Battery Rooms of TG Hall	Wall mounted bifurcated axial flow fan of spark proof construction	4 W + 2 S
6	Exhausting air from Aux. Transformer Rooms of TG Hall.	Wall mounted axial flow fan	4
7	Exhausting air from winch room of Service Building and TG building Elevator	Wall mounted axial flow fan	1 each

Sl. No	Function / Location	Type	Qty. of fans for 2 x 500 MW (Minimum)
8	Supplying air inside the lift.	Supply air fan	1 each
9	Exhausting air from Toilets of TG Hall, and Service Building	Wall mounted axial flow fan	1 each
10	Exhausting air from A.C. Plant Room,	Wall mounted axial flow fan	3
11	Exhausting air from DG Building	Wall mounted axial flow fan	4
12	Exhausting air from CPU Regeneration Building	Wall mounted axial flow fan	4
13	Exhausting air from ACW Pump house	Wall mounted axial flow fan	4

Note : The number of fans indicated above are minimum and required number of fans as per the heat load calculations/number of air changes per hour whichever is higher will be provided to make the system complete. Any other area requiring ventilation facilities within the terminal point will also be covered within the scope of the Contractor.

a) Complete Ventilation system consisting of the following along with all accessories for the ventilation of TG building.
   i. Air washer units (of metallic construction) of each of suitable capacity with all accessories.
   ii. Centrifugal fans each of adequate capacity and with drive motors and with all its accessories.
   iii. Circulating water pumps with drive motors and with all its accessories.
   iv. Circulating water piping along with valves, fittings, etc.
   v. Complete ducting (with Insulation for exposed ducting only), motor operated dampers, back draft dampers, grills, diffusers, fresh air intake louvers, etc.
   vi. Roof Extractors and Exhaust Fans with all accessories.
   vii. AC Motors for the above equipment
   viii. MCC, starter panel, electrics, instrumentation etc.

b) Ventilation system for various auxiliary buildings consisting of Supply air fans, exhaust air fans, roof extractors, back draft dampers, in-take louvers and along with accessories.

c) Set of commissioning spares as may be required during erection and commissioning and supply of complete mandatory spares.

d) Initial charge of all lubricants and grease.

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e) One (1) set Special tools and tackles required for maintenance of all the mechanical, electrical and C & I equipments.

f) Supply and installation of suitable vibration isolation pads for small equipments such as pumps etc supported on slabs to avoid transfer of any vibrations to the building structure.

g) Repairing and making good /sealing of cut outs/openings in walls, floor and roof slabs provided by Employer/ or prepared by the Contractor for executing the work under the package as required and making them water tight as directed by the engineer.

h) Painting for all equipments / items as detailed.

13.5 Description Of System (Tentative Requirement)

i. Evaporative cooling Ventilation system will be provided for each 500MW unit station building (TG hall, Switchgear room, Electrical Bay).

ii. Ambient Air Ventilation (Dry) system for miscellaneous areas.

13.5.1 Evaporative Cooling System for TG Building, Cable vault, Switch gear and MCC room of Power house building:

Air Washer will be of "Double bank spray system "designed for a saturation efficiency of 90% at design summer condition. In this system, fresh filtered air is drawn through air washers and evaporatively cooled (water spray through nozzle) before being supplied through the supply air distribution system. The filtered air while passing through the air washers would be cooled and humidified to minimum 90% saturation efficiency. This cooled and humidified air is distributed by Air washer fan to different parts of the station building through ducting would absorb the prevailing internal heat load due to equipment, piping etc before being exhausted. Suitable capacity air washers will be provided for ventilation of TG building including electrical bay, cable gallery and Switch gear rooms.

Each unit will be complete with Air intake Louvers with inspection doors and cat walk, Dry panel HDPE filter Spray & Flooding nozzles of Polypropylene with stainless steel tip, Moisture eliminator of FRPI/PVC, One Double Inlet Double Width (DIDW) type centrifugal fan, Two (2X100% -1 Operating + 1 standby) cooling water pumps of horizontal split casing type/ end suction top discharge type, each of adequate capacity. Humidistat and casing with frame work. The media will be designed for a maximum velocity of 2.5 m/sec.

Spray type air washers with water distribution arrangement etc.

Pre filter with HDPE media having 18 G GSS frame. The efficiency of the filters will be 90% down to 10 microns.

Inlet louvers and bird screen

Air distribution system comprising of GSS ducting, dampers, grilles etc.

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Roof ventilators of suitable capacity will be mounted on TG hall roof for exhausting the hot and vitiated air and as per ventilation schedule furnished above.

The method of air distribution will be as follows:

i. 2x50% air washers for A Row Side for each unit, 2x50% capacity air washer for BC Bay Side for each unit.

ii. Suitable capacity power roof ventilators will be mounted on TG hall roof and wall as convenient for exhausting the hot and vitiated air. The hot air from cable gallery and MCC/switch gear room is taken to the TG hall through gravity dampers, as required. The quantity of air exhausted will be kept lower than the quantity of air supplied (usually 60-65% of the supply air is exhausted) in such a way that a little overpressure is maintained inside the hall.

13.5.1.1 Air Washer Unit

Each Air Washer Units (Evaporative System) will consist of the various Sections such as Air washer chamber / Casing, Tank, Distribution plates, set of metallic/fabric filters at suction, suction louvers, bird screens, water headers, Spray nozzle, piping, valves, etc, Drift eliminators, Pumps, Fans, Necessary controls & Instrumentation and all other required accessories.

i. The air washer chamber casing will be fabricated from 10 SWG black M.S. sheet with adequate stiffeners etc. and various sections will be bolted through gaskets to avoid leakage of water. The inside of casing will be protected by spray galvanization or by three coats of epoxy painting.

ii. The air washer tank will be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the casing and tank will be spray galvanized. Minimum depth of the tank will be 600 mm. Tank construction will be such that the suction screen can be replaced while the unit is operating. Tank will 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 will be connected to drain pipe after isolating valve on drain pipe.

iii. The distribution plate will be fabricated out of 18G galvanized steel sheets & galvanized steel angle supports with minimum 50% free area.

iv. The spray nozzles will be of brass or bronze with chrome plating and will be self cleaning type. The nozzle will be designed to produce fine atomized spray and will 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.

v. Suitable number of brass screen will be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid will be used inside the screen for reinforcement.

vi. Both inside and outside of all the sections of the metal chamber unit will be spray galvanized to prevent corrosion. The nuts and bolts used for joining the

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section will be galvanized. The connection pieces will have at least two (2) coats of rust inhibiting paint.

vii. Resistance to air flow in washing chamber will not exceed 15 kgf/m2

viii. The switches will be provided at the out side of air washer.

ix. Suitable waterproof light will be provided inside the air washer with lead wiring and switches

x. The air to water ratio in the air washer will be taken as 1000:1. i.e (1000 CMH of Air = 1 CMH of Water.)

xi. Ducting outside the served premises of air washing unit will be insulated with 25 mm (minimum) thick insulation and aluminium cladding.

xii. Sizes for the air washer piping will be based on calculation considering flow velocity of 1 to 1.5 m /s.

13.5.1.2 Centrifugal Fan

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

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

The first critical speed of the rotating assembly will be at least 25% above the opening speed.

The fans will be provided with V-belts and sheaves. All belts will be sized for 150% rated HP. All V-belt will be equipped with removable belt guards that do not impede the air flow to the fan inlet. There will be a minimum of two belts per drive.

13.5.1.3 Axial Fans

These fans will have fixed / variable pitch cast aluminum blades of aerofoil design. Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. will be provided.

The speed of the fan will 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 will 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 will be atleast 25% above the operating speed.

13.5.1.4 Roof Ventilators

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The roof extractors will be "COWL" type.

Impeller will be of axial flow type, cast Aluminium in one piece and dynamically balanced. Casing will be heavy gauge sheet steel construction of 3 mm thick for impeller upto 750 mm diameter and 5 mm for fans with impeller of diameter 750 and above and the same will be spray or hot dip galvanised. In casing, access door with locking arrangement be provided.

The cowl will be designed for weather protection of the fan also inside of the roof on which the extractor is installed. Galvanised bird screen of 15 mm Square be provided with the cowl. All accessories, steel supports as required will be provided.

All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required will be provided.

13.5.1.5 Balance Equipment Specification

i. Centrifugal Pumps

S.No	Item	Material
1	Type of pump	Horizontal Centrifugal, Axially split type casing
2	Impeller	Closed type
3	Material of Construction	
	a) Casing	2% Ni Cast Iron : IS:210 Gr. FG-260
	b) Impeller	Bronze IS:318 Gr-2
	c) Wearing rings	Bronze
	d) Shaft	SS316
	e) Shaft sleeve	SS316
	f) Lantern ring	Brass/ Bronze
	g) Packing	Asbestos free
	h) Base Plate	Carbon Steel as per IS: 2062
	i) Speed	Maximum 1500 rpm

ii. Material of Construction for Piping & Fittings

S.No	Detail	Description
	Circulating water piping of Ventilation System	Heavy grade-IS: 1239 or Equivalentupto150 NB or Equivalent and IS: 3589 or Equivalent for pipes beyond 200 NB. The piping upto 100 mm diameter will be of galvanized steel and those above 100 mm dia will be black steel. The piping will be adequately supported
	Drain piping	Same as above & galvanized as per IS:4736
	Fittings	1. The steel fittings will conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B

	16.9/ANSI B16.11 / equivalent for sizes 65 NB and above. 2. For sizes 50 NB and below, the material will conform to ASTM A-105 3. All steel flanges will be of slip on type and will conform to ANSI B 16.5 4. For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends will be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections will not be more than 22.5 deg and will be as per BS: 2633/BS: 534. 5. Fittings, flanges and pipe joints of refrigerant piping will conform to ANSIB31.5
Steam piping / spray piping / fitting	1. Seamless Carbon steel pipe conforming to ASTM-106 Gr B will be used. Steam pipe line will be provided with necessary steam traps, vents and drain connections. 2. All pipe fittings will be seamless construction (forged) as per ASTM A 105. 3. Necessary hangers, supports and auxiliary structures for pipe supports will also be provided by the Contractor. 4. It is the sole responsibility of the Contractor to obtain clearance from IBR for the design, manufacture, erection and testing of pipes, valves, fittings, specialties etc. In order to obtain the above approvals, all necessary documentation etc. required to be furnished/arranged will be done by the Contractor. 5. In order to take care of thermal movement, due to the temperature of the fluid being handled, loops in vertical or horizontal plane may be provided to make the system flexible. However, in no case a U-type should be provided in the vertical plane. Further, the supporting system on this line should be such that it does not arrest the free movement of the pipe

iii. Valves

- Valves will have full sizes port and suitable for horizontal and as well as vertical installation.

- Valves for regulating duty will be of globe type suitable for controlling throughout its lift.
- Gate, Globe and stop check valves will have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- All safety /relief valves will be so constructed that the failure of any part does not obstruct the free discharge.
- Manual gear operators be provided for valves of size 200 NB and above.
- All valves with rising stem will have position indicators. All valves will be provided with locking arrangement.
- All water line valves will be of Cast Iron body for sizes 65 NB and above conforming to IS: 14846 and Gun Metal construction for sizes less than 65NB conforming to IS:778. Cast Iron parts will conform to IS: 210 Gr. FG 220. However, butterfly valves will confirm to latest revision of BS: 5155 or equivalent standard of required class/rating.

iv. Air Filters

Pre Filter

a) Fabric Type

i. Fibrous media will consist of suitable fibrous material (e.g. non-woven material of polyester / polyethylene) sandwiched between protective mesh of HDPE and supporting mesh of GI. However, filter media will be V fold galvanized wire mesh inter-spaced with a flat layer of galvanized wire mesh in case of metallic type.

ii. Casing will be GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge). Suitable aluminium spacers to be provided to ensure for uniform distribution of air flow.

iii. Casing will be provided with neoprene sponge rubber sealing on fitting face.

iv. Capable of being cleaned by water flushing.

v. Density of filter medium will increase in the direction of air flow in case of metallic pre-filter.

b) Efficiency

Average arrestance of 65 - 80 % when tested in accordance with BS: 6540 / ASHRAE – 52 – 76.

a) Minimum thickness : 50 mm for fabric type

b) Face Velocity : Not more than 2.5 m/sec.

c) Pressure drop : Initial pressure drop – Less than 5 mmwc at rated flow.

: Final pressure drop - Upto 7.5 mm WC

Fine Filters (Microvee type)

S.No	Detail	Description
1	Construction	By pleating a continuous sheet of filter medium into closely spaced plates separated by heavy corrugated

		aluminium spacers.
2	Frame	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3	Other requirements	a) A neoprene sponge rubber sealing will be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing
4	Efficiency	Average arrestance of 80-90% when tested in accordance with BS: 6540/ASHRAE–52-76.
5	Minimum thickness	150 mm or 300 mm.
6	Face Velocity	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
7	Pressure drop	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC
8	Location	i. At the discharge of each individual AHU. ii. At the discharge of each Fresh air

v. Low Pressure Air Distribution System

Material of air distribution system will be through galvanised steel sheet (Conforming to Grade 275 of IS: 277) or Aluminium alloy (grade 19000 / SIC or 3100/ NS3 of IS: 737)

Thickness of rectangular ducts will be as follows:

Larger Dimension of duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium 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)	1.5
2251 & above	1.25 (18 G)	1.8

Thickness of round ducts will be as follows:

Diameter of round duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet(mm)
150 to 500	0.63	0.8
501 to 750	0.8	1.0
751 to 1000	0.8	1.0
1001 to 1250	1.0	1.5
1251 & above	1.25	1.8

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vi. Duct Fabrication and Supports

Duct fabrication will be as per the latest relevant BIS standard.

- The ducts with larger side greater than 2250 mm will be supported by 15mm MS rods and 50x50x3mm MS double Angles while those below 2250 mm will be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports will be at a distance of not more than 1200 mm. The MS rods will be hung from building steel wherever available, with provision of necessary auxiliary or special steel members or by hooks or by dash fasteners fixed to the ceiling slab. 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 will be provided by Contractor.
- Where ever ducts are running outside the building and or at locations where it is not possible to support the ducts from Employers ceiling/floor due to non-availability of the same, the base steel frame/truss work for supporting the ducts between two columns will be provided by Employer. However all other auxiliary steel members, hooks, rods etc for supporting the duct work with the base frame/truss work will be provided by the Contractor.
- Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of at least 150 mm width will be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass.
- All curves, bends, off-sets and other transformations will be made for easy and noiseless flow of air. The throat of every branch duct will be sized to have the same velocity as in the main duct to which the branch duct is connected.
- Wherever duct passes through a wall, the opening between masonry and duct work will be neatly caulked or sealed to prevent movement of air from one space to the adjoining space.
- Wherever pipe hangers or rods pass through the ducts, light and streamline easement around the same will be provided to maintain smooth flow of air.
- Access doors will be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors will be of adequate size and will be lined with substantial felt edging to prevent air leakage. Access doors will be of built up construction, structurally strong and each will have at least two hinges. Access doors will have two rust proof window sash of approved type. All doors will be set so as to flush with insulation or plaster finish on the duct.
- Ducting outside the served premises of air washing unit will be insulated with 25 mm (minimum) thick insulation and aluminium cladding.

vii. Diffusers, Grills & Dampers

- Supply air diffusers/grills with volume control dampers be provided for all areas provided with evaporative cooling system.

- Inlet/Exhaust air grills/louvers are required for all negatively pressure ventilated areas. Back draft dampers will be provided for all areas pressurized under ventilation system.
- The diffusers/grills will be of powder coated mild steel construction for Ventilation system.
- Splitters and dampers will be provided for equipment/area isolation and for proportional volume control of system. The same will be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.
- Gravity operated back draft dampers will be installed in association with supply air system in order to maintain positive pressure inside MCC/switchgear and cable gallery areas.
- All volume control (VC) damper will be operated by a key from the front of the grills/diffusers and will be of GI sheet.
- The thickness of frames of Diffusers, grills & VC dampers will be of minimum 20 gauge and thickness of louvers will be of minimum 26 gauge.
- All plenum chambers of connections to fans, dampers etc will be constructed in 18 gauge GS sheet and supported on MS angle frame.

viii. Thermal And Acoustic Insulation

- All surfaces to be insulated both thermally and acoustically will be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products or Equivalent) be applied @ 1.5 Kg /Sqm on the surface.
- Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber or Equivalent) will be struck to the surface. All the joints will be sealed with bitumen.
- Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.

ix. Acoustic Insulation

- All ducts up to a distance of 5 meters from Air washer unit fan, and other centrifugal fan outlet will 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 will be fixed on wooden frame of 600 x 600 mm dimension.
- Fiber glass tissue sheet will be applied over the outer surface of insulation before applying perforated aluminium sheet.

13.6 Painting

- All the Equipments will be protected against external corrosion by providing suitable painting.

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- The surfaces of stainless steel, Galvanised steel, Gunmetal, brass, bronze and non-metallic components will not be applied with any painting. The Contractor will clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting will be thoroughly cleaned before applying painting by brushing, shot blasting etc as per the agreed procedure.
- For all the steel surfaces (external) exposed to atmosphere (outdoor installation), a coat of red oxide primer of thickness 30 to 35 microns followed up with three coats of synthetic enamel paint, with 25 microns as thickness of each coat, will be applied.
- For all the steel surfaces inside the building (indoor installation), a coat of red oxide primer of of thickness 30 to 35 microns followed up with two coats of synthetic enamel paint, with 25 microns as thickness of each coat, will be applied.
- 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 will 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.

13.7 Layout Requirements

While designing the layout of the equipment and system, the following points will be covered / considered :

- Co-ordinates and location of the building.
- Equipment layout with description
- Piping layout.
- Maintenance access and neatness of layout.
- Interference
- Equipment handling and removal facility
- Cable trenches and conduits
- Battery limit with elevation of utility services
- Location of MCC, IPBS, DB etc.
- Floor drain
- Floor wise ducting layout.

13.8 Maintenance Requirements

While designing the equipment and systems, the following maintenance aspects will be taken into consideration.

- Sufficient space for maintenance in the layout.
- Access to the equipment.
- Inspection and maintenance doors for equipment.
- Provision of chain pulley blocks with monorail for the equipment.

13.9 Inspection and Testing

Inspection and testing at the manufacturer's works/premises in general has been described in general condition of contract. However, for this technical specification, following guideline will also be followed.

All equipment will be tested as per relevant Indian Standards. List of all tools and test procedures proposed by manufacturer will be submitted to purchaser for prior approval.

13.10 Instrumentation and Controls

Necessary Instrumentation and controls will be provided for the systems. Safety and automation interlocks will be provided as described in the relevant clauses in the specification and are necessary for the operation of plant & equipment.

13.11 Data, Drawings and Information to be Submitted After Award of Contract

A broad description of drawings / documents / data to be submitted by the Contractor for purchaser's / consultant's approval are outlined hereunder. Over and above these drawings / documents / data, the Contractor will submit other drawings / documents which in purchaser's / consultant's opinion may require approval.

General arrangement drawings of all the equipment indicating overall dimensions, complete technical parameters with all accessories and bill of materials and materials specification.

-Foundation drawings of all the equipment indicating total weight of the equipment, load data, section view of the foundation, pocket sizes, foundation bolts and insert details.

Equipment / layout drawings with sections.

Schematic drawings of all the systems indicating different supply points quantities of air supplied, capacity and total pressure of system etc. Schematic flow diagram / drawing for each system, showing ducting, piping, fittings, valves, interlocking arrangement etc. as applicable.

Cross sectional drawings of Fans, pumps, chillers, heat exchangers along with parts list for ordering of O&M spares.

Detailed engineering calculation for selection of different equipment & pressure balance calculation etc.

Hydraulic flow diagram (for water system) with pressure drop calculations.

Process, instrumentation and control diagram including interlocks.

Complete piping layout drawing, showing overall dimensions of individual units, piping network, valves etc.

Performance data & characteristic curves for different fans, pumps and other equipment etc.

A brief write-up on the control an interlocking schemes of each system.

List of bought out items along with their make, catalogue & literature.

Duly filled in data sheet for different equipment / items.

Operation, maintenance and service manuals.

The following documents will be submitted during inspection / despatch of equipment.

a) Manufacturer's test certificates for all equipment.

b) Type and test certificates and performance record at works for compressors, fans, pumps, motors, filters etc.

13.12 Guarantee

The Contractor will guarantee the performance of ventilation and air conditioning systems on the following accounts:

- No undue vibration of the equipment
- Smooth running of the rotating parts of all machines. The equipment will be statically & dynamically balanced.
- No over heating of bearings.
- No leakage in the ducting / piping system and equipment.
- Ensuring specified parameters of various equipment.
- Any other relevant test parameters found necessary.
- Designed air flow at various points of system.
- Ensuring specified inside design conditions.

13.13 Performance Test (Ventilation system)

After erection of equipment with all necessary allied work ventilation and air conditioning systems will be commissioned. The systems will be set at required conditions.

The Contractor will submit the procedure of testing and assuring the compliance with technical parameters. Performance test will be carried out to prove the following guaranteed parameters.

Sl. No.	Parameter	Guaranteed figures
VENTILATION SYSTEM		
1	Room temperature for washed air supply ventilated premises	Not more than ambient temperature
2	Pressurised ventilation of Electrical premises in TG building.	Temperature not more than ambient and pressurization of 2 – 3

		mm WC
3	Saturation efficiency of air washer%	Not less than 90 %

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AC & VENTILATION SYSTEM

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12.1 General

Ventilation and air conditioning facilities will be provided for the various plant premises to ensure proper working environment both for men and machine and to maintain necessary environmental conditions for proper storage of plant, equipment and materials.

This specification will be read in conjunction with other parts / volumes (Vol. I, , II, , III, IV, V, VI & VII of the NTA1-SG portion) of the specification where other related project requirements have been given.

The intent of specification is to cover provision of ventilation and air conditioning facilities including all accessories for steam generator package on turnkey basis for 2 x 500 MW power plant at Neyveli Tamilnadu, India, as per the detailed scope of work described in clause 12.3.

12.2 Codes & Standards

All equipment, systems and works covered under this specification will comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed and the following publications, norms / guidelines, standards, acts and rules.

- Publications of Bureau of Indian Standards (BIS).
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
- American Conference of Governmental Industrial Hygienists (ACGIH) publications, U.S.A.
- American Refrigeration Industries (ARI).
- Publications of International Standards Organisation (ISO).
- VDI stipulation for vibration level.
- Handbook of Air Conditioning System Design by 'Carrier Air Conditioning Company'

The following codes & standard will be followed:

- IS: 226 Specification for structural steel (standard quality)
- IS: 655 Specification for metal air duct.
- IS : 277 Specification for galvanised steel sheets
- SMACNA Sheet Metal and Air Conditioning Contractors National Association

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

Metric system of units will be followed in design, manufacture and supply of all units. Name plates of equipment as well as operating / maintenance instructions will be in English language.

Noise level generated by the equipment supplied will not exceed the permissible limit of 65 dB (A) within the air conditioned served premises. In the air conditioning and ventilation plant room maximum allowable noise level will be 85 dB (A) at a distance of 1m from equipment.

The Contractor will also provide air conditioning and ventilation facilities to any other areas / technological system if envisaged besides those mentioned in this specification by the Contractor this stage or during detail engineering.

The air conditioning and ventilation equipment will be heavy duty type suitable for continuous operation under industrial duty conditions throughout the year.

12.3 Detailed Scope of Work

The scope of work covers the complete equipment / system design, engineering, manufacture / procurement, assembly, shop testing, shop painting, packing, transportation to site, unloading & storage at site, erection, supervision, site painting, testing, commissioning and conducting performance guarantee tests of all the ventilation & air conditioning systems including ducting, piping, dampers, valves, insulation, supports, measuring & control instruments etc.

The service facilities like civil, structural, electrics, illumination, instrumentation, water supply & drainage and handling & hoisting facilities needed for the ventilation and air conditioning systems will be included in the Contractor's scope of work.

Providing first charge of consumables like oil, grease, refrigerant etc. as required till successful completion of trial operation. The quantity and specification of such consumables will be indicated.

Supply of commissioning spares as may be required during erection, start up and initial operation of all the units / systems till successful completion of commissioning. The price for the commissioning spares will be deemed to be included in the contract price for the system.

Supply of tools & tackles required for maintenance of air conditioning and ventilation systems.

12.4 Performance Requirement

All equipment will be designed / selected such that the duty requirements as indicated in this specification can be maintained.

12.5 Inside design conditions

The following inside design conditions will be maintained in the various premises.

Sl.No	Premises	Inside dry bulb temp. °C	Relative Humidity %
1.	ESP Control rooms which also houses variable frequency drive panels of ID fans and other rooms need air conditioning	23 ± 1°C	55 ± 5%
2.	Central emission monitoring system room (CEMS), thyristor room(if applicable) for coal feeder drives	25°C (Max.)	-
3.	Shift In-charge rooms in ESP control room building, elevator machine rooms.	25°C (Max.)	
4.	MCC / Switch gear room, Electrical room, cable gallery and other rooms need supply air ventilation system	3°C above ambient temperature with pressurisation 2 – 3 mmWC	
5.	Fuel oil pump house, air compressor room, bunker bay building, AC plant rooms, chemical feed station, stores and toilets	Exhaust / general air exchange ventilation	

12.6 Design Criteria

The selection / design and manufacture of plant and equipment will be suitable for the intended service and the atmospheric / environmental conditions prevailing at the plant site.

The air conditioning and ventilation systems will include fan, dry panel type air filter, air conditioning unit, duct work, air supply grills, return air grills, dampers, insulation, piping, electrics, instrumentation and controls etc.

The following air velocities will be considered for the ventilation and air conditioning systems. However, standard sizes of equipment and accessories will be adopted satisfying the following limiting conditions.

- Louvers for air inlet - 1.5m/sec (max.)
- Dry panel filter (Face velocity) - 2.0 m/sec (max.)
- Main ducts (Ventilation) - 8 – 10 m/sec
- Main ducts (Air conditioning) - 6 – 8 m/sec

- Branch duct (Ventilation) - 6 – 8 m/sec
- Branch duct (air conditioning) - 4 – 6 m/sec
- Air supply grills - 3 – 4 m/sec
- Return air grills - 2 – 3 m/sec
- Centrifugal fan at inlet/outlet - 8 – 10 m/sec
- Water velocity in piping - 1.5m/sec. (max.)

Air conditioning and ventilation equipment will be located in a separate plant rooms. The plant rooms will be provided with separate approach, fire fighting and handling & hoisting facilities by the Contractor. The equipment will have at least 10% reserve capacity. Design calculations will be submitted for selection of system capacity as well as equipment selection. Air conditioning and ventilation systems will be designed considering the fire safety norms and will be interlocked with the fire detection system of the plant.

Central air conditioning system with chilled water based (vapor compression type) will be provided for ESP control rooms which also houses variable frequency drive panels of ID fans, Shift in charge rooms and other rooms require air conditioning facilities. Under deck insulation will be provided for all exposed roofs in the air-conditioned premises.

Chilled water expansion cum make up tank of adequate capacity will be provided at the highest point in the chilled water circuit. The tank will be complete with all accessories like float valve, limit switch with level indicator quick fill, drain, over flow etc. The tank will be thermally insulated.

Window type room air conditioner / Split type air conditioner will be used for air conditioning of the rooms for CEMS, thyristor room (if applicable) for lignite feeder drives and other small rooms located in far away from chilled water plant.

MCC / switch gear room, electrical room, cable gallery and other rooms require fresh air ventilation will be provided with fresh filtered air supply system. The rooms will be pressurized to 2 – 3 mmWC to prevent dust ingress by providing wall mounted gravity dampers.

Fuel oil pump house, air compressor room, bunker bay building, elevator machine rooms, AC plant rooms, chemical feed station, stores, toilet and other rooms generating fumes / heat will be provided with pressurized ventilation exhaust ventilation by installing wall mounted axial flow fan.

12.7 Type and Rating Of Equipment

Equipment Selection Criteria

12.7.1 Air conditioning systems

Air conditioning systems for ESP control room buildings of steam generation unit-I and unit-II will be provided. Common AC plant (if applicable) for ESP control rooms of unit 1 & 2 with 2 nos. screw chillers (1 W + 1 SB). Common AC plant

will be located in ESP building of Unit – 1. The contractor will do the design calculation of their own and furnish to the Owner/Consultant for approval for finalization of the system.

Chilled Water Plant for Air Conditioning System

The chilled water plant (for each ESP control room building) will include

Common AC plant for ESP control room unit 1 & 2 with:

a) 2 nos. screw chillers (1 W + 1 SB)
b) Chilled water pumps, 2 Nos. (1W+1R)
c) Condenser water pumps, 2 Nos. (1W+1R)
d) AHUs with accessories, 3 Nos (2W+1R)
e) Fan coil units for shift in charge room, quantity as per requirement.
f) Cooling tower with accessories – 2 Nos (1W + 1S).
g) Chilled water and condenser water piping with valves, pressure gauge, strainer etc.
h) Flow components in pipe lines
i) Thermal insulation of chilled water pipelines.
j) Humidity control arrangement with strip heater and pan humidifier
k) Refrigerant piping, valves and fittings
l) Ducting network with damper, supply air diffuser, return air grills, acoustic and thermal insulation.
m) Make up air filter with damper in different AHU rooms.
n) Insulated expansion tank. Tank will be located at the top most location of the entire chilled water piping network.
o) MCC, starter panel, electrics, instrumentation & controls etc.

Vapor compression machine with screw chiller will be chosen not only to ensure chilled water supply but also to perform efficiently at lower loads and at lower condenser water inlet temperature (particularly during winter season). If needed condenser water temperature control will be provided.

In general effort will be made for connecting the return air path from the control rooms in the gap between the roof and false ceiling and led back to the AHUs. Necessary duct line thermal and acoustic insulation will be provided as required.

Contractor will furnish the capacity range & inlet condenser water temperature range for their machines.

The Vapor compression machine with screw chiller and all pump sets will be installed in the AC plant room and various AHUs in AHU rooms to be located near / adjacent to the served premises.

Central emission monitoring system room (CEMS) & small rooms far away from chilled water plant will be air conditioned by providing suitable Split / window type air conditioner.

The cooling capacity of air conditioning system will be decided on the basis of heat dissipated in the premises, building heat radiation, illumination heat, occupancy heat, make up air heat etc. in the premises. Fresh air quantity will be based on 1.5 air changes / hour. The system will have at least 10% reserve capacity.

The air conditioning system will be provided with heating coil & humidifier for winter heating & humidity control.

12.7.2 Ventilation systems

Unitary Air Filtration (UAF) Unit for SG area (If applicable)

Ventilation system for SG area (i.e MCC/Switch gear rooms, electrical rooms, cable gallery and other rooms need supply air ventilation system inside ESP control room building) with unitary air filtration type air washer system will be provided. Saturation efficiency will be 70 % minimum.

Each UAF will consist 1x100% Centrifugal fan, 2x100% centrifugal circulating water pumps, air intake louvers, filters, evaporative cooling spray nozzles (Brass/ gun metal), UAF internals, ducting & piping network and other accessories. Cable galleries will be provided with miltilouvred gravity dampers to have positive pressure and also prevent dust nuisance. With this system the dry bulb temperature within the building will be maintained at a temperature not exceeding ambient temperature. The UAF capacity is to be decided based on:
Total internal heat load within the building, inclusive of electrical bay and maintenance bay and considering the heat dissipated by various electrical switchgear, equipment hot surfaces, steam piping as well as the dissipated heat, solar transmission through the building wall and glass, and any other sources of heat.

- Air change per hour (ACPH) as per design basis requirement
- Saturation Efficiency of air-washer will be 70% with spray system.

12.7.3 UAF for SG Area Building- Design and constructional details

i) UAF unit complete with air louver, single bank spray header with Polypropylene nozzles spraying water on flooded type water repellent filters, moisture eliminator, inspection window, marine light, maintenance cutaway etc. Saturation efficiency of UAF unit will not be less than 70%.

ii) Centrifugal pumps (one running & one stand by) complete with drive motors and accessories such as suction screen, pot strainer with bypass line valves, bends and fittings, inlet / outlet pressure gauge with isolating cock, complete make-up water plumbing with float valve, quick fill connection internal fitting

and supports, drain piping with valve, over flow connection, discharge piping etc will be provided.

iii) Piping for feed and make up water and also GI ducting grilles with volume control damper for UAF units will also be included.

iv) The sheet thickness for air washer tank will be 6mm and for the body of the air washer will be 5 mm.The casing and tank will be made of mild steel plate IS-2062 with epoxy protective paints inside and outside for corrosion protection. The distributor will be made of galvanised sheet steel and eliminators will be made of PVC.

v) The face velocity of air washer chamber will not be more than 2.5 m/sec.

12.7.4 Water Flooded Filter

i). The filter media will be of cleanable metallic type with efficiency 90% down to particle size of 10 microns when flooded with water.

ii). The filter media will be firmly secured on frame of rust proof material.

12.7.5 Moisture Eliminator Sets

i). Moisture eliminator sets used for the unitary air filtration units will be vertical and minimum 3 break type of PVC.

ii). Face velocity of air for the eliminator sets will not exceed 2.5 m/sec, Saturation efficiency of UAF ventilation system will not be less than 70 % for SG Area.

12.7.6 Design and Construction Details of Air Conditioning Systems

The equipment will be normally as per general specification of the project. However, brief description of main equipment is given below:

12.7.7 Vapor compression based Chiller

i) The packaged chilled water unit will be completely factory assembled and designed for continuous duty. Each package chiller unit will essentially comprise of rotary twin screw compressor, shell & tube type water chiller, refrigerant circuit, water cooled condenser, electric drives, instruments and controls and other standard accessories assembled in steel cabinet. The compressor will be semi-hermetically mounted on anti-vibration pads & dynamically balanced. Each chiller will have multiple screw compressors with independent refrigerant circuit.

ii) The chiller will be supplied with full operating charge of refrigerant R-134a & lubricating oil. Chiller performance will be ARI certified as per ARI standard 550. Cooler (evaporator) will be dry expansion type.

iii) Condenser will be shell & tube type construction dual refrigerant circuit water-cooled type. Unit will be equipped with suitable integral finned type, solid drawn, seamless copper tubes. The tubes will have internal turbulator. Fins will be made of Aluminium. Condenser shell will be constructed and tested in

accordance with section VIII, division I of ASME pressure vessel code. The shell will be capable to withstand refrigerant pressure of 300 psig, where as the tube side will be capable to withstand a water pressure of 150 psig. Cast iron water heads will be incorporated for easy removal, mechanical tube cleaning and/or tube replacement. Condenser will be provided with multiple pass to give optimum water velocity through tubes combining efficient heat transfer and allowable pressure drop.

iv) Fouling factor to be considered while designing the condenser will be 0.00025h-ft^2 F/Btu and temperature difference between inlet and outlet water will be approx. 7.5°F.

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

vi) Condenser will be provided with the following accessories / safety devices:

- Purge valve
- Charging valve
- Relief valve/ Fusible plug
- Liquid level indicator
- Flanged hot gas inlet / liquid outlet connection.
- Hand shut off valve for water inlet and outlet connection
- Flow switch in condenser water line
- Pressure & temperature gauges for water inlet and outlet
- Vent valve
- Drain valve

vii) Copper tubes of minimum diameter 16mm will be rolled in to grooves on tube sheet for a water tight and air tight joint. Joints between the tube sheet and the shell will be water tight while those between the shell and boxes will be airtight. Adequate sealing gaskets will be provided to prevent leakage of refrigerant and the infiltration of moisture and air in to the system Fouling Factor (water-side) 0.0001h-ft2F/Btu will be considered for design of cooler.

viii) Cooler shell will be capable of withstanding a pressure of 150 psig on shell side while 225 psig. on the tube side. Refrigerant will pass through the tube while water through the baffled shell. Refrigerant head is designed for proper number of passes to ensure refrigerant pressure drop is within the limit and adequate velocity for proper oil carry-over long with vapours.

ix) The chillier assembly will be thermally insulated with Armaflex material of 50mm thick and finished with aluminium cladding.

x) Minimum superheat of 3o C under design condition will be considered while selecting the chillers.

Following controls and safety devices / accessories will be incorporated in the chillers.

- Cooling and Anti freeze thermostat
- Flanged water inlet and outlet connection with flanges and shut off valves, including industrial type thermometer.
- Relief valve, purge valve, drain valve
- Pressure and temperature gauges at the water inlet and outlet.
- Refrigerant charging connection in the valve
- Flow meter and switches on the water line.
- View port

12.7.8 Split type Air-Conditioner

Split air conditioning unit will mainly comprise of two sections, viz. Indoor and Outdoor section. Indoor section comprises of cooling coil, fan, filter and supply air grills. Outdoor section comprises of air cooled condenser, blower, hermetically sealed compressor. Sealed refrigerant piping interconnects the indoor and outdoor sections. Outdoor unit will be installed in open space for easy heat dissipation from condenser. Indoor section will be high ceiling suspended or wall mounted type as per requirement. Remote control unit, thermostat and other standard accessories for successful installation of split type air conditioner will be included in the scope of Contractor. Any additional services required will be included in line with requirement. Split air conditioner unit will conform to IS:1391-1992 Part II.

12.7.9 Window Air-Conditioner

Window type air conditioner will comprise of hermetically sealed compressor, air cooled condenser, refrigerant piping, fan, instruments and controls, supply air grills with direction deflectors etc. enclosed in an insulated steel cabinet. Provision will be made in the front panel of the unit for controlling room ventilation and fresh air supply. Air filter installed will be of HDPE easily cleanable type. The front panel will be suiting to the interior décor of the room.

12.7.10 Air Handling Unit

i) The Air handling unit (AHU) will comprise of the following sections. The AHU will be provided with suitable control, instrumentation and accessories including switch fuse unit.

(a). Filter section

(b). Coil section

(c). Damper section

(d). Blower section

(e). Heater section

ii) Air handling unit will be made of GI sheet and rigid angle iron frame. Removable panels with double skin and sand witched insulation will be provided to make internal parts easily accessible for service and inspection, polyurethane foam (puf) insulation will be provided to prevent heat transfer to colder sections.

iii) Filter section should comprise of two filter banks, one, for pre-filtration and other for fine filtration.

iv) Velocity of air will not exceed 2.5 m/sec for pre filter and 1.5 m/sec for fine filter. Fine filter elements will be of superior compressed fill with adequate wool quantity.

v) Recommended pressure drop across filters when they are completely loaded is 12 mm WC.

vi) Filter framework will have lifting handles and locking metal wedges. Filter frame will be fabricated from MS sheet of suitable thickness in welded construction. All leakage areas should be sealed with suitable sealing compound.

vii) Cleaning efficiency of pre and fine filter will be according to manufacturer standard practice. Filter panels will be cleanable and reusable type.

viii) Coil section will have cooling coil manufactured from solid drawn copper tube with mechanically bonded aluminium fins. Face velocity of coil will not exceed 2.5m /sec. and pressure drop across the coil will be as minimum as possible.

ix) Damper section will be face and bypass damper. Damper should be suitable for automatic operation actuated by modutrol motor and modulating thermostat. Damper should have proportioning louvers so arranged that when face damper closes, bypass damper opens. No external bypass of air is acceptable

x) Manual dampers at the outlet of all the AHUs of air conditioning system will be provided.

xi) Centrifugal fan will be limit load characteristics.

xii) Impeller and shaft assembly of fan will be statically and dynamically balanced.

xiii) Centrifugal fan will conform to IS: 4894. Fan and motor assembly will be mounted on a common vibration proof base frame and the assembly will be provided with vibration arrestors, at the commissioning stage the vibration amplitudes will be measured to ensure that the vibrations are within the permissible limit.

xiv) Critical speed of the fan will be minimum 125% of the operating speed.

xv) Fan outlet will be fitted with canvass connections to isolate the vibration and outlet damper for the control of capacity.

xvi) Fan for AHUs will be provided taking care of pressure drop in the prefilter, fine filter, ducting losses in coil and other losses if any.

xvii) For fresh air requirement to AHU of ESP cum VFD Control room and for other areas, fresh air arrangement comprising of sheet metal fresh air duct will be provided with goose neck connection at intakes so as to serve as rain protection cover and bird guard. Filter element to match duct size and louvered damper complete with operation linkage to suit manual operation is to be provided. Fresh air filter element will be similar to that specified for prefilter earlier in the specification.

xviii) Heater section will consist of bank of electrically operated strip heaters to provide monsoon reheating as required and also winter heating for total air quantity to maintain specified inside design conditions. Selection of strip heater should be such that face velocity across heater is maintained at 2 to 3 m/sec. Heater bank frame should be electrically insulated for human safety. Heater will be flame proof/spark proof/tubular construction. Heater will be interlocked with AHU fan.

12.7.11 Cooling Tower

Induced draft type FRP cooling towers (1W + 1S) will be provided for the cooling of condenser water for chilled water air conditioning system. The cooling tower will be provided with fan & motor. The motor of fan will be of weather proof construction.

Cooling tower will be designed, manufactured and performance tested as per CTI codes. The capacity of the cooling tower will be adequate to take care of the cooling water requirement for the chilled water air conditioning system. The cooling tower will be mounted on RCC pillars near the air conditioning plant room. Inside fills will be of PVC.

Cooling tower basin will have accessories and connections for makeup, quick fill, drain screens and over flow. Float valve and limit switch interlocked with solenoid valves will be provided in the makeup water. The water distribution system will be either open basin with gravity feed nozzles or pipe system with nozzles requiring not more than 0.42 kg/sq.cm. water pressure at rated capacity. The nozzles will be spaced to give even distribution of water. The system will be self-draining, non-clogging and designed for flexible operation and ready accessibility. Suitable measuring orifices will be provided. All main piping connections will be brought out and will end in flanges to facilitate connections.

All the fasteners will be of stainless steel. Rubber/Neoprene gaskets must be used on all bolted joints as a seal against water leakage.

Nozzles for cooling tower will be of brass/gunmetal/stainless steel/ suitable material conforming to applicable standards. The cooling tower will be complete with ladder for maintenance and service requirements.

12.7.12 Insulation

i. Acoustic insulation

Acoustic insulation will be provided in the supply air duct up to 3m from AHUs. For applying acoustic insulation inside duct hot bitumen/ cold adhesive will be provided at the clean inside surface of duct. Then 25mm thick mineral wool will be provided. To hold the insulation 30 SWG perforated aluminium sheet will be provided and riveted with duct. Perforation will be of 5mm and 8 to 10mm centre to centre distance.

12.7.13 Thermal insulation

Thermal insulation will be provided on a portion of supply air duct out side the conditioned premises, pan humidifier, chilled water piping, drain pipes connected with insulated equipment etc. Thermal insulation of tail end duct will be provided to avoid condensation of moisture on the outside surface of the duct. The return air duct outside conditioned premises will also be insulated.

For applying thermal insulation, the outside surface of the duct/ pipe should be cleaned first, then hot bitumen/ cold adhesive should be applied on the clean surface. Then 50mm thick insulation material (mineral wool mat) with wire netting on outside will be provided. Then polythene with 50mm overlap will be sealed with adhesive. The polythene will be covered with 26 SWG aluminium sheet. All joints will be locked with self locking screw at a pitch of min 100mm.

12.7.14 Instruments and Controls

Following will be provided as applicable.

a) HP / LP cut out switch
b) Cooling and Antifreeze Thermostat
c) Pressure gauge and temperature gauge (6" dial type) in condenser water line and chilled water line
d) Water flow switch with interlock
e) Chilled water supply and return line valves, by pass valve, pressure and temperature gauges at supply and return line, AHU end
f) Refrigerant and water line strainers
g) Condenser purge, charging & relief valve
h) Refrigerant compressor HP, LP, OP gauges
i) Non return valve at pump out let
j) Any other instruments required for the system

12.7.15 Make up Water Tank

Make up water tanks will be provided for cooling tower of air conditioning systems. Tanks will be MS & inner surface spray galvanised. Make up water line with float valve & backup ball valve, quick fill line with ball valve, drain line with ball valve, overflow & vent line, level gauge will be provided.

12.7.16 Centrifugal Fan

These are used for ventilation system. The fans will be of limit load design. The fan will be of rugged steel construction and suitable for industrial duty condition. Fan housing will be of welded construction and provided with flanges at inlet and outlet sides for duct connections. The housing will be provided with lifting eye for ease of handling and bolted type access door.

The fan unit will be reasonably noise and vibration free in operation. The noise level for fan and motor assembly at 1 meter distance will be limited to 85 dB (A). The fan will be single inlet single width (SISW) type as per requirement. The fan will be both statically and dynamically balanced.

12.7.17 Dry Panel Filter

Dry panel type air filter will be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It will be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It will be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel will be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air will not exceed 2 m/sec. The resistance of air filter will not exceed 10 mmWC when dirty. Efficiency of the filter will not be less than 90% down to 10 microns. The whole filter and frame assembly will be fixed in a sheet metal casing of not less than 3.15 mm thick M S sheet.

12.7.18 Axial Flow (Tube Axial) Fan

These fans will be of heavy duty type. Fan impeller blades will be of aerofoil section of cast aluminium alloy. The impeller will be directly mounted on the motor shaft and the assembly will be mounted inside rigid tubular casing. Cable termination provision will be made on tubular casing. The connecting flanges will be provided at both ends of tube. Tube casing will be of minimum 2.5 mm thick M S sheet. The noise level for fan and motor assembly at 1 meter distance will be limited to 85 dB (A).

Axial Flow (Propeller) Fan

These are used for general ventilation of premises emitting heat / fumes. These will be of heavy duty and wall mounted type. Fan impeller blade will be aerofoil section and mounted directly on the motor shaft. Air entry from motor side. Louver shutter will be provided at the out let side of the fan to prevent back draft. Consequent loss in capacity will be taken in to account while selecting the fan. The noise level for fan and motor assembly at 1 meter distance will be limited to 85 dB (A).

Adjustable louver grills (Supply air Grills)

1.25mm MS sheet / 1mm GI sheet will be used for the manufacture of grill. All grills will be true to shape and will be checked with a level gauge before being secured in position. No distortion or warping is permitted.

Self Acting Damper (Gravity Damper)

Self acting dampers are provided to maintain pressurisation inside the premises. The damper will be of gravity type designed such as not to allow infiltration of air from out side. The damper will be multi blade type made of aluminium flaps of not less than 24G thickness and MS frame. These will be designed such that these will operate when the pressure inside the premises exceeds 2-3 mm WC. It can operate in fully open or partial open positions.

12.7.19 Centrifugal pump

The pumps will be designed, manufactured and tested as per IS: 1520-1980 (R.A. 1993), IS: 5120-1977 (R.A.1997) Amendment 2000, IS: 9137-1978 (R.A. 1993), IS6595-1993 (Part II) or as per other international standards acceptable to the Purchaser and will be suitable for the duty conditions and capacities as indicated in this specification.

The power rating of the pump motor will be larger of the following 110% of the power required at the duty point.

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

i. Shaft

The shaft will be of EN-8 or C-40 or equivalent and will be designed for critical speed. The ratio of critical speed to speed of shaft will be not less than 1.2 for solid shafts.

ii. Shaft sealing

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

12.7.20 Bearing

Two bearing assemblies will be provided, one within the frame to carry radial load only and the other to carry both radial and axial thrust. Bearings will be of manufacturer standard design, antifriction type, oil / grease lubricated. Suitable thrust bearings will be provided in the pump to take total thrust of the pump including hydraulic thrust. Thrust bearings will be of oil lubricated type with suitable cooling arrangement. Motor thrust bearing will be designed without water cooling arrangement. Suitable tapped holes will be provided for refilling of oil in the bearing housing.

12.7.21 Duct Work

Ducting will be fabricated from GI sheet as per IS: 655 standards. The ducting will be properly reinforced and braced to prevent sagging, buckling or vibration.

However minimum thickness of GI sheet will be 1mm considering the industrial duty conditions.

Flanges of sheet metal duct will be of angle iron type riveted with GI sheet on duct perimeter. Flange joints should be made air tight with use of felt gaskets. Spacing of duct flanges will be about 3 meters.

Turning guide vanes are to be provided inside the duct wherever change of direction occurs, to minimise eddy formation. The interior of all ducts will be smooth for free flow of air. Bends / elbows wherever used in duct work will have radius not less than the depth of duct work in change of direction. Collar is to be provided to duct bottom to connect with throat of supply air diffuser.

Access eye / measuring hatch for measurement of air quantity will be provided in ducting at convenient location. Duct work will be complete with flanges, stiffeners, fasteners, hangers, nuts, bolts, washer & gaskets etc.

12.7.22 Supply Air Diffusers

Supply air diffusers will be square / rectangular / circular in shape. The throat of a diffuser will be connected with collar piece provided at the duct bottom for holding the diffuser as well as for supply of air. No part of diffuser will project into the main duct. Each diffuser will be provided with volume control damper. Each diffuser will comprise of fixed plate, damper blade, damper blade operating knob, spindle, connecting rod etc and will be removable core type dully powder coated. The diffuser bottom should flush / match with the false ceiling. False ceiling will not bear the load of any diffuser. The load of any diffuser will be borne by the duct and collar. Each diffuser will be powder coated with appropriate colour to match with the colour of the false ceiling. The diffusers will be true to shape and will be checked with level gauge before being secured in position. No distortion or warping is permitted.

12.7.23 Return Air Duct

The air supplied in the served premises will return above false ceiling through return air grills / the return air slit of 50mm / 75mm (as required) all around false ceiling along the walls of the served premises. From there it will pass into the AHU room through a return air duct. Insulated return air duct of suitable size will be provided for smooth flow of return air. The return air duct will be connected to the AHU so that the AHU room will not be conditioned and this will avoid the heat load of the AHU room. Return air opening will be provided above false ceiling in the partition wall between served premises and AHU room.

12.7.24 Strip Heater Box

Strip heater box will comprise of finned heater, mounting plate, heater box/ casing made of 20 SWG G.I. sheet, cable terminal, terminal box with handle, 40x40x3 MS angle flange/ frame. Strip heater box will be placed/ inserted in supply air duct. Safety thermostat will be mounted on strip heater package to prevent

overheating. Strip heater box assembly will be a pre-fabricated unit with all its terminals and controls pre-wired.

12.7.25 Multi-louvre Damper

Multi-louvre damper will be provided at the out let of AHUs and below flexible connection in the supply air ducting. The damper blades/ louvres will be provided with external operating links for manual operation of the damper to control air flow. The damper will be made of GI sheet with MS frame. The fully close / open / partial closing position of the damper will be marked on the damper casing.

12.7.26 Thermometer and Pressure Gauge

Wet bulb and dry bulb thermometer will be provided and installed in the control room to measure the premises temperature.

Dial type (100 mm) mercury in steel thermometer will be provided for measuring the water temperature at inlet & outlet of condenser. The range of thermometer will be 0-100 °C.

Dial type (100 mm) pressure gauges will be provided at inlet as well at outlet of condenser water lines.

12.7.27 Return Air Grills

Return air grills will be square / rectangular / circular in shape. The throat of a diffuser will be connected with collar piece provided at the duct bottom for holding the grills. No part of grills will project into the return air duct. The bottom of grills should flush / match with the false ceiling. Each grills will be powder coated with appropriate colour to match with the colour of the false ceiling. The grills will be true to shape and will be checked with level gauge before being secured in position. No distortion or warping is permitted.

12.7.28 Condenser cooling water piping with accessories

Medium class GI piping is to be used as per IS: 1239 for interconnecting water piping network. Velocity of water in the pipe line will be limited to 1.5 m/sec. Butterfly valve will be provided in water pipeline for control and regulation purposes. Butterfly valve and non return valve will be provided in the delivery side of pumps.

Pot strainer will be provided in the water pipe line at inlet of condenser with by pass connection with isolation valves. Pipe fittings like bends, elbows, flanges, sockets, nipples etc. will be as per relevant IS/BS standards.

Drain piping network is to be included as required for condensate drain, with isolation valves at proper places. All piping will be tested to hydrostatic test pressure of at least one and half times the maximum operating pressure for period of not less than 24 hours. System may be tested in sections and such section will be securely capped.

12.7.29 Performance Parameters

The contractor will ensure the performance of ventilation and air conditioning systems on the following accounts:

- Ensuring specified capacities of various equipment
- Ensuring specified inside design conditions.
- The equipment will be statically & dynamically balanced.
- No overheating of bearings.
- No leakage in the ducting / piping system and equipment.
- Designed air flow at various points of system.

Performance testing and setting right of the equipment for the system will be carried out by the contractor at site.

12.7.30 Technical Data To Be Submitted

Contractor will furnish the following technical data for air conditioning and ventilation equipment / system during detail engineering and will ensure that such data/details will be in line with the requirements indicated in the Contract documents

Vapor Compression Machine	
1. Refrigerant Compressor a) Manufacturer b) Model No. c) Refrigerant d) Capacity at operating conditions with specific capacity of each type e) Maximum speed/operating speed f) BHP at operating conditions g) BHP/TR at operating conditions h) BHP consumption 100% load 75% load	DDE
2. Condenser a) Manufacturer b) Shell diameter and length (mm) c) Tube material d) Fouling factor e) No. of tubes	DDE
3. Water Chiller a) Manufacturer	DDE

Vapor Compression Machine	
b) Shell diameter and length (mm) c) Tube material d) Fouling factor e) No. of tubes	
4. Air handling unit / fan coil unit. a) Make & Model No. with specific capacity of each type b) Type of unit (Horizontal/vertical) c) Overall dimensions (mm)	DDE
5. Fan Section a) Air quantity (m3/hr) with specific capacity of each type b) Total/static pressure (mmWC) c) Fan speed (RPM) d) Fan dia (mm) & number e) Balancing (Static and dynamic) f) Fan motor (kW)	DDE
6. Cooling coil a) Coil fin materials b) Tube dia (mm) and thicknes	DDE
7. Filter section Pre filter a) Type & make b) Gross filter area (m^2) c) Velocity through filter (m/sec) d) Pressure drop through filter when dirty & when clean (mmWC) e) Efficiency	DDE
8. Split Air Conditioners / Window Air Conditioners a) Make & Model b) Quantity c) Capacity in TR (Nominal / Actual)	DDE

Vapor Compression Machine	
d) Air Flow m^3/h	
9. Centrifugal Fan a. Fan i. Make & Model No. ii. Quantity, no. iii. Type of blade iv. Capacity, m^3/h v. Static and Total pressure, mm WC vi. Speed, rpm vii. Shaft power, kW viii. Total / Static Efficiency, % ix. Motor rating, kW/ pole	DDE
b. Fan Drive Motor i. Type & make ii. Voltage, phase & frequency iii. Rated power iv. Speed	DDE
c. Axial Flow Fan i. Make & Model ii. Capacity in m^3/h. iii. Total / Static Pressure, mm WC iv. Material of construction and its thickness v. Speed in rpm.	DDE
10. Centrifugal Pump Set i. Make and model no. with specific capacity of each type ii. Type of pump iii. Capacity in m^3/hr. iv. Total head in m WC v. Material of Construction of vi. Shaft	DDE

Vapor Compression Machine	
vii. Impeller viii. Casing ix. Pump speed (rpm) x. Shaft power xi. Drive details xii. Motor make xiii. Motor kW xiv. Class of insulation xv. Frame size	
11. Dry Panel Filter f) Make & Model. g) Capacity in m^3/h. h) Pressure drop in mmWC. i) When clean ii) When dirty i) Effective cross sectional area in m^2	DDE
12. Cooling tower a) Make & Model b) Type c) Quantity d) Overall size of cooling tower e) Capacity of cooling in TR. f) Water flow m^3/h	DDE

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SCHEDULE-9

9 PERFORMANCE GUARANTEES

9.1 General

1. The contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in the Contract specifications.
2. The contractor shall demonstrate and establish performance guarantee for various equipment and achieve performance guarantee values as per Contract Specification, at site in the presence of the Purchaser/Consultant for each unit individually.
3. Details of performance guarantee tests and method of computation of performance values shall be as per Technical Specification.
4. The Contractor shall supervise and direct the operation during performance tests and shall take complete responsibility in this regard.
5. During performance tests, the Purchaser shall make available necessary normal operating & maintenance personnel.
6. The Contractor shall provide and install all measuring instruments required for checking the guaranteed performance which are not included among the permanent measuring instruments of the system/sub-system. Such instruments shall be furnished by the Contractor on a temporary basis for the duration of the performance guarantee tests.

9.2 Performance Guarantee Values, Categories, Demonstration of Performance/Acceptance Tests and Liquidated Damages for Shortfall in performance / Non-Performance

1. Performance and ratings of the various offered equipment, as covered in this specification, shall be guaranteed by the Bidder.
2. The guaranteed performance parameters furnished by the bidder in its offer, shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties (permitted as per agreed test codes) and other uncertainties shall be deemed to have been included in the guaranteed figures.
3. The successful Bidder (Contractor), during performance guarantee / acceptance test, shall demonstrate all the guarantees as covered in this Schedule. Bid price quoted by the Bidder shall include all costs associated with the tests.
4. Ambient conditions for guaranteed efficiency of steam turbine generator shall be as follows:

   (a) Ambient Air Temperature : 27°C

(b) Relative Humidity : 71%

Note! No credit shall be given to the Bidder, in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions / guarantee etc. if the values considered by the bidder for parameters indicated above are lower (or better) than those specified above.

5. The performance guarantee tests shall be conducted by the successful Bidder/ Contractor for each unit individually and liquidated damages for non-performance as indicated under this schedule will be levied separately for each unit.

9.3 Performance Guarantee / Acceptance Test

1. The final test (performance guarantee / acceptance test) shall be conducted at site by the Contractor in presence of the Purchaser / Consultant. Such test will be completed, within a period of 3 (three) months after the successful completion of Trial Operation. Any extension of time beyond the above three months shall be mutually agreed upon.
2. Instrumentation used, their accuracy class, their numbers & location etc. for carrying out performance guarantee / acceptance / demonstration tests shall be as per relevant codes and shall be subject to Purchaser's approval. In addition the values of parameters shall also be logged from the information system provided under Purchaser's DDCMIS (under Purchaser's scope) Tests will be conducted at specified load points.
3. Any special equipment, tools and tackles required for the successful completion of the performance guarantee / acceptance / demonstration tests shall be provided by the Contractor at his cost.
4. **Guarantees Category wise**

   If equipment / system fail to meet the guarantees, all necessary modifications and / or replacements shall be carried out by the successful Bidder(contractor) without any extra cost to the Purchaser so that the equipment / system comply with the guaranteed requirements. However, if even after above modifications / replacements, the contractor is not able to demonstrate the guarantees within 90 days or within a reasonable period allowed by the Purchaser (reckoned from the date on which the tests have been completed) the Purchaser will have the right to the following:

   (a) To reject the equipment / system / plant and recover the payment already made

   OR

   to accept the equipment / system / plant after levying Liquidated Damages (LD) as specified in this Schedule (These are termed as "**Category – I**" Guarantees)

   (b) To reject the equipment / system / plant and recover the payment already made. (These are termed as "**Category – II**" Guarantees and

conformance to the performance requirement is mandatory. Category - II Guarantees do not attract LD)

In addition to the above the Contractor shall demonstrate performance parameters indicated in Cl.9.4.3, under Demonstration Guarantees, during the PG Tests

9.4 Schedule of Guarantees

9.4.1 Category-I, Guarantees: Liquidated Damages

S.No	Description	Parameter for Performance Guarantee	Liquidated Damages
1.	Turbine Cycle Heat rate in kcal / kWh	For increase in every kcal/ kWh or part there of in the guaranteed value.	**Rs.2,27,10,000/-** (Indian Rupees Two Crores Twenty Seven Lakhs Ten Thousand only)
2.	Continuous TG output of 500 MW	For deficiency in every kW or part there of by which the output, determined by the test, falls short of the guarantee figure.	Rs **1,17,000/-** (Indian Rupees One Lakh Seventeen Thousand only)
3.	Total Auxiliary Power Consumption including MDBFP	For every kW increase or part thereof from the Guaranteed value	Rs. **1,99,000/-** (Indian Rupees One Lakh Ninety Nine Thousand only)
4.	Total Auxiliary Power Consumption excluding MDBFP	For every kW increase or part thereof from the Guaranteed value	Rs. **1,99,000/-** (Indian Rupees One Lakh Ninety Nine Thousand only)

9.4.2 Category-I, Guarantees: Performance Guarantees Attracting Liquidated Damages

S. No	Particulars	Unit	Value inclusive of design, manufacture and all other Tolerances including measurement uncertainty
(i)	**Gross Heat Rate**: Turbine Cycle Gross Heat rate in kcal / kWh under rated steam conditions at 81 mm Hg (abs) design back pressure with zero make up at 500 MW unit load, design CW temperature and CW flow	kcal/ kWh	
(ii)	**TG Output**: Continuous TG output of 500 MW under rated steam condition at 81mm Hg (abs) design back pressure with 3% make-up (including 0.5% blow down and 2.5% non recoverable auxiliary steam) and design CW temperature and CW flow.	MW	

S. No	Particulars	Unit	Value inclusive of design, manufacture and all other Tolerances including measurement uncertainty
(iii)	**Total Auxiliary Power Consumption including MDBFP**: This shall include all the following working electrical drives of TG & auxiliaries running at continuous output of 500 MW, 3% make-up and 81 mmHg (a) back pressure (with in the bidders scope), design CW temperature and CW flow (a) Condensate Extraction Pumps (CEP) (b) Motor Driven Boiler Feed Pump (MDBFP) (c) Condenser Air Evacuation pump (d) Control oil Pump (e) DMCW Pumps (f) ACW pumps (g) LP Drain Condensate Pump (If provided)	kW	
(iv)	**Total Auxiliary Power Consumption excluding MDBFP**: This will include all the following working electrical drives of TG & auxiliaries except motor driven BFP running at continuous output of 500 MW, 3% make-up and 81 mmHg (a) back pressure (with in the bidders scope) design CW temperature and CW flow. (a) Condensate Extraction Pumps (b) Condenser Air Evacuation pump (c) Control oil Pump (d) DM CW (e) ACW pumps (f) LP Drain Condensate Pump (If provided	kW	

9.4.3 Category-II, Guarantees (conformance to Guarantees is mandatory)

S. No	Particulars	Unit	Value Inclusive of design, manufacture and all other tolerances including measurement uncertainity
a)	Final feed water temperature	°C	To be optimized and quoted by Bidder
b)	Total cooling water requirement in the condenser at a cooling water temperature of 34°C	°C	Bidder to quote
c)	Dissolved oxygen at Condenser outlet and Deaerator outlet.	cc/litre	0.015 & 0.005 respectively
d)	Generator and excitation system	-	Bidder to quote

S. No	Particulars	Unit	Value Inclusive of design, manufacture and all other tolerances including measurement uncertainity
	parameters		
e)	Excitation system response ratio and field forcing capability	-	Bidder to quote
f)	Temperature rise in the Generator and excitation system	°C	Bidder to quote
g)	Hydrogen leakage	m^3/day	Bidder to quote
h)	Maximum continuous generator capability under all normal operating condition (e.g. frequency varying between 50 Hz -5% to + 3%).	kW	Bidder to quote
i)	The max. permissible noise level shall not exceed 85 dB (A) at a distance as specified in the specification.	dBA	85
j)	Each CEP shall be guaranteed for capacity, head, efficiency, NPSH and power input to motor at best efficiency point at shop. The best efficiency point shall correspond to 100 % TGMCR conditions.	As applicable	Bidder to quote
k)	Each BFP shall be guaranteed for capacity, head, efficiency, NPSH and power input to motor at best efficiency point at shop. The best efficiency point shall correspond to 100 % TGMCR conditions.	As applicable	Bidder to quote
l)	Air-conditioning System: Inside conditions of air conditioned premises		Temp : 23 ± 1°C and RH 55 ± 5%
m)	Ventilation System: Temperature Saturation efficency Pressurization		Temp:Not more than ambient temp Not less than 90% 2 to 3mm WC
m)	TG Hall EOT Crane: Full load and 25% over load on hoisting and long and cross traverse motion	Tonnes (T)	Full load and 25% over load
o)	Condensate Polishing Unit: Design flow rate through the polisher units, Ionic Concentrations of Effluent, Dissolved solid and Suspended solids.	As required	
p)	DG sets : • MCR Generation	kVA	Bidder to quote

S. No	Particulars	Unit	Value Inclusive of design, manufacture and all other tolerances including measurement uncertainity
	• Fuel consumption	m3/h	Bidder to quote
q)	Elevators: Speed and load test		As per IS

9.4.4 Demonstration Guarantees

S. No	Particulars	Unit	Value Inclusive of design, manufacture and all other tolerances including measurement uncertainty
a)	Gross Heat rate at VWO, 100% MCR, 80% MCR and 60% MCR conditions for 0% make-up and 0% auxiliary steam	kcal/kWh	Bidder to quote
b)	Gross Heat rate at VWO, 100% MCR, 80% MCR and 60% MCR conditions for 3% make-up and 0% auxiliary steam	kcal/kWh	Bidder to quote
c)	HP Turbine exhausts pressure & temperature.	mm of Hg / °C	Bidder to quote
d)	Pressure drop between first HP Heater inlet and top HP Heater outlet flanges	kg/cm^2 (a)	Bidder to quote
e)	Combined pressure drop in condenser tube, water box, and inlet and outlet piping. This shall be measured in between intake and discharge point of the CW. system and also at the Bidder's terminal points with cleanliness factor of 0.90.	kg/cm^2 (a)	Bidder to quote

9.5 Liquidated Damages for Non Performance

1. Should the results of the formal test show that the Steam Turbine Generator has failed to meet its guarantee, the Contractor shall carry out the modification at its own cost, if considered necessary, to meet the guaranteed values. In such a case the performance and guarantee tests shall be repeated by the Contractor within one (1) month from the date the equipment is ready for retest. If the specified guarantees are not established within 90 days of notification by the Purchaser, the Purchaser may at his discretion reject the equipment and recover the payments already made or accept the equipment after assessing the liquidated damages payable at the rates specified in Cl 9.4.1 of this Schedule for each steam turbine generator. The recovery of such amount shall be from the amounts due to the Contractor. These liquidated damages shall be prorated for fractional parts of the deficiencies.

2. Specific performance guarantees which attract liquidated damages are detailed in Cl.9.4.1 of this schedule. The Bidder shall furnish declarations in the manner prescribed in the bid proposal schedules (Vol-IB) for these guarantees.

3. Other performance parameters as detailed in Clause 9.4.2 and 9.4.3 of this schedule, which do not attract liquidated damages, shall be termed as demonstration parameters. Demonstration parameters / capabilities shall be demonstrated during the trial operation period/guarantee tests of the respective system/equipment as per the detailed test procedure to be approved by the Purchaser/Consultant.

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SECTION: C3

ELECTRICAL SPECIFICATION

2x500 MW NEYVELI NEW THERMAL POWER STATION (NNTPS)

TECHNICAL SPECIFICATION

FOR

VENTILLATION SYSTEM

(ELECTRICAL PORTION)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

c) Supply of mandatory spares as specified in the specifications of mechanical equipments.

d) Erection and commissioning spares.

e) Erection & Maintenance tools & tackles.

f) Electrical load requirement for Air conditioning System.

g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL.

i) Various drawings, data sheet 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 implications to BHEL.

j) Motor shall meet minimum requirement of specification AC/DC motors.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

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

a) A copy of this sheet "Electrical Equipment Specification for Ventillation System" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.

b) List of Erection and Commissioning spares.

c) List of Erection & Maintenance tools & tackles.

d) Electrical load requirement.

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

4.0 LIST OF ENCLOSURES

4.1 Electrical scope between BHEL & vendor.- 2 sheets.

4.2 Std. Technical specification for LV motors.- 5 sheets

4.3 Std. Technical specification for Cabling installation.- 6 sheets.

4.4 Data Sheets (A) for 415V Electric Motors.- 2 sheets.

4.5 Data Sheets (C) for 415V Electric Motors- 2 sheets.

4.6 Quality plan for motor below 75kW.- 2 sheets

4.7 Quality plan for motor above 75kW.- 9 sheets

4.8 Load data format.- 1 sheet

Scope sheet for Scope between BHEL & Vendor

PROJECT : 2 x 500 MW NEYVELI TPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	1. 415 V AC/240 V AC 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 including power supply equipment (battery charger etc) required for the PLC/control panel (as applicable) for the system supplied by vendor. 2. Interposing relays (RE 302 of Jyoti make or equivalent), if required for PLC and microprocessor based systems, shall be provided by BHEL in MCCs. Requirement of these relays shall be furnished by vendor during detailed engineering stage.
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. Sizes and quantity of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL). Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by BHEL except for cabling in vendor scope. 3. Termination at BHEL equipment terminals by BHEL. 4. Termination at Vendor equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	
5	Cable trays, accessories & cable trays supporting system	BHEL	BHEL	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power cables 3. Solder less crimping type heavy duty copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer/ BHEL approval at contract stage.
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	BHEL	BHEL	
10	Below grade grounding	BHEL	BHEL	
11	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
12	Mandatory spares	Vendor	-	Vendor to quote as per specification.

Scope sheet for Scope between BHEL & Vendor

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
13	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
14	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies in the BHEL cable schedule format.
16	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Electrical equipment layout drawing shall be to BHEL approval.
17	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.
18	Junction Boxes	Vendor	Vendor	

NOTES:

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

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

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 ofr rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechnical vibration of rotatinf electrical machines
IS:12615	**Energy Efficient Induction Motors - Three Phase Squirrel Cage**

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.

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 fro three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be sutable fro mimimum 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, mechnical 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: 4691and 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.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 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.

4.7 **Terminals and Terminal Boxes**

4.7.1 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 statedin 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".

4.7.2 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.

4.7.3 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 V W & V respectively.

4.7.4 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.

4.7.5 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.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 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.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 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.

4.8 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.

4.9 **General**

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.

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

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 ofr rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechnical vibration of rotatinf electrical machines
IS:12615	**Energy Efficient Induction Motors - Three Phase Squirrel Cage**

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.

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 fro three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be sutable fro mimimum 20,000 starts during the life time of the motor

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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, mechnical 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: 4691and 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.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 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.

4.7 **Terminals and Terminal Boxes**

4.7.1 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 statedin 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".

4.7.2 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.

4.7.3 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 V W & V respectively.

4.7.4 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.

4.7.5 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.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 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.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 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.

4.8 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.

4.9 **General**

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.

1.0	Design ambient temperature	:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor	:	160KW *
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz + 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 boxes		
	o 90 kW and above (Breaker controlled)	:	50 KA for 0.25 sec.
	o Below 90 kW (Contactor controlled)	:	50 KA protected by HRC fuse
	f) LV System grounding	:	Solidly
5.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
6.0	Minimum voltage for starting (As percentage of rated voltage)	:	85% of rated voltage
7.0	Power cables data	:	Shall be given during Detailed engg
8.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg
9.0	Space heater supply	:	240 V, 1¢ , 50 Hz
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
11.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS 12615*
12.0	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
13.0	Makes	:	BHEL/ Customer approval
14.0	Paint shade	:	Shall be given during Detailed engg
15.0	Degree Of protection for motor/ terminal box	:	As per IS 4691

* **LT motors of continuous duty shall be energy efficient IE2 class conforming to IS12615**

16.0 TESTING

16.1 Type Tests

For HT & LT Motors above 50kW, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years from the date of bid opening viz. February 2012 shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

16.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

	TITLE	SPECIFICATION NO.
	MOTOR	**VOLUME II B**
		SECTION D
	DATA SHEET - C	**REV NO. 00 DATE 01.08.14**
		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			

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 ≥ 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			

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-006/0			SPECIFICATION TITLE			
	SHEET 1 OF 2		SYSTEM			ITEM AC ELECT. MOTORS BELOW 75KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.O	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	3	-	-	
2.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	3	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	3	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	3	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	3	2,1	2,1	NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006/0			SPECIFICATION : TITLE :			
	SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 75KW (LV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	3	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007/2			SPECIFICATION : TITLE			
	SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BROUGHT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	-	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	-	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	-	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	-	

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	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	-	
		4.INTERNAL FLOWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	-	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO BREAKAGE ON OTHER PHY. DESIGN	-DO-	3	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	-	

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	SHEET 3 OF 9	SYSTEM		ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV)			SECTION			VOLUME III		

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	-	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3	-	-	
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3/2	-	2	

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1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	-	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG.	MANFR'S DRG.	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
1.11	SLIP RING	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC.	MANUF'S SPEC.	-DO-	3	-	-	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

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									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	3	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	3	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	3	-	2	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	3	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	3	-	-	

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									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	3	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	3	-	-	
		3.CORE LOSS & HOTOPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	3	-	2	(FOR MOTORS OF 2MW AND ABOVE)
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	3	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	3	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	3	-	-	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	3	-	2	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	3	2	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	3	2	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	3	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	3	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	3	-	2	THREE DIPS TO BE GIVEN
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1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	3	-	2	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	3	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	3	-	-	
		2.SOUNDNESS	CR	MALLET TEST & MV TEST	-DO-	-DO-	-DO-	Log Book	3	-	-	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	3	-	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	3	2	1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	3	2	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	3	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	3	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	3	-	2	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	3	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	3	-	-	

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	SHEET 8 OF 9	SYSTEM		ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV)			SECTION			VOLUME III		
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1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	3	1	1,2	NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	3	1,2	1,2	NOTE - 2
		3.VIBRATION	MA	-DO-	100%	IS-12075	IS-12075	-DO-	3	1,2	-	
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	3	2,1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	3	-	2,1	TC FROM AN INDEPENDENT LABORATORY NOTE-3
		6.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	3	2,1	-	
		7.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	3	-	2,1	NOTE-3
		8.PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	3	2,1	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY

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