BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TYPE OF DOC.	**TECHNICAL SPECIFICATION**			**NAME**	**AJ**	**AR**	
TITLE							
VENTILATION SYSTEM (400KV-Gas Insulated Switchyard)				**DATE**	**10.05.22**	**10.05.22**	
				GROUP	**TBEM**	W.O. No	**84007**

CUSTOMER	**TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD.**
CONSULTANT	**DESIN PVT. LTD. NEW DELHI**
PROJECT	**2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS. CHENNAI - 400 KV GIS**

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SECTION -1

INTENT, SYSTEM DESCRIPTION, DESIGN CRITERIA AND SCOPE

1.0. INTENT OF SPECIFICATION

1.1 This specification covers the design, manufacture, inspection and testing at bidder's and/ or his sub vendor's work(s), proper packing, transportation & delivery, storage and handling at site, erection, testing and commissioning, final painting and carrying out acceptance tests at site of **Ventilation System** as detailed in this section and in various other sections of this specification for different rooms located inside the 400KV Gas Insulated switchyard (GIS) control Building and GIS Hall of **2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER AT ASH DYKE OF NCTPS. CHENNAI-400 KV GIS.**

1.2 The requirement(s) specified under 'SECTION 2, SECTION 3, SECTION 4' and 'SECTION 5' of this specification shall be considered as part of this section. In case of variance between sections, the requirement of Section-1 shall prevail. Customer specification in annexure to section-2 shall be adhered to by the bidder.

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/ Owner, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance herewith.

1.4 The bidder shall be deemed to have understood completely all the tender drawings and documents and quoted accordingly. Some part of engineering is already done by purchaser (BHEL) and same shall be validated by contractor. Relevant drawings and documents shall be shared with successful bidder during detailed engineering stage.

1.5 The bidder has to note carefully the parameters, estimated capacities of equipment indicated and the tender drawing in the specification are only for guidance of the bidder. The system shall be designed as per relevant standards / codes and exact capacities and quantities are to be estimated by the bidder. All such estimations and design calculations shall be submitted for Purchaser's approval.

1.6 *Deviation:* In case of any deviation, the bidder shall indicate separately the deviations clause-wise with respect to the specification in the 'Schedule of Deviation' given in schedule 2 of section-5. Deviations in any other form including clarifications / assumptions / etc. will not be considered and it will be construed that the bid conforms strictly to the specification.

1.7 The Contract shall be on Unit Rate basis for the quantities furnished by BHEL. The quantities furnished in Price bid (BOQ) are as per preliminary design only. BHEL reserves the right for quantity variation (upward/ downward) due to any reason upto ±30% of total contract value at same unit rate and terms & conditions during execution of contract.

1.8 The Purchaser, Consultant and Customer in this specification stand for BHEL, DESEIN and TANGDCO respectively. The successful bidder shall be referred to as Contractor.

2.0. VENTILATION SYSTEM

This system shall be designed with the objective of providing Ventilation in different rooms located inside the 400KV Gas Insulated switchyard (GIS) control Building and GIS Hall of **2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER AT ASH DYKE OF NCTPS. CHENNAI-400 KV GIS**

2.1. CODES AND STANDARDS

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

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

IS: 655 - Specification of metal Air-Ducts
IS: 4999 (Part-51) - Noise Level
IS: 3588 - Specifications of Electrical Axial Flow Fans
IS: 2312 - Propeller type Ventilation fans
BS: 6540 Part I - Air Filters used in General Ventilation
IS: 4671 - Expanded polystyrene for Thermal Insulation purpose
IS: 8183 - Bonded Mineral wool

2.2. SCOPE

Ventilation system for various areas of 400KV GIS Switcyard control building and 400kV GIS Hall shall be provided as below:

*Exact dimensions of different areas may be referred from architecture drawing.

Ventilation System

a) All the areas served by means of dry mechanical ventilation shall be designed for a maximum inside temperature of 3 deg. Celsius above the design ambient (DBT) condition during summer or according to suitable air changes per hour. The criterion that gives the highest flow rate will be considered for design & selection of the equipment.

b) All the ventilation fans shall operate on 100% fresh air considering all the equipment of ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.

c) ***Heat dissipation from GIS bays (188KW) shall also be considered as one of the criterion for sizing of ventilation system of GIS hall.***

d) Selection of size, rating & number of ventilation fans shall be done through proper calculation and the same will be submitted for final approval during detailed engineering stage.

e) **Wall mounted supply air fans** of suitable capacity (CMH) & required static head (WC) each having pre filter & fine filter **(Efficiency of pre filter shall not be less than 90% down to 10 micron while fine filter 99.5% down to 5 micron)**, rain protection cowl, bird screen and mounting arrangement

along with gravity operated back draft damper (to maintain pressurized condition) shall be provided for positive pressurization of the following rooms:

i. Cable Vault (In Control building of GIS)-25ACPH

ii. ACDB/DCDB MCC Room (In Control building of GIS)-25ACPH

f) **Wall mounted Exhaust fans** of suitable capacity (CMH) each having rain protection cowl, bird screen and mounting arrangement shall be envisaged for the transformer room (15ACPH), battery charger room & Battery rooms (30ACPH) of control building of GIS.

g) **Wall mounted Propeller fans for Pantry and toilets (both gents and ladies)**

Special provision for Battery rooms -Motors for the fans of this room shall be flameproof with epoxy painting. These exhaust fans for shall be of bifurcated construction with motor away from the air stream. These fans shall have spark proof construction.

Supply of air to battery room shall be through intake louvers provided at suitable location in the room.

Inside dry bulb temperature for battery room shall be maintained at 25^{o}C. The air flow rate for battery room shall be sized considering min. 30 air changes per hour or 2% or less of the room volume whichever gives higher air flow shall be considered.

For proper distribution of air, Battery room shall have ducted arrangement with lovers for fresh air to have proper ventilation in the room.

Indoor trench layout of control room building (TB-378-510-008, R-01) is attached for your reference

h) **Supply and exhaust fans of above mentioned areas shall be provided with their local starter/push button (3 phase DOL starter).**

i) **Supply and exhaust fans of above mentioned areas shall be in multiplicity minimum 2X50%.**

j) The axial/propeller fans shall have a single piece cast aluminium impeller with blades of aero-foil design. The fan casing shall be of heavy gauge sheet steel construction minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized. Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided. The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However, for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be at least 25% above the operating speed. The static pressure of supply air fans with pre & fine filters shall not be less than 32 mm WC while for exhaust fans 10 mm WC. However, the propeller fans for toilets and pantries shall be 5 mm WC. All other accessories like supporting structure etc. as required shall be provided.

k) Gravity dampers (self-acting dampers) are provided to ensure pressurization of above areas. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

l) **Ventilation system for 400 kV GIS Hall**

Ventilation system shall be provided to maintain positive pressure inside GIS building. The system shall comprise of supply air fan assemblies with Pre & Fine filters, Gravity louvers, exhaust air fans, gravity dampers or a suitable combination of these along with necessary filters, ducting, grilles etc. Fans and accessories for this ventilation system shall be placed in separate ventilation room provided adjacent to the GIS Hall. This dry mechanical ventilation system shall be designed for a maximum inside temperature of 3 deg. Celsius above the design ambient (DBT) condition during summer or according to suitable air changes per hour (**minimum 15 ACPH**). **The criterion that gives the highest flow rate will be considered for design & selection of the equipment. Ventilation system for GIS hall shall operate on 100% fresh air.**

Plant shall mainly consists Supply air fans of DIDW type with pre and fine filters, Supply air ducting and grills. Two (2) nos. DIDW supply air centrifugal fans on 2x100 % (One working and one standby) basis shall be provided for the collective requirement of GIS Hall. It shall also have GSS intake louvers with wire mesh, frame and bird protection screen and HDPE filters of min. 99% down to 5 micron. The vibration level of fans shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans).

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

These filters shall be arranged in a panel formation with filter module mounting frame on the downstream side. Wall cut outs for mounting of intake louvers shall be made available in ventilation room wherein all ventilation plant shall be installed. Two Supply air duct shall be taken from plenum chamber which shall run on the both walls along the length of the GIS Hall with necessary grilles/ diffusers to make proper ventilation arrangement inside the hall to facilitate proper mixing and avoid any hot spot. Motorized & CBRI certified Fire damper of fire rating 2 hrs. shall be installed in supply air path. No exhaust or return air ducting is envisaged in this area. Spring actuated counter weight operated Pressure relief dampers with frame & bird screen shall be provided of suitable size and quantities on both walls of GIS hall above supply air ducts to release hot air & excessive pressure inside the hall beyond design over pressure.

Ventilation duct running inside GIS Hall shall be suitably placed to avoid any fouling with GIS incoming/outgoing ducts and LCC panels.

For fans and blowers, continuous motor rating (at 50 deg. C ambient) shall be at fifteen percent (15%) above the demand of the equipment at duty point or ten percent (10%) above maximum load demand of the equipment whichever is higher. For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

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

All ducts shall be made of galvanized steel sheets confirming to IS 277 with minimum grade of 275 GSM. Duct sizing and fabrication shall comply with requirements of IS 655.

Duct design criteria- Velocity shall be 12m/s (max.) for main duct, 9m/s (max.) for branch duct and 3.75m/s for the grills.

All the equipments of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.

Schedule of Fan and capacity

Sl. No.	Description of area	Total CMH requirement	Selected capacity of each fan (CMH)	Static Head (mm WC)	Quantity of fans (Nos.)	Remarks
01	ACDB/DCDB MCC Room	20000	4000	30	05	Wall mounted Supply air axial fan with pre-filter, fine filter and gravity dampers.
02	Battery room	15000	7500	15	02	Wall mounted Exhaust air axial fan (with flame proof motor) with supply air grills and ducting arrangement as defined in this technical specification.
03	Cable Vault	28000	4000	30	07	Wall mounted Supply air axial fan with pre-filter, fine filter and gravity dampers.
04	Transformer room	20000	10000	10	02	Wall mounted Exhaust air axial fan with supply air grills
05	Pantry room -FF	1000	1000	5	01	Wall mounted propeller fan
06	Pantry room - GF	1000	1000	5	01	Wall mounted propeller fan
07	Gents toilet - GF	1000	1000	5	01	Wall mounted propeller fan
08	Gents toilet - FF	1000	1000	5	01	Wall mounted propeller fan
09	Ladies toilet - GF	1000	1000	5	01	Wall mounted propeller fan
10	Ladies toilet – FF	1000	1000	5	01	Wall mounted propeller fan
11	400kV GIS hall	240000	240000	50	02	Centrifugal supply DIDW fans with pre & fine filters and gravity dampers.

✓ **Notes:**

Ventilation fan's minimum capacity are given in this technical specification. Bidder shall choose the exact capacity or higher based on the chosen make and availability of the same in

market. There shall not be any additional price implication to BHEL on account of higher capacity considered by bidder.

DCS (Distributed control system) based control system with OWS (operator work station) shall be provided by purchaser (BHEL) for overall control, operation and monitoring of Ventilation system.

Contractor shall make all the provision of supply instruments, sufficient potential free contacts in their PDB etc. under Ventilation System to take all the inputs to its dedicated DCS panel positioned in the switchyard control room. All cabling between instruments and PDB to DCS shall be done by contractor. This dedicated DCS shall be looped with the nearest DCS panel with FO cable. Hence all the data shall be transferred using soft link to central DDCMIS (Put in central control room and supplied by others) for monitoring at remote.

Broadly, all the On/off command and feedback corresponding centrifugal fans, all type of dampers and instruments may be considered by Bidders under their scope and list of the same shall be finalized during detailed engineering with customer. Sufficient DI/DO and AI/AO shall be made available in the DCS panel by other agency.

Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, and Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument shall be digital type with precise reading display and having sufficient contacts to measure it at remote DCS.

DP switch across filter units for taking status/feedback for clogging/chocked conditions to ensure replacing/washing of the same on regular time interval to have efficient and reliable system performance.

Pressure Transmitter at fan discharge shall be provided which shall be used for annunciation in the event of low air pressure at fan Discharge.

2.3. Air Distribution System

I) Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The thickness of sheets type of bracings and other fabrication details shall be as specified below: -

Sl. No.	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
a.	Upto 600	0.63 (24 g)	S-drive, 25 mm pocket or bar slips on 2.5 m centers	25 x 25 x3 angles 1.2 m from joint
b.	601 thru 750	0.63 (24 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x 3 angles braced at 1.2 m from joints.

c.	751 thru 1000	0.80 (22 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x3 angles braced at 1.2 m from joints.
d.	1001 thru 1500	0.80 (22 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers	40 x 40 x 4 angle braced at 1.2 m from joints.
e.	1501 thru 2250	1.00 (20 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers.	40 x 40x 4 angle braced at 600 mm from joints.
f.	2251 and larger	1.25 (18 g)	50 x 50 angle connections or 40 mm pocket or 40 mm bar slips 1 m centers with 35 x 3 bar reinforcing	50 x 50 x 5 angle braced at 600 mm from joints.

Notes: All duct support shall be painted after final installation and color shade shall be finalized at site in consultation with customer/BHEL site engineer.

II) The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanized bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

III) Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of red-oxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Wherever in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.

I**V)** Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections.

Connections shall be made from non-combustible heavy glass fabric 1.02 kg/M2 (30 Oz per sq.yd) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

V) All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

VI) Wherever duct passes through wall, all the openings between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

VII) An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.

VIII) Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods, there shall be locking device with a mark to show the final adjusted position of the splitter

IX) All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be riveted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.

X) Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

XI) Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type. Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.

XII) All air terminals shall be of mill finish extruded aluminium profile construction.

XIII) The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalization during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation, supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

XIV) Each branch line shall have dampers to isolate the branch for maintenance purpose.

3.0. POWER SUPPLY REQUIREMENT

a. One (1) no. MCC cum Power distribution board (PDB) in ventilation room of 400 kV GIS Hall shall be provided. This PDB shall extend power supplies to centrifugal fan/exhaust fans and motorized dampers etc. under GIS hall ventilation system as well as have feeders of suitable rating to extend power for fuse boards meant for axial flow fans in battery rooms, ACDB room, transformer room and cable vault as defined in this specification.

   BHEL shall provide two incomers each of rating 250A from main ACDB board (supplied by BHEL) to feed this MCC cum PDB. Contractor shall provide necessary arrangements of termination in the MCC cum PDB accordingly. Two nos. incomers of 250A rating (through MCCB) of cable size 1RX3.5CX300 sqmm. (Al/XLPE) shall be provided from the main ACDB by BHEL and the same will be terminated in MCC cum PDB. Detailing of PDB including SLD with suitable rating of outgoing feeders (Size and rating of Bus duct, MCC, MCCB, SFU's etc. as per applicability) shall be finalized during detailed engineering with customer. Mechanical and electrical interlocking arrangement shall also to be provided in MCC cum PDB by contractor. Lamps shall be provided for indicating the status of each fan etc. in the panel. All annunciations related to failure of equipment, tripping of equipment, source of failure/reason due to which the equipment is stopped/tripped, low & high limits of parameters such as level, temp., pressure drop etc. as applicable shall be provided for each fan unit in the panel. **Fully wired, 20% spare annunciation windows and terminal blocks shall be provided in the panel. Provision should be made available to suitable operation of system from DCS panel placed remotely at switchyard control building.** All necessary protection & interlocking shall also be provided to avoid simultaneous switching on the two units (working & standby).

b. Four (4) nos. wall mounted fuse boards each for extending power supplies to 3 phase supply/exhaust fans in Cable vault, ACDB/DCDB MCC room, transformer room, battery/battery charger room, shall be located in their respective rooms. Also necessary cabling shall be done further from the fuse board to each fan's 3phase DOL local starter & motors by contractor. Lamps shall be provided for indicating the status of each fan etc. in the panel. The incomers for these fuse boards of suitable rating shall be taken from MCC cum PDB (Installed in Ventilation room of GIS hall). All cabling (only erection and termination) between MCC cum PDB to fuse board in each respective area shall be done by contractor.

c. One no. spare feeder shall also to be provided of each type and rating in the MCC cum PDB. Spare feeders shall be completely wired up.

d. No DC feeder shall be provided by BHEL and necessary convertor (AC/DC) shall be supplied by contractor, if required.

e. Single phase power supply points to ventilation fans of Toilet and Pantry will be provided through illumination package of BHEL TBG.

4.0. Inspection & Testing requirement

Being standard equipment, no shop tests have been envisaged for air conditioning equipments and ventilation fans. Test certificates for all major equipments of air conditioning and ventilation system will be submitted to customer for verification and release of dispatch instruction.

After the installation is over, the system will be subjected to performance guaranteed test in the presence of customer.

"Performance Guarantee Test Procedure" will be submitted during detailed engineering for approval of customer/consultant.

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

5.0. List of Mandatory Spares

(i) *Mechanical Spares*

I. *Ventilation system*

SL. NO.	ITEM DESCRIPTION	QUANTITY
A.	**Centrifugal Fans**	
1	V-BELTS	2 SETS OF EACH TYPE
2	BLOWER BEARING SETS	2 SETS OF EACH TYPE
3	BLOWER MOTOR BEARINGS	2 SETS OF EACH TYPE
4	SEAL GASKET AND OTHER WEAR OUT PARTS IN SETS	2 SETS OF EACH TYPE
5	VIBRATION ISOLATORS	2 SETS OF EACH TYPE
B.	**Axial Fans (Supply/Exhaust)**	
1	Fan Bearings	2 SETS OF EACH TYPE
2	Fan Motor Bearing	2 SETS OF EACH TYPE
3	Dry Filters	2 SETS OF EACH TYPE & SIZE

(ii) *Electrical Spares for Ventilation system*

I. 415V Motors (Mandatory Spares)

SL. NO.	ITEM DESCRIPTION	QUANTITY
1.	Terminal plates	10 Nos. each for small motors up to 30 kW & 4Nos. each for more than 30 kW
2.	Heaters	2 sets
3.	Greasing arrangements	4 sets each type of motor

4.	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher
5.	Bearings (DE and NDE) for each type and rating of motor	4 sets
(iii) *C & I Spares for Ventilation system*		
SL. NO.	**ITEM DESCRIPTION**	**QUANTITY**
I.	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	20 % of Installed of each type.
II.	**Measuring Instruments**	
1.	Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument	10% of total number of instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.
III.	**Relay Based Control Panels**	
1.	LEDs for indicating lights	10% of qty. installed.
2.	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	300% of installed of each type, current rating.
3.	Relays modules & contactors.	20% spare of qty Installed of each type & rating.

5.1. Special Tools

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

	For Ventilation System	
1	RING SPANNER - 6 MM TO 32 MM (12 Pcs)	1 Set
2	OFFSET SCREW DRIVER	1 No.
3	LOCK WITH KEY FOR TOOL BOX	1 No.
4	MS TOOL BOX	1 No.
5	BOX WRENCHES - 6 MM TO 22 MM (14 Pcs)	1 Set
6	FLAT D WRENCH - 6 MM TO 32 MM (12 Pcs)	1 Set
7	ALLEN KEYS - 2 MM TO 10 MM	1 No.
8	CRESCENT SCREW SPANNER	1 No.
9	SCREW DRIVER	1 No.
10	INSULATED PLIER	1 No.
11	TORCH LIGHT (SUITABLE FOR 2 CELL)	1 No.
12	HAMMER 1 LB	1 No.
13	OIL CAN	1 No.
14	RATCHET 1/4"	1 No.

References:

i. *Arch drawings-ground & first floor plan of control room building-TB-0-378-607-620-1 for 400kV (GIS) Switchyard at Ennore.*

ii. *Arch drawings-ground floor and gantry level plan of GIS building-TB-378-607-640-1 for 400kV (GIS) Switchyard at Ennore.*

Notes:

- Ventilation system for different areas of Gas insulated switchyard control building & GIS Hall shall be designed as per the latest architecture drawings during detailed engineering stage.
- Customer/ consultant approval on all the technical data sheets of equipments /drawings/ documents for this package will be obtained during the detailed engineering stage.

6.0. SCOPE OF SUPPLY & SERVICES

The scope of the work under the contract shall be deemed to include all such items, which although not specifically mentioned in the bid documents and/or in the bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation, unless the same is specifically excluded from the Bidder's scope of work under clause 7.0 of this section.

6.0.1 Bidder shall also consider the following while quoting for the system:

i) Power & Control cables including instrumentation and FO cable for Ventilation System will be supplied on free issue basis to contractor. Contractor shall have to choose their cables from the available sizes (with BHEL) only and necessary modifications in their equipment for termination of these cables shall be made by contractor.

ii) Since laying & termination of all cables is in contractor's scope, supply of cable accessories such as lugs, glands, cable tags & markers etc. shall be included by the bidders in their offers

iii) Necessary cable trays will be supplied on free issue basis to the contractor, however necessary hardware for fixing the same on walls or elsewhere shall be included by the bidders in their offers.

iv) Earthing material viz. GS flat & wire will also be supplied on free issue basis to contractor; however, requirement shall be given by the bidders in their respective bids.

v) Bidder shall ensure that sufficient quantities of commissioning spares are made available for timely completion of commissioning of the system. The bidder shall furnish a list of Commissioning spares that will be brought by him. The unused commissioning spares shall be returnable to the bidder.

vi) Conducting performance guarantee tests as per approved procedure to the satisfaction of Owner / Purchaser and handing over an operational system to the owner. Procedure for performance guarantee test shall be submitted by contractor for customer review and approval.

vii) Contractor shall submit valid Type test report for approval by owner. Fresh type test of equipment is not envisaged. It is presumed that equipment offered is duly type tested.

In case the type test reports are found un-satisfactory, tests shall be carried out afresh by contractor without any additional cost implication to BHEL.

6.1.0 Scope of services

A. Erection, Testing & Commissioning (ETC) requirements

i) The scope of ETC shall include receipt of material at site, unloading, safe storage of material, handling of equipment/ material at site, erection of equipment /material at site including fabrication, equipment and system testing, commissioning of the entire system, conducting performance guarantee tests to the satisfaction of Owner / Purchaser and final handing over to the owner of the entire system.

ii) Furnishing technical calculations in support of equipment selection or sizing as and when required.

iii) Supply and erection of MS frames required for proper installation of pre and fine filter units for GIS Hall ventilation system.

iv) Supply and erection of duct support structure with all accessories shall be in contractor scope.

B. Electrical System

i) Preparations of cable interconnection diagram for equipment supplied under this contract and accordingly offer guidance to the purchaser for laying necessary cables. Termination details shall also be furnished in the said interconnection table.

ii) Cables laying for incomers to the PDB panel shall be done by the purchaser while termination of the same to the PDB panel end supplied under this contract is in bidder's scope of works. The contractor has to lay and terminate all the other power and control cables supplied under the present scope.

iii) Laying & Termination of Power/ Control cables/FO Cables for the equipment under the scope of this specification. Bidders shall include all cable accessories like lugs, glands, cable tags, markers etc in their respective bids.

iv) Earthing of all installations (to the nearest earth mat/ earthing pad) supplied under the scope of this specification.

C. All machinery tools & tackles and consumables required for erection/testing / commissioning of the system shall be arranged by the Bidder.

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

E. Painting of all the equipments shall be as per customer specification.

F. After completion of erection and commissioning of the system, the bidder shall train site engineers of Purchaser/Owner so that they are fully conversant with both electrical and mechanical part of this package.

G. Bidders to ensure that sufficient quantity of spares are made available for timely completion of commissioning of the system. The bidder shall furnish a list of commissioning spares that will be brought by him. The unused commissioning spares shall be returnable to the bidder.

H. **Obtaining approval on documents & installations.**

i) Obtaining, "As Built" certification from purchaser or owner on applicable drawings. Completing documentation as per specification requirement.

ii) Obtaining customer's written acceptance of satisfactory completion of job. (Acceptance of PG + handing over of system and mandatory spares (if any)).

iii) Any other service not explicitly illustrated herein but which may be required to complete the system with its desired functionality or in the spirit of contract shall also deemed to be under the scope of bidder.

I. Civil Works

Major civil works such as room & foundations for various Ventilation equipments shall be in purchaser's scope. However, following shall be in contractor scope of services:

a. Wall openings at suitable locations for duct & ventilation fans shall be made by the contractor. Associated civil works such as grouting, filling up crevices/cut outs etc during installations of equipments shall also be in contractor's scope. Any other damage caused to civil works during ETC work of the equipment/system shall be made good to the original finish by the contractor at no extra cost to the purchaser.

Minor modifications, alterations in system installation as per customer's specific requirements shall be done without any extra cost to purchaser. The Bidder shall however supply foundation bolts & hardware and undertake minor civil works such as grouting, filling up of crevices/ cut outs etc. Any damage caused to civil works during ETC work of the equipment/system shall have to be made good to the original finish by the Contractor at no extra cost to the Purchaser.

Note: Prices of above scope of ETC deemed to be included and suitable distributed among the items covered in the BOQ.

7.0. Exclusions

a) **Supply of power & control cables, Instrumentation and FO cable except any special type cable (used within the supplied system or exclusive/mandatorily required) are excluded from contractor scope. However, laying and termination of all these cables to erect and commissioned the complete ventilation package items shall be under contractor's scope.** The bidder shall furnish quantity and type of cables required complete system in their respective bids. Laying & termination is in contractor scope.

b) **Supply of necessary cable trays for laying cables, however hardware for fixing the same on wall trenches or elsewhere shall be included by the bidder in his bid.**

c) **Supply of GI flat for earthing of equipments.**

d) **Major civil works such as room & foundations for various Ventilation equipment, however contractor shall provide all necessary input details.**

8.0. Utilities Available

Construction water and electricity shall be available at one point each. Contractor shall be required to make own arrangement for taking supplies from there. Please refer NIT tender terms and conditions for detailed scope.

9.0. Engineering Drawings/ Documents

Engineering shall start immediately after the award of the contract.

Submission & approval of all drg. / data sheet – as per tender requirement.

Some part of engineering is already done by purchaser (BHEL) and same shall be validated by contractor. Relevant drawings and documents shall be shared with successful bidder during detailed engineering stage.

10.0. OPERATION & MAINTENANCE (O&M) MANUAL

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

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

11.0. Handing & Taking Over

It is the responsibility of the contractor to maintain the Ventilation system for switchyard till PG test conducted successfully and it is handed over to customer. Any defect noted during the period shall be rectified by the contractor without any price implication to BHEL. Also suitable PG tests shall be conducted by the contractor to show the achievement of guaranteed parameters in line with the requirements of specification/ standards/ codes and to the satisfaction of Purchaser/ Owner.

12.0. Various Heads to be quoted for

Based on the above input it is recommended that the bidders shall submit their offers in the prescribed format only.

MAIN SUPPLY

Sl. No.	Item Description	Unit	Qty.	Remarks	Unit Ex-Works	Total Ex-Works	Unit ETC	Total ETC
1	CENTRIFUGAL FAN WITH MOTOR - 240000 CMH	No.	2	Supply air type Centrifugal fan (1W+1S) with motor, V-belt drive, pulley, casing				

				alongwith fixing hardware and all accessories as per technical specification. Fan shall have 50 mmwc static pressure and motor rating of minimum 75kW.				
2	PRE FILTER	No.	76	Size 610X610mm				
3	FINE FILTER	No.	76	Size 610X610mm				
4	GSS DUCT SHEET - 24 G - VENTILATION SYSTEM	SqMt	50	Ducting fabricated from GSS having zinc coating as per class 275 of IS 277 complete with hangers, supports, joints/ washers.				
5	GSS DUCT SHEET - 22 G - VENTILATION SYSTEM	SqMt	328	Ducting fabricated from GSS having zinc coating as per class 275 of IS 277 complete with hangers, supports, joints/ washers.				
6	GSS DUCT SHEET - 20 G - VENTILATION SYSTEM	SqMt	566	Ducting fabricated from GSS having zinc coating as per class 275 of IS 277 complete with hangers, supports, joints/ washers.				
7	GSS DUCT SHEET - 18 G - VENTILATION SYSTEM	SqMt	111	Ducting fabricated from GSS having zinc coating as per class 275 of IS 277 complete with hangers, supports, joints/ washers.				
8	SUPPLY AIR GRILL WITH VCD	SqMt	22					
9	VOLUME CONTROL DAMPER	SqMt	14					
10	MOTORIZED FIRE DAMPER	SqMt	6	Motorized Fire Damper excluding actuator with fire rating of 2 hours				
11	MOTORIZED ACTUATOR FOR FIRE DAMPER	No.	2	Actuators for fire damper with control panel				
12	NON RETURN DAMPER	SqMt	6					
13	AIR INTAKE LOUVERS	SqMt	39					
14	PRESSURE RELIEF DAMPER	SqMt	6	18 Nos. of size 600x450 sqmm				
15	GRAVITY DAMPER	SqMt	2	5 Nos. of size 600x450 sqmm				
16	EXHAUST AIR GRILL	SqMt	3	For Battery Room				

17	AXIAL FLOW SUPPLY FANS - 4000 CMH	No.	12	Axial flow supply fans with pre and fine filter (wall mounted) complete with casing, TEFC sq cage induction motors & mounting frame, MS rain protection cowl, bird screen, gravity dampers, local push buttons and all other accessories as specified, fan shall have 30 mmwc static pressure and motor rating of minimum 0.75kW.				
18	AXIAL FLOW EXHAUST FANS - 10000 CMH	No.	2	Axial flow exhaust fans (wall mounted) complete with casing, TEFC sq cage induction motors & mounting frame, MS rain protection cowl, bird screen, supply air grills, local push buttons and all other accessories as specified, fan shall have 10 mmwc static pressure and motor rating of minimum 0.75kW.				
19	AXIAL FLOW EXHAUST FANS WITH FLP MOTOR - 7500 CMH	No.	2	Axial flow exhaust fans (spark proof construction, wall mounted) complete with casing, flame proof motor & mounting frame, MS rain protection cowl, bird screen, supply air grills, ducting arrangement, local push buttons and all other accessories as specified, fan shall have 15 mmwc static pressure and motor rating of minimum 0.75kW.				
20	PROPELLER EXHAUST AIR FANS - 1000 CMH	No.	6	Exhaust fan (propeller type) complete with induction motor & mounting frame MS rain protection cowl, bird screen and all other accessories as specified, fan shall have 5 mmwc static pressure.				
21	MCC CUM POWER DISTRIBUTION BOARD	No.	1	AS PER SPECIFICATION				
22	WALL MOUNTED FUSE BOARD	No.	4	AS PER SPECIFICATION				
23	MEASURING INSTRUMENT	Set	1	Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, and Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument shall be digital				

				type with precise reading display and having sufficient contacts to measure it at remote DCS. DP switch across filter units for taking status/feedback for clogging/chocked conditions to ensure replacing/washing of the same on regular time interval to have efficient and reliable system performance. Pressure Transmitter at fan discharge shall be provided which shall be used for annunciation in the event of low air pressure at fan Discharge.				
24	MAINTENANCE TOOLS & TACKLES	Set	1	As per clause 5.1 of technical specification.			NA	
25	Cable Laying along with accessories	Meter	1000	ETC scope only	NA			

Note: Bidder shall strictly follow the data sheet of equipment attached to section-2 of this technical specification.

MANDATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks	Unit Ex-Works	Total Ex-Works	Unit ETC	Total ETC
i	V-Belts of each type for Centrifugal fans	Set	2	2 SETS OF EACH TYPE			NA	
ii	Blower Bearing Sets of each type for Centrifugal fans	Set	2	2 SETS OF EACH TYPE				
iii.	Blower Motor Bearings of each type for Centrifugal fans	Set	2	2 SETS OF EACH TYPE				
iv.	Seal Gasket and other wear out parts in sets of each type for Centrifugal fans	Set	2	2 SETS OF EACH TYPE				
v.	Vibration Isolators of each type for Centrifugal fans	Set	2	2 SETS OF EACH TYPE				
vi.	Fan Bearings of each type for axial fans	Set	2	2 SETS OF EACH TYPE				
vii.	Fan Motor Bearing of each type for axial fans	Set	2	2 SETS OF EACH TYPE				
viii.	Dry Filters of each type & size for axial fans	Set	2	2 SETS OF EACH TYPE AND SIZE				
ix.	Terminal Plates	Nos.	10	10 Nos. each for small motors up to 30 kW & 4Nos. each for more than 30 kW				
x.	Heaters for Motor	Set	2					
xi	Greasing arrangements	Set	4	4 sets for each type of motor				

xii.	Motor of each type and rating	Set	1	10% of the installed quantity or minimum 1 number whichever be higher			
xiii.	Bearings (DE and NDE) for each type and rating of motor	Set	4				
xiv.	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	Set	1	20% of Installed of each type.			
xv.	Measuring Instruments	Set	1	10% of total number of instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more. Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument.			
xvi.	LEDs for indicating lights	Set	1	10% of qty. installed.			
xvii.	Control circuit fuses/MCB/MCCB/Semiconductor Fuses	Set	1	300% of installed of each type, current rating			
xviii.	Relays modules & contactors.	Set	1	20% spare of qty Installed of each type & rating.			

***** Remarks: Bidder should go through the technical specification TB-378-316-123A-00 Rev.02 for detailing of all equipment.***

a) The quantities given in the Bill of Quantities are estimated and provisional, and are given to provide a common basis for bidding. The basis of payment will be the actual quantities of work ordered and carried out, as measured by the Contractor and verified by the Purchaser and valued at the rates and prices bid in the priced Bill of Quantities.

b) A rate or price shall be entered against each item in the priced Bill of Quantities. The cost of Items against which the Contractor has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities.

c) The whole cost of complying with the provisions of the Contract shall be included in the Items provided in the priced Bill of Quantities, and where no Items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.

d) General directions and descriptions of work and materials are not necessarily repeated nor summarized in the Bill of Quantities. References to the relevant sections of the Contract documentation shall be made before entering prices against each item in the priced Bill of Quantities.

e) Miscellaneous items like hardware, fixtures, fittings etc. shall be deemed to be included under the relevant BOQ items and bidders shall consider the same while quoting for BOQ items.

f) Exact requirements shall be worked out during detailed engineering after award of contract.

g) Bidders shall consider makes for various equipments as per Annexure-I, which shall be subjected to customer's (end client) approval during detailed engineering stage. Bidder can propose any other make also under some conditions of non-availability/ that is not included in the list only if it is acceptable to ultimate customer during detailed engineering without any cost implication to BHEL. ***No additional price implication shall be made to BHEL on account of customer's non-acceptance on any proposed makes/sub vendor provided by contractor during detailed engineering.***

h) Bidder shall strictly follow the data sheet of equipment attached to section-2 of this specification.

PROJECT : 2X660 MW ENNORE TPS
PACKAGE : VENTILATION SYSTEM
CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LTD
VENTILATION SYSTEM SUPPLIER :
DOCUMENT NO : PE-V0-412-554-A001

SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
1	AIR WASHER & UAF*	CAT-I / III	HYDERABAD POLUTION CONTROL SK SYSTEM ADVANCE VENTILATION DRAFT AIR BLUE STAR VOLTAS STERLING WILSON ROOTS COOLING SYSTEM C DOCTOR TAP PACK PLAST INDUSTRIAL PROJECTS AND PRODUCTS	CAT-I, UAF IS MANUFACTURES AT FACTORY CAT-III, AIR WASHER UNIT IS ERECTED AT SITE
2	CENTRIFUGAL FAN*	CAT-II	FLAKT KRUGER DRAFT AIR HOWDEN HYDERABAD POLUTION CONTROL ADVANCE VENTILATION PATEL AIR NICOTRA SK SYSTEM MARATHON CB DOCTOR SARLA COMEFRI	
3	FRESH AIR/ SUPPLY/ EXHAUST/ RE UNIT FANS / PROPELLAR *	CAT-III	HYDERABAD POLUTION CONTROL SK SYSTEM ADVANCE VENTILATION KRUGER NICOTRA ALMONARD MARATHON TCF Nadi FLAKT CB DOCTOR SARLA (SITAL) PATEL AIR KHAITAN	
4	PUMPS	CAT-II	BEST & CROMPTON JYOTI SAM TURBO KBL KSB M&P VOLTAS BEACON-WEIR WORTHINGTON FLOWMORE SULZER PUMPS INDIA LTD. BHARAT PUMPS & COMPRESSORS LTD FLOWSERVE INDIA CONTROL PVT LTD V-FLOW PUMPS & SYSTEMS CO KISHORE PUMPS	
5	LV MOTORS (FLAME PROOF)	CAT-II / III	SIEMENS ABB CGL MARATHON KEC BHARAT BIJLEE BHARAT ELECTRIC NGEF JYOTI LHP	CAT-III - FOR MOTOR SIZE LESS THAN 30 KW CAT-II - FOR 30 KW AND ABOVE MOTOR SIZE
6	LV MOTORS (NON FLAME PROOF)	CAT-II / III	SIEMENS ABB CGL MARATHON KEC BHARAT BIJLEE BHARAT ELECTRIC NGEF JYOTI LHP	CAT-III - FOR MOTOR SIZE LESS THAN 30 KW CAT-II - FOR 30 KW AND ABOVE MOTOR SIZE

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SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
7	AIR FILTER	CAT-III	PUROLATOR	
			FMI	
			ANFILCO	
			TENACITY	
			JOHN FOWLER	
			SPECTRUM	
			AIR TECH	
			CLEAN FILTER INDUSTRIES PVT LTD	
			PUROMATIC	
8	INSULTATION MATERIAL	CAT-III	BEARDSHEL	
			K-FLEX	
			PARAMONT	
			ARMAFLEX	
			SUPREME	
			LLOYDS	
			UP TWIGA	
			AEROCELL	
9	FIRE DAMPER	CAT-III	TSC	
			CARRYAIRE	
			AIR MASTER	
			RAVISTAR (SYSTEM AIR)	
10	BUTTERFLY VALVES	CAT-III	AUDCO	
			FOURESS ENGG	
			INTER VALVE	
			ADVANCE VALVE	
			BDK	
			WEIR BDK	
			TYCO	
			CRANE PROCESS	
			KEYSTONE	
			FLUIDLINE	
			INSTRUMENTATION LTD	
			R AND D MULTIPLES (METAL CAST) PVT LTD	
			SURYA VALVES AND INSTRUMENTS MFG CO	
			PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED	
			UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED	
			VENUS PUMPS AND ENGG. WORKS	
11	NON RETURN VALVE	CAT-III	LEADER VALVES	
			H SARKAR	
			FLUIDLINE	
			HI-TECH	
			CRESCENT VALVES	
			A V VALVES	
			KIRLOSKAR	
			BANKIM	
			SHIVADURGA	
			SURYA VALVES AND INSTRUMENT MANUFACTURING	
			ATAM VALVES	
			GM DAULI & SONS	
			KBL	
			VENUS PUMPS AND ENGINEERING WORKS	
12	STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	CAT-III	CRESCENT VALVES	
			BDK	
			AUDCO	
			FOURESS ENGG	
			KIRLOSKAR	
			SANT VALVES	
			BOMBAY METAL & ALLOYS	
			BANKIM	
			LEADER VALVES	
			H SARKAR	
			AV VALVES	
			VENUS PUMPS	
			FLUIDLINE	
			HI –TECH	
			SHIVADURGA	
			SURYA VALVES AND INSTRUMENT MANUFACTURING	
			ATAM VALVES	
			GM DAULI & SONS	
			KBL	

PROJECT : 2X660 MW ENNORE TPS
PACKAGE : VENTILATION SYSTEM
CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LTD
VENTILATION SYSTEM SUPPLIER :
DOCUMENT NO : PE-V0-412-554-A001

SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
13	PIPES (MS/GI) - ERW	CAT-III	SURYA ROSHNI	
			TISCO	
			DADU PIPES	
			INDUS TUBES	
			WELSPUN	
			TATA	
			BST	
			JINDAL	
			SAIL	
			PSL	
			LALIT PROFILE	
			SAMSHI PIPE INDUSTRIES	
			S MUKUT PIPES	
			MANN INDUSTRIES	
			SURENDRA ENGINEERING	
			PRATIBHA PIPES AND STRUCTURES PVT LTD	
			JCO GAS PIPES	
			NUKAT TANK AND VESSELS	
			GOODLUCK TUBES	
			ADVANCE STEEL TUBES	
			BIHAR TUBES	
			HITECH PIPES	
			RATNAMANI	
			MAHARASHTRA SEAMLESS	
14	GI SHEETS FOR DUCTING	CAT-III	TISCO	
			INDIAN IRON & STEEL CO	
			RASHTRIYA ISPAT NIGAM LIMITED	
			ESSAR	
			ISPAT INDUSTRIES	
			JSW	
			JSPL	
			UTTAM VALUE	
			LLOYDS	
			BHUSHAN STEELS	
			TATA	
			SAIL	
			JINDAL	
15	GRILL /DIFFUSER / VOLUME CONTROL DAMPER	CAT-III	AIR FLOW	
			TSC	
			AIR MASTER	
			CARRYAIRE	
			RAVISTAR (SYSTEM AIR)	
16	Y / POT STRAINER	CAT-III	MULTITEX	
			GREAVES COTTON	
			JAYPEE	
			SANT VALVES	
			OTOKLIN	
			GRAND PRIX	
			GUJARAT OTOLIFT	
			DS ENGG	
			SAROJINI ENTERPRISE	
			BHATIA ENGINEERING	
			FILTERATION ENGINEERS INDIA PVT LTD	
			SUNGOV ENGINEERING	
			FLOWTECH ENGINEERS	
17	HUMID STAT	CAT-III	JOHNSON CONTROL	
			HONEYWELL AUTOMATION	
			PENN	

PROJECT : 2X660 MW ENNORE TPS
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SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
18	PRESSURE / DIFF. PRESSURE GAUGE	CAT-III	GENERAL INSTRUMENT CONSORTIUM	
			BELLS CONTROLS LTD	
			H. GURU IND	
			WAAREE INSTRUMENTS	
			H. GURU INST	
			Forbes Marshall	
			Manometer India	
			A. N Instrument	
			Gauges Bourdon	
			GLUCK INDIA	
			WIKA.	
			ASHCROFT INDIA PVT LTD.	
			BAUMER TECHNOLOGIES INDIA PVT. LTD.	
			PRECISION MASS PRODUCTS	
			BOSE PANDA INSTRUMENTS PVT.LTD.	
18	TEMPERATURE GAUGE	CAT-III	H. GURU IND	
			H. GURU INST	
			FORBES MARSHALL	
			DETRIVE INST & ELECTRONICS	
			PYRO ELECTRIC	
			TOSHNIWAL	
			BROSS	
			WAREE INSTRUMENTS	
			A. N Instrument	
			GOA INSTRUMENTS	
			WIKA	
			ASHCROFT INDIA PVT LTD.	
			BAUMER TECHNOLOGIES INDIA PVT. LTD.	
			GOA THERMOSTATIC	
			Gauges Bourdon	
			BUDENBERG GAUGE	
			PRECISION MASS PRODUCTS	
20	LEVEL INDICATOR	CAT-III	GENERAL INSTRUMENT CONSORTIUM	
			CHEMTROL	
			SBEM	
			AUTOMAT MUMBAI	
			SIGMA	
			TOSHNIWAL	
			TECHNOMATIC	
			TELACO	
			LEVCON	
			D K INSTRUMENTS	
			PUNE TECHTROL	
			FLOW STAR	
			BLISS ANAND	
21	PRESSURE/ DP/ VACUUM/ TEMPERATURE SWITCH	CAT-III	BELLS CONTROLS LTD	
			DANFOSS	
			DK INSTRUMENTS	
			DRESSER	
			SOR INC	
			VASU	
			SWITZER INSTRUMENT LTD.	
			INDFOSS	
			TRAFAG	
			GIC	
			ASHCROFT INDIA PVT LTD.	
			KASTURBA UDYOG	
			BARKSDALE GMBH	
			PRECISION MASS PRODUCTS	
			MITTAL REFRIGERATION	

PROJECT : 3X660 MW ENNORE TPS
PACKAGE : VENTILATION SYSTEM
CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LTD
VENTILATION SYSTEM SUPPLIER :
DOCUMENT NO : PE-V0-412-554-A001

SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
22	LEVEL SWITCH-FLOAT TYPE	CAT-III	SBEM	
			BLISS ANAND	
			HI-TECH	
			RAMAN INST	
			SIGMA	
			SOR INC	
			WAREE INST	
			LEVCON	
			DK INSTRUMENTS	
			V AUTOMAT	
			CHEMTROL	
			SIEMENS	
			FLOW STAR	
			TRAC	
			FLOW TECH	
			NIVO CONTROLS	
			PUNE TECHTROL	
			SAPCON INSTRUMENT	
			BAUMER TECHNOLOGIES INDIA PVT. LTD.	
			GIC	
23	LEVEL SWITCH- CAPACITANCE TYPE	CAT-III	SBEM	
			BLISS ANAND	
			HI-TECH	
			RAMAN INST	
			SIGMA	
			SOR INC	
			WAREE INST	
			LEVCON	
			DK INSTRUMENTS	
			V AUTOMAT	
			CHEMTROL	
			SIEMENS	
			FLOW STAR	
			TRAC	
			FLOW TECH	
			NIVO CONTROLS	
			PUNE TECHTROL	
			SAPCON INSTRUMENT	
			BAUMER TECHNOLOGIES INDIA PVT. LTD.	
			GIC	
24	LOCAL CONTROL PANEL	CAT-II	INDUSTRIAL CONTROL & APPLIANCE	
			PYROTECH ELECTRONICS PVT. LTD.	
			POSITRONICS PVT. LTD.	
			CONTROL & SWITCHGEAR	
			SIEMENS	
			L&T	
			GE POWER	
			RITTAL	
			HOFFMAN	
25	MOTORIZED ACTUATOR	CAT-III	SIEMENS BUILDING TECHNOLOGY	
			JOHNSON	
			BELIMO	
			HONEYWELL	
			RAPID CONTROL	
			ALC	
			AUMA	
			ROTORK	
			WEIR BDK	
			LIMITORQUE	
26	TEMPERATURE TRANSMITTERS	CAT-III	ABB	
			ENDRESS+HAUSER (INDIA)	
			MOORE	
			SIEMENS	
			SMART INST	
			SBEM	
			TOSHNIWAL	
			V AUTOMAT	
			EMERSON PROCESS MANAGEMENT (ROSEMOUNT)	
			YOKOGAWA	
			HONEYWELL AUTOMATION	

PROJECT : 2X660 MW ENNORE TPS
PACKAGE : VENTILATION SYSTEM
CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LTD
VENTILATION SYSTEM SUPPLIER :
DOCUMENT NO : PE-V0-412-554-A001

SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
27	PRESSURE/ DIFF. PRESSURE TRANSMITTER	CAT-III	SBEM	
			TAYLOR	
			ABB	
			BRISTOL BABCOCK	
			BIRLA KENT TAYLOR	
			BLISS ANAND	
			SMART INST	
			V AUTOMAT	
			FISHER-ROSEMOUNT	
			SIEMENS	
			TATA HONEYWELL	
			PUNE TECHTROL	
			NIVO CONTROLS	
			PANAM ENGINEERS	
			EMERSON PROCESS MANAGEMENT (ROSEMOUNT)	
			MOORE	
			TOSHNIWAL	
			YOKOGAWA	
			ENDRESS+HAUSER (INDIA)	
			FUJI	
			HONEYWELL AUTOMATION	
			ABB	
28	SIGHT FLOW INDICATORS	CAT-III	SIGMA	
			LEVCON	
			V AUTOMAT	
			TELLACE	
			EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	
			TATA HONEYWELL	
			BLISS ANAND	
			SCIENTIFIC DEVICES	
			BK EQUIPMENTS	
			INSTRUMENTATION ENGINEERS	
29	CHAIN PULLEY BLOCK	CAT-III	TUOBRO FURGUSON (INDIA) PVT LTD	
			LIFTING EQUIPMENTS AND ACCESSORIES	
			TRACTEL TIRFOR INDIA PVT. LTD.	
			HERCULES HOISTS LTD.	
30	ELECTRIC HOIST	CAT-III	CONSOLIDATED HOISTS PVT LTD	
			TUOBRO FURGUSON (INDIA) PVT LTD	
			EDDY CRANES PVT. LTD.	
			ARMSEL MHE PVT LTD	
			ALPHA SERVICES	
			CENTURY CRANE ENGINEERS PVT LTD	
			GRIP ENGINEERS PVT LTD	
			HERCULES HOISTS LTD.	
			LIFTING EQUIPMENTS AND ACCESSORIES	
			MANGLA HOISTS PVT LTD	
			REVA INDUSTRIES LTD.	
			TECHNO INDUSTRIES	
31	PAINT	CAT-III	ASIAN PAINTS	
			BERGER PAINTS INDIA LTD	
			GOODLASS NEROLAC	
			JENSON & NICHOLSON	
			CDC CARBOLINE	
			SHALIMAR PAINT	
			ADDISION PAINT LTD	
			GRAND POLYCOAT	
			BOMBAY PAINT	
			HEMPEL PAINT (SINGAPORE)	
			JOTUN PAINT	
32	SOLENOID VALVE	CAT-III	ASCO	
			ROTEX	
			SCHRADER	
			AVCON	
			HERION-NORGREN	
			IMI-NORGREN	
			NUCON	
			JAFFERSON	

PROJECT : 2X660 MW ENNORE TPS
PACKAGE : VENTILATION SYSTEM
CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LTD
VENTILATION SYSTEM SUPPLIER :
DOCUMENT NO : PE-V0-412-554-A001

SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
33	LIMIT SWITCH	CAT-III	BCH	
			SIEMENS	
			JAIBALAJI	
34	ANNUNCIATOR	CAT-III	IIC	
			MINILEC	
			PROCON	
35	INTERPOSING RELAY	CAT-III	ABB	
			SIEMENS	
			ALSTOM	
			HONEYWELL	
			OMRONAN	
			JYOTI	
36	SELECTOR SWITCH	CAT-III	ALSTOM	
			SIEMENS	
			L&T	
			KAYCEE	
37	INDICATION LAMPS	CAT-III	SIEMENS	
			ABB	
			ALSTOM	
			TECHNIC	
			STS	
			L&T	
38	PUSHBUTTON	CAT-III	SCHENIDER	
			GE- POWER	
			ABB	
			SIEMENS	
			BCH	
			ALSTOM	
			TECHNIC	
			L&T	
39	AUX. CONTACTOR	CAT-III	SCHENIDER	
			GE- POWER	
			ABB	
			ALSTOM	
			SIEMENS	
			L&T	
40	AUX. RELAYS	CAT-III	SCHENIDER	
			ASEA BROWN BOVERI LIMITED	
			ALSTOM	
			SIEMENS	
			ABB	
			GE- POWER	
41	TIMER	CAT-III	L&T	
			ABB	
			HAVELLS	
			GE-POWER	
			SIEMENS	
42	VVVF DRIVE	CAT-II	YASKAWA(L&T)	
			ABB	
			SIEMENS	
			DANFOOS	
			TOSHIBA INDIA	
			ALLEN BRADELY	
			HI-REL ELECTRONICS LTD	
			HITACHI	
			FUJI	
			SCHNIEDER	
43	TRANSFORMERS	CAT-III	INDCOIL	
			LOGICSTAT	
			KAPPA	
			AUTOMATIC ELECTRIC	
			PRECISE ELECTRICALS	
			SILKAAN ELECTRIC MFG. CO. LTD.	
			SOUTHERN ELECTRIC	
			NEC	
44	MCB	CAT-III	MDS	
			INDO COPP	
			STANDARD	
			SIEMENS	
			L&T	
			ABB	
			SCHNEIDER	

PROJECT : 3X660 MW ENNORE TPS
PACKAGE : VENTILATION SYSTEM
CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LTD
VENTILATION SYSTEM SUPPLIER :
DOCUMENT NO : PE-V0-412-554-A001

SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION

SL. No	ITEM	QP / INSPN CAT	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	REMARKS
45	INSTRUMENT FITTINGS	CAT-III	PRECISION ENGINEERING INDUSTRIES	
			PANAM ENGINEERS	
			PERFECT INSTRUMENTATION CONTROL (INDIA) PVT. LTD.	
			COMFIT & VALVE PVT. LTD.	
			AURA INCORPORATED	
			ARYA CRAFTS & ENGINEERING PVT. LTD.	
			FLUIDFIT ENGINEERS PVT. LTD.	
			HP VALVES & FITTINGS INDIA PVT. LTD.	
			FLUID CONTROLS PVT. LTD.	
			VIKAS INDUSTRIAL PRODUCTS	
46	CABLE LUGS (NON FLAME PROOF)	CAT-III	3D	
			DOWELL	
			CHITRA	
47	CABLE GLANDS (NON FLAME PROOF)	CAT-III	ARUP	
			SUNIL	
			QPIE	
			COMMET	
48	PUSH BUTTONS	CAT-III	SIEMENS	
			L&T	
			BCH	
			SCHNEIDER	
49	JUNCTION BOX	CAT-III	AJMERA INDUSTRIAL	
			FLEXPRO ELEC	
			K.S.INST PVT.LTD	
			SUCHITRA INDUSTRIES	
			JACKSON	
			JOSPER	
			SHRENIK & COMPANY,	
			CHEMIN CONTROLS AND	
			CREATIVE INSTRUMENTS & CONTROLS	
			INFO CONTROL SYSTEMS INC.,	
			MANISHA COMPOSITEKS PVT LTD	
			PRAMMEN INDUSTRIES,	
			SAJAS ELECTRICALS,	
			SHIBSHA INSTRUMENTS(INDIA)P.LTD.,	
50	FLOAT VALVE	CAT-III	H.SARKAR	
			LEADER	
			GM DAULI & SONS	
51	NON CHEMICAL TREATMENT EQUIPMENT	CAT-III	THERMAX	
			SCALEBAN EQUIPMENTS PVT. LTD	
			SCALE OFF	
			SCALE GUARD	
			ION EXCHANGE	
			DOSI ION	

CATEGORY I: QUALITY PLAN APPROVAL & PHYSICAL INSPECTION BY TANGEDCO AS AGREED IN QUALITY PLAN ARE ENVISAGED. BASED ON INSPECTION / INSPECTION TEST REPORT APPROVAL, TANGEDCO WILL ISSUE MDCC

CATEGORY II: QUALITY PLAN APPROVAL & PHYSICAL INSPECTION BY BHEL AS AGREED IN QUALITY PLAN ARE ENVISAGED. TEST REPORTS SHALL BE SUBMITTED BY BHEL AND GIT IT APPROVED BY TANDEDCO BEFORE ISSUANCE OF MDCC BY TANGEDCO.

CATEGORY III: QUALITY PLAN APPROVAL & PHYSICAL INSPECTION BY TANGEDCO ARE NOT ENVISAGED. MDCC TO BE OBTAINED FROM TANGEDCO BASED ON SUBMISSION OF CERTIFICATE OF CLEARANCE (COC) BY BHEL.

SECTION -2

EQUIPMENT SPECIFICATION

- Customer contract document is enclosed as part of this specification. Only equipment specification pertaining to section -1 shall be referred. Regarding quantities and type of Ventilation equipment, section-1 shall be referred. In case of variance between section-1 and section-2, the requirement of Section-1 shall prevail. Customer specification and technical datasheets in annexure to section-2 shall be adhered to by the bidder.
- Some drawings are already prepared and the wall openings are provided as per the same at site. Contractor shall ensure the location and sizes of such openings while preparing the layout drawings to minimize the changes at site.

CHAPTER 19

19.0 AIR CONDITIONING AND VENTILATION SYSTEM

19.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract not withstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

19.2 Codes and Standards

Relevant Indian/International standards, such as ASHRAE, ISHRAE, AMCA and IS etc. as applicable to AC & ventilation system and latest issues of these applicable codes and standards shall be adopted.

19.3 Design Criteria for Air conditioning system

19.3.1 Dry bulb temperature 47^{o} C.

For other details of ambient conditions, refer published documents for meteorological data for Plant site.

19.3.2 Inside design conditions to be maintained in all air-conditioned areas.

Dry bulb temperature : 22$\pm$ 1.0^{o}C

Relative humidity : 50$\pm$ 5%

19.3.3 A minimum design margin of 10 % shall be considered while sizing AC Plant and related equipment like chillers, chilled water pumps and AHUs for each area. Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.

19.3.4 Margins for calculating heat load:

i. 12.5%, 10% & 10% margins on sensible heat, latent heat & overall heat respectively is to be considered while calculating heat load.

ii. For winter load calculations, 50% of the equipment load as available in the room is to be considered.

19.3.5 All windows in the air conditioned area shall be provided with light coloured venetian blinds.

19.3.6 Fresh air quantity of 1.5 air change/hour or 35m^{3}/hr per person or suitable to maintain over pressure of 2 MMWC whichever is higher shall be considered.

19.3.7 False-ceiling shall be provided in all air conditioning areas.

19.3.8 For chemical lab, the airconditioning system shall be designed for 100% outdoor air (the room air is exhausted and not recirculated through the A/C unit). 2 x 100 % Split units are acceptable for chemical lab.

19.3.9 To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas , air handling units room and Packaged Air conditioners (PAC) rooms shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/m^3 finished with 26 swg aluminum cladding.

19.3.10 AHU room's walls ,Packaged Air Conditioners room's walls and first 6 meters of supply air duct from AHU/PAC air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/m^3 and shall be covered with 26G aluminum perforated sheet. Perforation area shall be 30% of free area.

19.3.11 Lighting load of 2 Watts per Ft^2 or actual which ever is higher shall be considered for heat load calculations.

19.3.12 The occupancy for general/ office area shall be minimum one person per 3 Sq.M and for conference room the same shall be one per 1.5 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq.M (Minimum).

19.3.13 The Air-conditioning spaces shall be maintained at positive pressure of 2 mmwc to avoid any infiltration of dust.

19.3.14 Plant for all air-conditioned areas shall operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).

19.3.15 Motor operated valves shall be provided as per system requirement for chilling machines, pumps, cooling towers in order to facilitate remote operation of entire air-conditioning plant and to select standby unit.

19.3.16 Noise Criteria – Design noise level shall be of NC 35-45 within Control room, Control equipment room, Instruments and Electronic room and offices.

19.3.17 Design Criteria for Air Inlet Louver – Face velocity of the louver shall be 2.5 m/s (max.).

19.3.18 Design Criteria for Volume Control Damper – Velocity across the Damper shall not exceed 10 m/s.

19.3.19 Duct Design Criteria – Velocity shall be 7.5 m/s.(max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.0 m/s. for the diffusers/grills.

19.3.20 Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec.

19.3.21 Water piping shall be sized for a maximum velocity of 2.5m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.3.22 Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1 deg C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.

19.3.23 All Carbon steel sheets under air conditioning system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall

conform to Class 275 of IS: 277.The air distribution system shall be sized to have a constant frictional drop.

19.3.24 For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100.

19.3.25 Thermal Insulation Design Criteria –

EQUIPMENT/MATERIAL	THERMAL INSULATION
Ducting	50 mm thick fibre glass of density 48 kg/cum and TF quality finished with 26 swg aluminium cladding. For Exposed ducting, 50 mm thick fibre glass rigid board (density 48 kg/cum and TF quality) finished with 26 swg aluminium cladding.
Refrigerant Piping for Split Air Conditioners and Packaged air conditioners	13 mm thick Nitrile foam.
Refrigerant Piping of Water Chilling Unit	75 mm thick expanded polystyrene (TF Quality) of density 32 kg/cum finished with chicken wire mesh, 12.5 mm thick sand cement plaster.
Chilled Water Piping and associated valves.	Chilled water piping shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum covered with 12.5 mm thick Sand Cement Plaster. The portion of CHW pipe exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum and finished with 26 swg aluminium cladding.
Drain Piping from AHU and Chiller	Drain Piping shall be insulated with 25 mm thick EPS (TF quality) of density 16 kg/cum covered with 26 swg aluminium cladding.
Chiller	As per manufacturer standard.
Chilled Water Pump	50 mm thick thermal insulation of EPS (TF quality) of density 32 kg/cum covered with 26 swg aluminium cladding.
Expansion Tank	50mm thick thermal insulation of EPS (TF quality) of density 16 kg/cum covered with Sand Cement Plaster.
Air Handling Unit	Double skin type with PUF insulation
Indoor Unit of split AC	As per Manufacture's Standard
Package A.C	As per manufacturer's standard

19.3.26 Design Chilled water flow shall not be less than 0.7 Cu.M/hr per TR air-conditioning load and design Condenser cooling water flow shall not be less than 1.0 Cu.M/hr per TR air-conditioning load.

19.3.27 For maintenance of compressors/chilling units, pumps, AHUs (air handling units) etc. chain pulley block of suitable capacity and/or suitable structure shall be provided in the AC plant rooms and AHU rooms.

19.3.28 Redundancy of Equipments

The number of chilled water pumps, condenser water pumps and cooling towers shall be equal to the number of chilling units and condensing units.

- Chilling Units - 2 x 100%
- Condensing Unit - 2 x 100%
- Condenser water pumps - 2 x 100%
- Chilled water pumps - 2 x 100%
- Package air conditioners - 2 x 100%
- Window/Split air conditioners - 2 x 100%
- FRP cooling towers - 2 x 100%
- Air handling units (DX type) - 2 x 100% (Per AHU room)
- Air handling units water type) - Multiple AHUs of similar (Chilled capacities per AHU room
- Fresh air fan unit - 2 x 50% per AHU room

19.3.29 All the pumps shall have 10% margin on capacity and head over the actual requirement.

19.4 **Design Criteria for Ventilation system:**

19.4.1 The capacity of Air washers, Supply air fans, exhaust air fans/ roof extractors, ducting system shall be designed as per the Design criteria & Equipment specification elaborated below. Sizing calculations for all the equipments shall be submitted for approval of Owner. However the minimum quantity of the air washer units of Ventilation System for each unit shall not be less than 4 numbers (two numbers on A row and two on B row). A minimum 10% margin shall be considered while sizing the equipment/plant capacity.

19.4.2 The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

S No.	Area	Air Changes
i.	For all evaporative type ventilation system	8
ii.	General areas	15
iii.	Various pump houses	20
iv.	Switch gear / MCC rooms.	25
v.	Battery rooms & other areas where gaseous fumes are generated	30
vi.	Chlorination plant building	30
vii.	D G set room	45

19.4.3 However in areas producing lot of heat, the temperature limitation should be the criteria, which is as follows:

- Inside dry bulb temperature shall be minimum 5 deg.C below the design ambient dry Bulb temperature during summer for evaporative cooled areas.
- Inside dry bulb Temperature shall be maximum 3 deg.C above the design ambient dry Bulb temperature during summer for mechanically ventilated areas.
- The criterion which gives higher number of air changes/higher quantity of air in either of the conditions as mentioned above shall be the basis for selecting the required air flow for that area.
- Inside dry bulb temperature for battery room shall be maintained at 25°C. The air flow rate for battery room shall be sized considering minimum 30 air changes per hour or hydrogen concentration of 2% or less of the room volume whichever gives higher air flow shall be considered.

19.4.4 All ventilation system shall operate on 100% fresh air.

19.4.5 All mechanically ventilated areas like MCC/Switchgear rooms shall be positively ventilated by means of supply air fans, generally in combination with exhaust fan/ roof extractors. Wherever exhaust fan/ roof extractors are not provided, the pressurised condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odour generating areas such as toilets shall be negatively ventilated by means of exhaust air fans/ roof exhausters and inlet louvers.

19.4.6 Supply air fan catering for electrical switchgear/MCC rooms, Elevator machine rooms etc. shall be provided with pre filters and fine filters. Efficiency of Pre filter shall not be less than 90% down to 10 microns while for fine filter 99.5% down to 5 microns.

19.4.7 All the equipments of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.

19.4.8 The supply air ducts of evaporative/ UAF type ventilation system shall be provided with automatic (motor operated) fire dampers of fire rating 2 hours at the entry to each of the enclosed area like switchgear rooms, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and the operation of these dampers shall also be possible from the control panel remote manually.

19.4.9 For maintenance of Air washer unit material handling equipment as per size & type defined in Chapter 17, Vol III of specification shall be provided in the Air Washer rooms of Evaporative Ventilation System.

19.4.10 Circulating water capacity for Air washer units shall be minimum 1 M^3/hr per 1000 M^3/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 M^3/hr per 1000 M^3 /hr of air flow.

19.4.11 Water piping shall be sized for a maximum velocity of 2.5 m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.4.12 The air distribution system shall be sized to have a constant frictional drop along its length.

19.4.13 The air washer unit and unitary air filtration unit shall be designed for a maximum face velocity of 2.0 m/sec.

19.4.14 The air washer unit shall be designed for at least 90% saturation efficiency while UAF for 60% saturation efficiency.

19.4.15 For pumps, fans and blowers, continuous motor rating (at 50^0 C ambient) shall be at fifteen percent (15%) above the demand of the equipment at duty point or ten percent (10%) above maximum load demand of the equipment whichever is higher.

19.4.16 For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

19.4.17 All Carbon steel sheets under evaporative ventilation system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall conform to Class 275 of IS: 277.

19.4.18 For calculating friction loss in piping system, WILLIAM & HAZEN formula shall be used with C - value as 100.

19.4.19 Supply air fans, exhaust air fans/ roof ventilators of each area shall be provided with their local starter panel.

19.4.20 Design Criteria for Back Draft Damper – Velocity across damper shall not exceed 6 m/s.

19.4.21 Duct Design Criteria – Velocity shall be 12 m/s.(max.) for main duct, 9.0 M/s. (max.) for branch duct and 3.75 m/s. for the grills.

19.4.22 REDUNDANCY OF EQUIPMENTS

- Pumps for each Air Washer Unit shall be 2 x 100% Capacity or 3 x50%. For UAF it shall be 1 x 100%.
- Fans for each air washer unit shall be 3x 33% capacity while for unitary air filteration unit shall be 1x100% capacity.
- Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

19.5 **Systems to be Furnished**

19.5.1 **Air Conditioning System**

a) A centralized water cooled chilled water system with screw chilling units shall be provided for the following areas:

Main control room areas comprising unit control room, electronic cubicle room, shift in-charge, engineers room, maintenance engineers room, printer room, UPS room, relay room, SWAS (Dry) panel room, conference room, office rooms, record room, analyzer room and static excitation room in TG building.

b) A separate water cooled direct expansion type air conditioning plant of 2x100% capacity shall be provided for ESP/VFD control room.

c) Water Cooled Precision Type Packaged air conditioners shall be provided for the following areas:

i) Switchyard control room

d) Water Cooled Package Type AC units shall be provided for the following areas

- Each floor of Administration building covering all areas
- Each floor of Service Building

e) Air Cooled Non Ductable Split/Window AC units shall be provided for the following areas

- Office and meeting room areas of workshop building
- Weigh bridge Control Room
- Elechtrochlorination plant control Room
- ETP Control Room
- CW Control room
- Fire Station building control room
- H2 Generation Control Room
- Technical library
- Space/ Room for storing C & I items in warehouse.
- Operator cabin of TG Hall EOT Crane
- Ash handling control rooms
- DM plant control room including labs & offices
- CHP Control Room
- ECHS Control Room in NCPTS Stage II
- Sea Water Intake Pumphouse Control Room at NCTPS
- Clarified Water Pumphouse Control Room
- Filtered Water Pumphouse Control room
- GIS Control Room
- Chemical laboratory
- RO Stage I Control room in including labs & offices
- RO Stage II Control Room
- C&I laboratory, training hall, MRT laboratory
- Fuel oil Control Room
- Any other Control Room

19.5.2 **Ventilation System**

a) TG Building

Evaporative type ventilation system shall be provided for TG building as specified below. Air washer units of double bank spray system shall be distributed along A-row and B-row of the building. Filtered and Cooled air from each air washer unit shall be distributed to various areas through supply air ducting and grills. The TG building shall be provided with adequate number of roof extractors.

b) ESP Control Room (Non air conditioned areas)

Unitary Air filtration units of single bank spray system using water repellant type nylon filters shall be provided for ESP building. Unitary air filtration units shall be located at roof top of ESP building.

c) Ambient air ventilation system for the other areas

i) Turbine hall- Roof exhausters
ii) CW pumphouse
iii) Filtered Sea Water Pumpshouse in NCTPS Stage II
iv) Filtered Water Pumphouse
v) Fire Water Pumphouse
vi) Ash Water Pumphouse
vii) Ash Recovery Pumphouse
viii) Ash Slurry pumphouse
ix) Workshop Building
x) Air compressor room
xi) Air Compressor Room in NCTPS Stage II
xii) AC plant rooms
xiii) DG set rooms
xiv) RO Plant I
xv) RO Plant Stage II
xvi) Sea Water Intake Pumphouse in NCTPS Stage II
xvii) RO Stage I Permeate Pumphouse in NCTPS Srage II
xviii) UF Permeate Pumphouse in NCTPS Stage II
xix) Chemical House in NCTPS Stage II
xx) DM Plant
xxi) CPU
xxii) Stores
xxiii) Gate Houses
xxiv) Switchyard control building (Non a/c areas)
xxv) Battery and battery charger rooms
xxvi) All MCC rooms & cable vaults
xxvii) Compressor/vacuum pumphouse (AHP)
xxviii) Coal handling switchyard gear room
xxix) Transfer tower/tunnel for CHP.
xxx) Elevator machine rooms
xxxi) All other areas not airconditioned.
xxxii) Workshop
xxxiii) Toilets
xxxiv) Stores
xxxv) H2 Generation Building

Any other area/building which has not been specifically included above, but required ventilation shall be provided with suitable ventilation system.

19.6 **System description Air Conditioning System**

19.6.1 **Centralized Water Cooled Chilled Water System**

(a) A centralized water cooled chilled water system with screw chilling units are envisaged for airconditioning the areas viz. main control room areas. The water cooled screw chilling units along with chilled water pumps, condenser cooling water pumps and cooling towers shall be provided. The number of chilled water pumps, condenser cooling water pumps, cooling towers shall be equal to the number of chilling units. The air conditioning system shall also include multiple air handling units, associated air distribution system, chilled water piping, condenser water piping, valves & fittings, insulation, strip heaters, humidifiers, expansion tank and all other associated accessories and controls. A central control panel within the air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Makeup water for the condenser cooling

water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

(b) The screw chillers shall operate to meet the overall building cooling load requirements through out the day. The chillers shall operate by a combination of chiller optimization and sequencing. The airconditioning controls shall be designed as to interface with the safety controls of each of the air conditioning equipment along with automatic operation. Selector switches and push buttons shall be provided for manual operation of all air conditioning equipment.

(c) Chilled water flow of 10 cum/hr shall be supplied to Sample Cooler in the Analyzer room from the main airconditioning chilled water system.

(d) The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

(e) Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

(f) Humidification package with all necessary controls.

(g) Air distribution system including ducting, grilles, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

(h) Monorail and hoist for handling the A/C units, pumps, etc.

(i) Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge shall be provided for sensitive areas of main control room i.e unit control room, electronic cubicle room, printer room, UPS room, relay room, SWAS (Dry) panel room, & conference room. Other areas shall be provided with pre filters & fine filters. .

(j) The chilling plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of chilling units, pumps etc.

(k) Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

19.6.2 **Water Cooled Direct Expansion System (DX System)**

Independent water cooled central air conditioning system of direct expansion (DX) type with reciprocating compressor is envisaged for ESP control room

i. The water cooled condensing unit along with Air handling units, condenser cooling water pumps and cooling towers shall be provided. The number of Air handling units, condenser cooling water pumps, cooling towers shall be equal to the number of condensing units. In addition, one common standby condensing unit and the associated equipment shall be provided. The air conditioning system shall also include associated air distribution system, condenser water piping, valves and fittings, insulation, strip heaters, humidifier, Differential pressure for filters and all other accessories and

controls. A central control panel within air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Make up water for the condenser cooling water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

ii. The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

iii. Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

iv. Humidification package with all necessary controls.

v. Air distribution system including ducting, grillers, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

vi. Monorail and hoist for handling the A/C units, pumps, etc.

vii. Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge.

viii. The condensing plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of condensing units, pumps etc.

ix. Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

19.7 **System description Ventilation System**

19.7.1 **Evaporative Cooling System for Turbine Building**

i. Four (4) nos. air washers of adequate capacity shall be provided for evaporative cooling of various floors of turbine building including maintenance bay and electrical bay. Each air washer system shall consists of two (2) nos. centrifugal fans (both working), two (2) nos. centrifugal circulating water pumps (1 working + 1 standby), Send trap and air intake louvers, filters, air washer internal, ducts and other accessories. Besides, roof extractors shall be provided. With this system the dry bulb temperature (DBT) within the turbine building shall be maintained at a temperature not exceeding 5^{o}C less than ambient DBT at all times of the year. The air washer capacity is to be decided based on:

a) Total internal heat load within the turbine building, inclusive of electricity bay and maintenance bay and considering the heat dissipated by various electrical switchgear, motors, equipment hot surface, steam piping as well as the dissipated heat, solar transmission through the building walls and glass, and any other sources of heat.

b) Summer ambient conditions as furnished to be considered.

c) Efficiency of air washer shall be 90% with two banks opposed type spray system

ii. The number of roof extractors in the turbine building to be sized so as to exhaust about 70% of the total air supplied in order to reduce ingress of dust-laden air into the building.

iii. Air washer shall be double bank spray type mainly consists of an airtight chamber or casing containing air distribution louvers, spray nozzles, a tank for collecting spray water, eliminators with flooding nozzles, pre and fine filters and a pump with piping valves, strainers and specialities for re-circulating water. One (1) level switch in the air washer tank shall be provided to give an alarm in the air washer plant room.

iv. The supplied air will be exhausted through roof exhausters to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.2 **Unitary Air filtration Unit for ESP Control Building**

For ventilation of this building (except the control room), ambient air will be drawn through unitary air filtration units of single bank type comprising fresh air intake louvers, automatically cleanable nylon filters (with water spray) and moisture eliminator and supplied to the space by means of centrifugal fans.

The supplied air will be exhausted through wall mounted gravity operated dampers to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.3 **Ambient Ventilation System for other areas**

Ambient ventilation system shall comprise of supply air fan assemblies with Pre & Fine filters, Gravity louvers, exhaust air fans, roof extractors, gravity dampers or a suitable combination of these along with necessary filters, ducting, grilles etc.

Transfer towers/tunnels of Coal handling plant shall mainly consists Supply air fans of DIDW type with pre and fine filters, Supply air ducting and grills, Exhaust air ducting and grills and Exhaust air fans of SISW type.

The ventilation system for the various areas shall be designed duly considering the factors such as temperature, relative humidity and maximum allowable concentration of gases present in the rooms, corresponding to international guidelines.

19.7.4 **Specific Requirements**

All battery rooms to be painted with acid & fume resistant paint.

iv. In chlorination room, ducted exhausts shall be provided and exhaust air grilles will be located near the floor level. The fan, motors ducting and grilles shall be given acid and fume resistant paint.

v. For hazardous areas, fans with anti-spark characteristics to be provided.

vi. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.

vii. Evaporative cooling ventilation fans shall be interlocked with fire protection system, to get the same tripped in the event of fire.

viii. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Airwasher nozzles/ water circuit.

19.8 **Equipment Description**

19.8.1 **Chilling Unit/Condensing Unit**

Type		Water cooled type.
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	:	a) For the Chilling units of T G building control room areas, the compressor shall be Hermetically sealed Screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities b) For condensing units of ESP/VFD control rooms shall be Hermetically sealed screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities
Type of drive	:	Motor driven, through direct
Accessories	:	High / Low pressure cutouts, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Condenser		
Type	:	Water cooled, shell and tube type.
Fluid		
	:	Shell side – Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective compressor and to provide atleast 2 deg.C sub-cooling. To store full charge of refrigerant.
Design fouling Factor	:	Not less than 0.0002 (in MKS units)
Shell material	:	Mild steel (IS:2062)
Tube material	:	Replaceable seamless copper (ASME B-111)
Fin material		Copper
Accessories	:	Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc.
Refrigerant	:	For chilling Unit- R 134a For Condensing Unit - R-22
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Chiller		
Type	:	DX type and Shell and tube type
Superheating of	:	At least 2 deg.C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Water
		Tube side - Refrigerant
Capacity	:	To match with respective plant capacity.

Shell material	:	Mild steel (IS : 2062)
Tube material		Replaceable seamless finned copper
Fin material	:	Aluminium
Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, thermostatic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame etc.
Steel Structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

19.8.2 **Air Handling Unit (AHU)**

a) Each AHU shall consist of Casing, Fan impeller section, Cooling coil section, damper section, Steel frame with vibration isolators (minimum efficiency of 85%) for the complete AHU, Isolation dampers at the Suction and discharge of each AHU, Pre-filter at the suction and Fine filters (micro-vee type) in the discharge of each individual AHU/common plenum, Absolute (HEPA type) filters in individual discharge of all AHU's/common plenum of Control room, control equipment room, computer, programmer rooms etc and Heater section in the common discharge of AHUs.

b) The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 22 swg (0.8 mm) galvanized steel, with 25mm thick polyurethane (PUF) insulation of minimum 40Kg./ Cum density in between. 16 gauge galvanized steel hat-channel shall be used as reinforcing to give structural strength.

c) Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.

d) Cooling coil shall be of seamless copper tubes with Aluminium fins and shall be provided with suitable drains and vents connections.

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

f) Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.

g) Centrifugal Fan

a)	Fan impeller	:	Forward/ backward curved blade & centrifugal type.
b)	Impeller material	:	Mild steel spray galvanised with minimum zinc deposition conforming to Class 275 of IS:277.

c)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
d)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.
e)	Drive	:	Motor driven. With removable belt guard.
f)	Static pressure (minimum)	:	120 mm wc

19.8.3 **Precision Type Packaged Air Conditioners**

Packaged air conditioners shall be of precision control type complete with hermetic type Scroll compressor ,shell and tube type water cooled condenser, air handling fan, D-X cooling coil, Microvee filters,In-built dehumidification cycle thru solenoid valve for reading ADP, humidifier package with humidistat and other accessories and controls, electrical strip heaters with suitable thermostat, first charge of refrigerant and oil, controls and all necessary instruments and accessories, all housed in a cabinet made of heavy gauge sheet steel finished in epoxy paint of approved colour and suitable for floor mounting. Suitable drain connection shall be provided for removal of condensable collected inside a tray under cooling coil.

i. Compressor shall be hermetically sealed Scroll type with drive motor. It shall be suitable for R22/R407c refrigerant. The compressor shall be mounted on springs at the lower most section of packaged unit such that the same is easily accessible for servicing.

ii. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.

iii. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.

iv. Cooling coils shall be of direct expansion type and made of heavy gauge copper with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of air flow.

v. Filters shall be non-rusting corrugated metallic wire mesh cleanable type and of adequate area so that the air velocity across the filters shall not exceed 2.5 m/sec. Filter shall be in-built with unit heaving efficiency 95% down to 5 microns.

vi. Refrigerant piping shall be heavy gauge copper or IS:1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.

vii. Cabinet Construction:

The frame & panel shall be constructed of Cold rolled cold annealed sheet steel duly powder coated and shall be assembled with pop rivets. The side panels of unit shall be double skinned for increase life span and reduction of noise & vibration. Front panel shall be removable hinge for easy service.

viii. De-Humidification

Specific de-humidification cycle (Split Liquid / Split Suction) shall operate by reducing the operating surface temperature in a section of one of the Refrigeration coil by means of a solenoid valve in the Liquid line / Suction line. Full air flow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

ix. All necessary operating and safety controls shall be provided including the following:

Controls:

The controls shall be of microprocessor based programmable PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:

a) Modes of operation (cooling, heating, humidification, de-humidification).

b) Simultaneous displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.

c) Date, time and unit identification display.

d) System component Auto / Manual status display on the controller screen.

e) Backup battery charge status display on the controller screen.

f) Visual system alarm indication (along with mutable audio alarm as well).

g) Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).

h) 24 Hours temperature and relative humidity graph display menu.

i) Programmable services interval indication display / alarm.

There should be a feature to enable operator to program the start-up and shut off of the system components (blower fan start / stop delay, first compressor start / stop delay, second compressor start / stop delay, etc.). Access to the controller settings shall be protected with passwords to prevent against unauthorized access.

Safety Protections:

The unit shall also incorporate the following protections:

a) High pressure trip- Manual reset for each compressor
b) Low pressure trip- Manual reset for each compressor.
c) Single phasing preventers.
d) Reverse phasing
e) Phase imbalancing
f) Phase failure

g) Overload tripping (MPCB) of all components

Safety Interlocks:

Operation of heaters & humidifiers shall be possible only when blower fan is in operation.

Fire detection signal from fire detector system shall be able to switch off the package unit operation in event of fire in conditioned space.

x. A suitable number of vibration isolation pads shall be provided for the packaged units.

19.8.4 **Centrifugal Pumps**

a)	Type	:	Horizontal Centrifugal, Axially split type casing pump
b)	Impeller	:	Closed type
c)	**Material of Construction**	:	
	i) Casing	:	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 410
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	As per manufacturer's standard.
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm

19.8.5 **Air Filters**

a) Pre Filter

1)	**Filter medium :**			
	i)	Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for Fabric type.		
	ii)	V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh for Metallic type pre-filters.		
2)	**Frame**			
		GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge) supported by galvanised steel wire mesh of 10 mm Square with handles.		
3)	**Other requirements :**			
	a)	Suitable aluminium spacers be provided for uniform air flow;		
	b)	Casing shall be provided with neoprene sponge rubber sealing.		
	c)	Capable of being cleaned by water flushing.		
	d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.		
4)	**Efficiency :**			
		Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 - 76.		
5)	Minimum thickness	:	50 mm for Fabric type.	
6)	Face Velocity	:	Not more than 2.5 m/sec.	

7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location		
	a) Fabric type	:	1) At the suction of each AHUs (AC system)
		:	2) At the suction of each Fresh air fan (AC)
		:	3) At suction of each PAC unit

b) Fine Filters (Microvee type)

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)
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame. 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 18 mm WC.
8)	Location	:	i) At the discharge of each individual AHU (AC system). ii) At the discharge of each Fresh air fan (AC system)

c) Absolute Filter / Hepa Filter

1)	Media	:	100% sub-microscopic glass fibres.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
4)	Efficiency	:	99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B.
5)	Minimum thickness	:	300 mm
6)	Face Velocity	:	Not more than 1.2 m/sec.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 20 mm WC at rated flow; Final pressure drop - Up to 60 mm WC.
8)	Location	:	At the discharge of each individual AHU feeding to computer rooms, programmer rooms, control room and control equipment room in central control building.

19.8.6 Cooling Towers

Type		Induced draft, cross or counter flow.
Capacity		110% of rated capacity of each cooling water

		pump.
Material of construction of Casing & Sump tank		F.R.P
Fan		Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill		Non combustible PVC or Equivalent of light grey, cream or white colour.
Louvers		F.R.P / PVC / Aluminium.
Nozzles		Brass with chrome plating/Polypropylene.
Eliminators		In removable sections to reduce the drift loss to 0.2% of water flow.
Supporting structure		Mild steel with spray galvanisation or epoxy painting.
Strainer at water outlet		Plate strainer made of GI /SS wire mesh of 16 gauge.
Bird screen		25 mm square made of GI/SS wire mesh of 16 gauge.
Ladder		Hot dip galvanised steel ladder for each tower.
Distribution Pipe		Galvanised MS pipe.
Accessories		Drain connection with isolation valve Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. Overflow connection Equalizing connection to connect sump of all the towers wherever applicable. Access door in louvers / fan deck.

Individual sets of cooling towers shall be provided for Central chilling plant in T G building areas, DX type air conditioning system for ESP/VFD control room and Packaged type air conditioning systems for Administrative building, Switchyard control room, AHP control room and other areas/control rooms.

Non- Chemical Type Scale Preventor

The unit should be a non-chemical on-line type scale preventor not requiring any chemicals. Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment.It should work with a combination of Adsorption, and Turbulence. The inner core should be able to convert the hardness salts into colloidal particles.The unit should not require any electricity or any other source of energy.The unit should not have any recurring, operating and maintenance cost.The size of the unit shall be determined based on the water quality and water flow rate.The unit shall be installed in the condenser water circuit.The outer casing should be of stainless steel.The method of checking the performance of system through computer simulation shall be provided

19.8.7 **Air Distribution System**

I) Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The thickness of sheets type of bracings and other fabrication details shall be as specified below: -

	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
a.	Upto 600	0.63 (24 g)	S-drive, 25 mm pocket or bar slips on 2.5 m centers	25 x 25 x3 angles 1.2 m from joint
b.	601 thru 750	0.63 (24 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x 3 angles braced at 1.2 m from joints.
c.	751 thru 1000	0.80 (22 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x3 angles braced at 1.2 m from joints.
d.	1001 thru 1500	0.80 (22 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers	40 x 40 x 4 angle braced at 1.2 m from joints.
e.	1501 thru 2250	1.00 (20 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers.	40 x 40x 4 angle braced at 600 mm from joints.
f.	2251 and larger	1.25 (18 g)	50 x 50 angle connections or 40 mm pocket or 40 mm bar slips 1 m centers with 35 x 3 bar reinforcing	50 x 50 x 5 angle braced at 600 mm from joints.

II) The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

III) Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of redoxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Wherever

in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.

IV) Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections. Connections shall be made from non-combustible heavy glass fabric 1.02 kg/M^2 (30 Oz per sq.yd) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

V) All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

VI) Wherever duct passes through wall, all the openings between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

VII) An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.

VIII) Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods, there shall be locking device with a mark to show the final adjusted position of the splitter

IX) All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonary construction to which angles are fastened.

X) Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

XI) Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type.

Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.

XII) All air terminals shall be of mill finish extruded aluminium profile construction.

XIII) The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation, supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

XIV) Each branch line shall have dampers to isolate the branch for maintenance purpose.

19.8.8 **Pipe work Valves and Specialities**

i. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanised steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS:3589 with minimum 6.35 mm thickness.

ii. Fabricated elbows from pipe (5 piece mitre) shall be furnished for pipe fittings of sizes 200 mm & larger. Locally available long radius (R=1.5D) hot bends with thickness same as that of the pipe having butt welding ends as per ASA B-16.9 shall be furnished for pipe fittings of sizes 150 mm up to 65 mm NB. 3000 # ASA standard forged carbon steel pipe fittings to A-105 Gr.II or IS:1875 Class-2 or approved equal with socket welding ends as per ASA-B-16.11 shall be furnished for pipe fittings of sizes 50 mm NB and smaller.

iii. Unless otherwise specified, all flanges shall be ASA # 150 standard (as applicable) forged carbon steel slipon flanges to A-105 Gr.II or approved equal, faced and drilled to ASA-B-16.5. The pipework flanges shall match with the valves and equipment connections. Hexagonal head machined carbon steel bolts to IS:1367 Class 4.6 or approved equal shall be furnished with hot forged carbon steel hexagonal head nuts to IS:1367 class 4.6. The gaskets shall be 3 mm thick wire inserted red rubber full face gaskets, 150 # ASA standard and drilling details to match with the flanges as required.

iv. In general, all the line joints for sizes 65 mm and larger shall be butt welded and the joints at valves shall be flanged unless otherwise specified. For pipe sizes 50 mm and smaller, the line joints shall be in general socket welded and the joints at valves shall be screwed unless otherwise specified. The joints at equipment and instruments shall be as per manufacturer's drawings.

v. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

vi. All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Seller. The Seller's support shall utilize the Purchaser's steel as far as practicable. Where additional secondary steel is required for the hangers, these shall be furnished. The secondary auxiliary steel required for the hangers and supports shall be welded to the Purchaser's steel structure as directed by the Engineer. Welding shall not be permitted across the bottom flange of main structural members.

vii. The bidder shall ensure that the location of hangers and supports shall not increase the force and moments on equipment beyond the permissible limits. The anchors shall be designed for rigid fastening to the structure directly or through brackets. As far as possible, attachments of supports brackets to brick walls shall be avoided. All concrete inserts shall be galvanised and shall be installed on the concrete structure where required for fastening supporting devices.

viii. Bolted pipe clamps used for rod hangers shall be of minimum 6 mm thick. Hanger rods shall be 10 mm dia. All hanger components shall be given a shop prime coat of red lead paint.

ix. Upon completion of the installation of all pipework as per approved drawings, the pipe lines section shall be subjected to hydrostatic testing at 1.5 times the design pressure. All joints shall be carefully examined for sweating or leakage and repairs conducted as necessary and the hydrostatic test repeated till its satisfactory completion to the Engineer's satisfaction. After completing the hydrostatic test, the pipe lines shall be drained and flushed several times to ensure complete cleanliness inside the pipes.

x. All the drain piping between the drain connection of each equipment upto the Purchaser's common drain point in the equipment room shall be provided by the Contractor. Necessary seal loops as required shall be incorporated in the drain piping.

xi. The bidder shall submit the circulating water piping layout for Evaporative Cooling System. The quantities of piping, valves and instruments as required shall be included in the proposal. Requirement of pipe fittings, flanges, bolts and nuts, gaskets, couplings and associated accessories shall be estimated by the bidder and included in the scope of supply.

19.8.9 **Valves**

i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.

ii. Valves for regulating duty shall be of Globe type suitable for controlling through out its lift.

iii. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

iv. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

v. Manual gear operator be provided for valves of size 250 NB and above.

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arranement.

viii. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

19.8.9 **Air Washer Unit**

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

ii. The air washer chamber casing shall be RCC or fabricated from MS sheet as the case may be. The sheet metal air washer chamber casing shall be fabricated from 3.15 mm black M.S. sheet with adequate stiffeners etc. and various sections shall be bolted through gaskets to avoid leakage of water. The inside of casing shall be protected by spray galvanization or by three coats of epoxy painting.

iii. The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the casing and tank shall be spray galvanized. Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.

iv. The distribution plate shall be fabricated out of 16G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

v. Air washer shall be two-bank construction (one uni-flow and the other cross flow). The water shall be sprayed at filter bank. All header and stand pipes shall be galvanized.

vi. The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 $Kg/cm^2(g)$.

vii. The eliminator plates shall be of 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 mm. The eliminator section

made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray and drain pipe.

viii. An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.

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

x. The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for TG building and SISW / DIDW for and ESP/VFD building.

xi. Both inside and outside of all the sections of the metal chamber unit shall be spray galvanized to prevent corrosion. The nuts and bolts used for joining the section shall be stainless steel. The connection pieces shall have at least two (2) coats of rust inhibiting paint.

19.8.10 **Unitary Air Filtration**

Each unitary air filtration shall be of single bank (cross flow) consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Water shall be sprayed at filter bank .Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

All equipments, components used in unitary air filtration system shall be in line with the specification requirements stipulated in air washer units above except the fans may be of SISW type.

19.8.11 **Instruments, Protective Devices and Interlock**

On-off thermostat with adjustable setting shall be provided with temperature control. Interlocks shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with condenser water flow switch, chilled water flow switch / circulation pump. Safety devices such as high/low pressure cut out, hermetic motor winding thermostat etc. shall be provided. HP cutout shall be manual reset type while LP cutout shall be auto reset type. The control system shall be PLC based with redundant processor, power supply and communication modules, with CRT operator interface and peripherals serial link shall be provided for transfer of important signals to the DCS in the central control room.

Strip heaters shall be provided with an adjustable thermostat to control the temperature and a safety thermostat and safety interlock shall be incorporated to cut-off the electrical supply to the heater whenever there is failure of airflow.

Fire dampers (solenoid operated) shall be installed at places where supply air duct crosses fire barrier wall, floor slab, return air space (near the wall separating AHU rooms / PAC rooms and A/C area). The fire damper shall be of the same fire resistance as the structure but in no case less than 90 minutes and should be energized to close and the air conditioning equipment shall be tripped off in the event of fire.

19.8.12 **Centrifugal Fans for Evaporative cooling plants**

i. The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanisation. In case of spray galvaniation zinc deposition should conform to class 275 of IS:277. The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required. The fan shall be of class I construction and Fan velocity should not exceed 10 m/s.

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

iii. The bearing shall be self aligning, heavy duly ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.

iv. Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.

v. Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 70% efficiency.

vi. The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

vii. Centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less then 96%.

viii. The static pressure of fan shall not be less then 75 mmwc.

19.8.13 **Power Roof Extractors**

Power roof extractor's impeller shall be of axial type. Casing shall be made of MS minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized and impeller shall be made of cast aluminium impeller with blades of aerofoil design. The speed of the roof ventilators shall not exceed 960 rpm for impeller diameters larger than 450 mm and 1440 rpm for impeller diameters 450 mm and less. Hood of the roof ventilator shall be of hinged type providing easy access to motor and impeller. Mounting frame for mounting the roof ventilators shall be provided. Weatherproof lockable type disconnect switch shall be provided such that, the hood can be opened only when the disconnect switch is in "OFF" position.

The roof extractors shall shall be used for buildings of height 7 (seven) metres and above. The static pressure of power roof extractor shall not be less then 15 mmwc.

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

19.8.14 **Axial and Propeller Fans**

These fans shall have single piece cast aluminium impeller with blades of aerofoil design.

The fan casing shall be of heavy gauge sheet steel construction minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized.

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

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

The static pressure of supply air fans with pre & fine filters shall not be less then 32 mmwc while for exhaust fans 10 mmwc. However the propeller fans for toilets and pantries shall be 5 mm wc.

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

19.8.15 Gravity Damper

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

19.8.16 **Fresh Air Unit for Air Conditioning System**

The fresh air unit shall consist of:

- Wall cowl with bird screen, tube axial fan with motor.
- Pre-filter made up of HDPE and efficiency 90% down to 10 microns and maximum face velocity of 1.75 m/sec. The prefilter used for evaporative coolers and ventilation system shall be of same specification.
- Fine filter made up of HDPE and efficiency 99.5% down to 5 microns and maximum face velocity 1.25 m/sec.
- Volume control damper, ducting, fixing frame and necessary supports.
- Filter frame shall be of aluminium and shall be flanged.

19.8.17 **Plant Control for Air conditioning system**

a) **General**

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

b) **Control Scheme of Air Conditioning System**

i. The Air Conditioning System control system shall be PLC based. The PLC configuration and detailed specification of the same shall be as per Control & Instrumentation requirements specified elsewhere in the specification.

ii. Each system shall be provided with required I/O modules and two numbers of Operator Work (OWS) Stations. All the functional requirements specified below and general control logic specifed under this section shall be implemented in the respective PLCs.

iii. The basic function of the system shall be to closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to optimize/minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and for maintaining the room temperature/ RH by controlling the 3 way mixing valves at chilled water line, humidified system and duct heater.

iv. PLC provided for the Control of AC system shall suitably interface with integral microprocessor based controls of Chiller units.

v. The PLC based control system of Air Conditioning system shall also interface with Wide Area Network of the Station to be supplied by the Bidder.

c) **Water Chilling Plant Control**

i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.

ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.

iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v.

vi. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vii. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

viii. Provision shall also be made for the manual restarting of the compressor.

ix. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

x. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.

xi. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xii. Closure of fire dampers shall raise an annunciation in the panel.

xiii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.

xiv. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.

d) **Air Handling Unit chilled water type**

i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.

ii. Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.

vii. Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii. Miscellaneous control requirements

ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.18 **Plant control for Evaporative cooling and Ventilation system**

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

ii. Air Washer Units (AWU) & Unitary Air Filteration Units (UAF)

iii. Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

iv. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/tripped.

v. Auto/Manual selector Switches and working/Standby selector switches for the pump shall be provided in the panel.

vi. A selection switch enabling the running of AWU fan or pump alone shall be provided.

vii. Miscellaneous control requirements

viii. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ix. Lamps shall be provided for indicating the status of each pump, fans etc. of Ventilation system in the main and local panel.

x. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the respective panel.

xi. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.19 Bidders shall ensure that the guaranteed control room noise level is maintained and the units are designed for achieving the same. The vibration level of the units shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans) and airconditioning system equipment (A/c units, AHUs, Cooling Towers, Pumps etc.)

CHAPTER - 11

LV SWITCHGEAR

1.00.00 CODES AND STANDARDS

IEC: 60947 - Low-Voltage Switchgear and Control gear

IS: 13947 (parts 1 TO 5) - General Requirements of Switchgear and Control gear For Voltage Not Exceeding 1000 V AC.

2.00.00 DESIGN CRITERIA

2.01.00 Power from Unit / Station LV service transformers will be supplied to 415 V switchgears. Power from 415 switchgears to the various PMCCs, ACBDs, MCCs, Emergency MCCs, etc. shall be supplied from redundant incomers. These switchgears will distribute power to LV auxiliary motors and also to other auxiliary loads viz. MCCs / ACDBs, etc. LV switchgears will be of metal enclosed indoor type. Incomers / bus-couplers, outgoing tie feeders rated above 400 amps and motor feeders rated 90 kW and higher, will be equipped with air circuit breakers of fault interrupting capacity of 50 KA rms. Lower rated feeders will be equipped with fully-rated MCCBs.

2.02.00 **System Parameters**

1)	Nominal system voltage	415 V AC	220 V DC
2)	Highest system Voltage	433 V	240 V DC
3)	Voltage variation	±10%	190 - 240
4)	Rated frequency	50 HZ	-
5)	Frequency variation	+3% to (-)5%	-
6)	One minute Power frequency withstand voltage Main circuit Auxiliary Circuit	 2.5 kV 2.0 KV	 2.5 kV 2.0 KV
6)	System Earthing	Solidly Grounded	Unearthed

7)	Maximum system fault level	50 KA for 3 secs	25 KA for 1 sec
4.	**Molded Case Circuit Breaker**		
a)	No. of poles	TPN/TP	
b)	Short time current for 1 sec.	50 kA rms	
c)	Rated short circuit breaking current	50 kA rms	
d)	Rated short circuit making current	105 kA peak	
e)	Overload release setting	Yes	
f)	Short circuit release setting	Yes	
g)	Undervoltage rellease	Yes	
h)	Shunt trip	Yes	

2.03.00 **Type**

Circuit Breakers	Shall be air break, three pole, spring charged, and horizontal draw out type, suitable for electrical operation.
Switchgear	Fully draw out type single front
MCC	Fully draw out type single front/Double front.
ACDB/DCDB	Fixed type single front

2.04.00 **List of minimum required LV switchgears**

S.No Name of LV Switchboard

1. UNIT PMCC
2. WT PMCC
3. P.H. ACDB
4. BUNKER FLOOR MCC
5. P.H.B. MLDB
6. VENTILATION MCC
7. AC MCC

8. BOILER MCC
9. SOOT BLOWER MCC
10. BOILER VALVE DAMPER MCC
11. MILL SYSTEM MCC
12. TURBINE AUX. MCC
13. TURBINE VALVE DB
14. BOILER ACDB
15. ESP # 1A PMCC
16. ESP # 1B PMCC
17. ESP # 1C PMCC
18. ESP # 1D PMCC
19. ESP ACDB
20. ASH SILO PMCC
21. HYDROGEN GEN PLANT MCC
22. SEA WATER PUMP HOUSE PMCC
23. WATER TREATMENT MCC
24. SWPH MLDB
25. SERVICE BLDG MCC
26. WORKSHOP ACDB
27. AIR CDM MCC
28. CHLORINATION MCC
29. CHP MCC
30. MLDB CHP
31. AHP PMCC
32. ASH SLURRY MCC
33. AHP WATER SYSTEM MCC
34. AHP MLDB
35. FIRE WATER PMCC
36. MLDB RWFW PHASE
37. DG SWGR1 AMF PANEL
38. UNIT NORMAL EMERGENCY PMCC
39. 415 AC ELDB
40. 415MLDB AWR PMCC
41. ADMIN BLDG. PMCC
42. MLDB ADMIN BLDG AREA
43. FUEL OIL UNLOADING PH PMCC
44. MLDB FOHS AREA

45. WATER SERVICE PMCC
46. DM PLANT MCC
47. ETP MCC
48. PRETREATMENT PLANT MCC
49. MLDB WATER SERVICE S/S
50. INTAKE RAW WATER MCC
51. CLARIFIED WATER PUMP HOUSE MCC
52. FD PRESSURISING AREA MCC
53. ESP STANDBY PMCC
54. RO Plant SWGR
55. ICHS Stage I SWGR
56. PIPE CONVEYOR END SWGR
57. Any other LV Switchgear not mentioned herein but required for safe and reliable functioning of the plant.
58.

3.00.00 TEMPERATURE RISE

The temperature rise of the horizontal and vertical busbars and main bus link including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg. C with silver plated joints and 40 deg. C with all other types of joints and busbars over an ambient of 50 deg C.

4.00.00 OPERATIONAL REQUIREMENTS

4.01.00 Automatic Reverse Closure

Automatic Reverse Closure (ARC) to the reserve supply source shall be provided for 415V unit essential service and other critical switchgears.

4.02.00 Breakers

4.02.01 Breakers shall have anti-pumping feature.

4.02.02 The incomer and bus coupler breakers for switchgear shall be electrically operated with over current releases or relays.

4.02.03 Breakers shall have inherent fault making and breaking capacities. They shall have shunt trip coils. In case releases are offered, the same shall have contact for energization of lockout relay. All breakers shall have built in interlocks for equipment and personnel safety.

4.02.04 Paralleling of two supplies shall be avoided by interlocking except for switchgear where auto-changeover is provided. Breaker contact multiplication, if required, shall be through latch relay.

4.02.05 Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control switches for other circuits.

4.02.06 Provision of mechanical closing of breaker only in 'Test' and 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. It shall be possible to close the door with breaker in test position.

4.02.07 Clear status indication for each circuit shall be provided through lamps, switch positions or other mechanical means.

4.02.08 Supervision relay shall be provided for trip coil monitoring.

4.02.09 All air circuit breakers (ACBs) and moulded case circuit breakers shall be of short circuit performance category as per IS: 13947.

4.02.10 The MCCBs shall be of current limiting type. When MCCBs are used as short circuit protection devices for motor modules they shall provide type 2 coordination with associated contactor and thermal overload relay as per IS: 8544 under all operating conditions for the all currents up to the design fault current. The MCCBs on upstream and downstream shall be coordinated. Test reports to prove the requirements of type-2 coordination shall be obtained.

4.02.11 The local start push button shall be connected to the DCS so that the drive can be started on checking the process permissive through DCS.

First contact of STOP PB shall be hardwired directly to switch gear for triping the drive. Another contact of local push button (Stop) shall be connected to DCS for alarming LPB latched condition in DCS.

4.03.00 Switches and Contactors

4.03.01 Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be of utilisation category AC-3 for ordinary and AC-4 for reversing starters. DC contactor shall be of DC-3 utilization category.

4.03.02 MCCBs shall be provided for short circuit protection. Isolating switches shall be of AC 23A category when used in motor circuit, and AC 22A category for other applications.

4.03.03 Isolating switches and MCCBs shall have door interlocks and padlocking facility.

4.03.04 Moulded case Circuit Breakers (MCCB) / Motor Protection Circuit Breakers (MPCB)

MCCBs shall be of three / four pole construction for panel mounting. The MCCBs shall be provided with front operating handles and mechanical ON / OFF indicators.

MCCB shall be provided with spring assisted quick-make, quick-break, current limiting type manually operated trip free mechanism, mechanical ON/OFF/TRIP position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm contacts. The MCCB module shall be provided with service, test and isolated position. The thermal and short circuit tripping device shall be adjustable type.

The MPCB's shall be in general similar to that of MCCB's in all the features mentioned above.

MCCBs/MPCBs shall be provided with overload thermal release setting range of 50% to 100% of rated current and adjustable short circuit magnetic release of 5 to 10 times rated current.

MCCBs/MPCBs shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stress caused by the peak short circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 20 m.second. When used for motor circuit, shunt trip devices shall be provided and the let through power of controlling MCCB/MPCB shall be lower than the respective contactor, Contactor and overload relays shall be selected so as to withstand the let-through energy of the connected MCCB/MPCB in the feeder and consequent thermal and dynamic effects. All power feeder module MCCBs shall be equipped with earth fault release.

The DC circuits shall be provided with DC rated MCCB / MCBs.

MCCBs/MPCBs shall have following accessories and features:

a) Shunt trip release

b) Under voltage release

c) Auxiliary contact for ON/OFF/ trip position

d) Fault signaling contact

e) Insulation shields to isolate the connection between each pole

f) Finger protection plate to prevent accidental contact

g) The compartment door shall be interlocked with handle of MCCB/MPCB.

4.04.00 Panels

4.04.01 All switchgears, MCCs, DBs, panels, modules, local starters and push buttons shall have prominent engraved identification plates.

4.04.02 Local push button stations shall have metal enclosure of die cast aluminium or rolled sheet steel of 1.6mm thickness & shall be of Degree of Protection IP55. Push buttons shall be of latch type with mushroom knobs.

4.04.03 Operating height of the panels shall be maximum 1800 mm and minimum 300 mm from finished floor level.

4.04.04 Wherever breaker/starter module front serves as compartment cover, suitable blanking covers, one for each size of modules per switchboard shall be supplied for use when carriage is withdrawn.

4.04.05 All non-current carrying metal work of boards/panels shall be effectively bonded to earth bus of galvanized steel, extending throughout the switchboard/MCC/DB. Positive earthing shall be maintained for all positions of chassis and breaker frame.

4.04.06 Suitable trolley arrangement shall be provided for breaker/starter modules. Two trolleys per switchgear room shall be provided so that top most breaker module of all types, sizes and rating can be withdrawn on trolley and lowered for maintenance purpose.

4.04.07 The incoming connection to transformer of more than 1000 KVA and inter-connecting sections between switchboards shall be of busducts. The busduct enclosure shall be made of minimum 3mm thick aluminium alloy. The section of the busduct should have adequate strength to withstand internal and external forces resulting from the various operating conditions. Aluminium sheet hood shall be provided for outdoor busduct enclosure joints to provide additional protection against water ingress. The busduct top shall be sloped to prevent retention of water. The bus duct shall have DOP of IP55.

4.04.08 It should be possible to carryout maintenance on a feeder with adjacent feeders alive.

4.05.00 Control, Protection & Metering Requirements

4.05.01 Control circuits shall operate at suitable voltage of 110V AC. Necessary control supply transformers of 415/110 volts shall be provided for each module of MCC, with its connection after MCCB. However the breakers shall operate on 220V DC.

4.05.02 Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and downstream breakers//MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per relevant IEC.

4.05.03 All relays shall be numerical and timers shall operate on available DC supply and not have any inbuilt batteries. They shall be provided with hand-reset operation indicator (flags) or LEDs with pushbuttons for resetting.

The relays shall have provision of both current and voltage inputs. The current operated relay shall have provision for 5 sets of CT inputs, 3 nos. for phase fault and 1 CT input for earth fault & 1 CT input for CBCT. Relay shall be suitable for both residually connected CT input as well as CBCT input. Relays shall be suitable for CT secondary current of 1 A / 5 A selectable at site. The voltage-operated relay shall have provision for 3 PT inputs. Relays shall be rated for operation on 110 V, VT secondary voltage. Relays used in Incomers and bus couplers shall have provision of two sets of voltage signal inputs for the purpose of synchronization.

All CT and PT terminals shall be provided as fixed type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. In no circumstances Plug In type connectors shall be used for CT/ PT connections.

All numerical relays shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote. Relays shall have suitable output contact for breaker failure protection.

Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures.

The numerical relay shall be able to provide supervisory functions such as, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis

The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.

Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.

Numerical relays shall be capable of storing Minimum of 150 time tagged events/ records with time stamping. The numerical relays shall be able to store last 5 faults including the indication, waveforms, protection operated, fault location relay and operating time, currents, voltage and time. All Setting parameters, Fault data, waveforms & event logs shall be stored in Non-volatile memory only.

Sequence of events shall have 1 ms resolution at device level.

Measurement accuracy shall be 1 % for RMS Current and voltage.

Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature. All IOs shall have optical isolation. Analog inputs shall be protected against switching surges, harmonics etc.

The alarm/status of each individual protection function and trip operation shall be communicated to DCS/Respective control system. The numerical relay system shall have built-in features/hardware interface to provide such inputs to Respective control system for analog/digital values.

Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC/ ANSI programmable characteristics.

Numerical relays shall have two level pass word protections, one for read only and other for authorization for modifying the setting etc.

Timer functions shall be programmable for on/off delays.

The protective relays shall have at least 10 nos. potential free contacts (Programmable) Auxiliary relays shall have contacts as required. Relay output contacts shall be suitable for directly wiring in the breaker closing and trip circuit operating from 220 V DC control voltage.

Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Interrogation voltage for the binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages.

No separate earth bus shall be required for the relays. It shall be possible to connect the relay earth to the common earth bus in the switchgear panel which shall be connected to the plant earth mat.

All protective relays shall be latest numerical type, having following features/functions:

- Protection functions as required
- IEC IDMT characteristics
- Measurements
- Event/fault/disturbance recording
- Binary input/output relays as required
- LEDs to indicate status of the relay
- LCD display for measurements, settings, faults etc.
- Key pad on the front of the relay
- Communication ports for transmitting settings, measurements, alarms, faults, events, disturbance records to DCS/Respective control system/SAS (Substation Automation System)
- Communication port for software setting/access measurements/maintenance/fault analysis
- Self-monitoring

All protective relays shall be latest numerical type with one USB port at the front for connecting to Laptop and one port (RJ45/FO port) at rear suitable for communication on IEC 61850 protocols.

The Numerical relays shall be networked through Ethernet switch, Gateway/Data Concentrators and shall be further integrated with SCADA based electrical monitoring system (for monitoring, measuring, fault data analysis & relay parameterization).

All necessary hardware including Managed Ethernet switches, accessories and licensed software shall be supplied by the vendor.

Ethernet switches shall be 'substation hardened' and shall comply with IEC61850-3 for communications and environment requirements. The Ethernet switches shall be of managed type with two (2) no. of fibre optic cable ports for ring network and Fourteen/Sixteen of Copper ports to achieve the LAN configuration. These switches shall be mounted inside the switchgear Panel.
The switchgear shall be provided with DC fail relay and DC fail indication lamp.
Breaker auxiliary contacts used for interlocking purposes shall be multiplied using electrically latched relay.

4.05.04 All equipments shall have necessary protections. However, following minimum protections shall be provided:

1) MCCB controlled motor feeders (all motors up to 90 kW)
   a) Instantaneous short circuit protection on all phases through MCCBs rated for 80 kA rms (prospective breaking capacity at 415V).
   b) Thermal overload relay in all the three phases with inbuilt protection against single phasing.
   c) Instantaneous over current protection on all outgoing feeders.

2) ACB controlled motors feeders (motors rated above 90 kW) (protection relays shall be of numerical type)
   a) Instantaneous short circuit protection on all phases
   b) Overload protection on two phases
   c) Over load alarm on third phase
   d) Earth fault protection (sensitive earth fault detectors shall be provided in DC system to annunciator earth fault)
   e) Under voltage protection
   f) hand reset lockout relay

3) Incomers/bus coupler/outgoing breaker feeders other than motor feeders.
   a) Definite time delay short circuit protection
   b) Hand reset lockout relay

4) Incomer From DG Set.

a) Differential Protection (87) - Three Pole

b) Reverse Power Protection.

c) Overload Alarm on one phase

d) Earth Fault Detection Relay (64) definite time delayed earth fault protection connected to transformer LV neutral CT (for Transformer Incomer feeder).

e) Voltage controlled over current relay

f) Generator under/over voltage Protection

g) Hand Reset Lockout Relay

h) 3-phase Digital Multifunction meter.

4.06.00 Meters / instruments

Plant electrical parameters shall be metered to the extent required for proper operation and monitoring of plant conditions. Current, voltage and watt-hours measured on each incomer and for each bus. Currents measured on each feeder. Voltage measured on each bus

All meters/ instrument shall be flush mounted on front panel, at least 96 sq.mm. size with 240 degree scales and accuracy class of 1.0. It shall have cramped scale above 2 times to 8 times the rated current for indicating the starting current.

4.06.01 All motors of 15 kW and above shall have an Ammeter. Bus-section shall have bus VT, voltmeter with selector switch, and other relay and timers required for protection. Ammeters shall also be provided for all critical drives such as AOP, jack oil pump, seal oil pumps etc., irrespective of ratings and can be decided during detailed engineering. Adequate control and selector switches, push buttons and indicating lamps shall be provided. Thermostatically controlled space heaters with switches shall be provided to prevent condensation.

4.06.02 Breaker controlled panel shall also be of remote controlled with following features:

Each feeder shall have local/remote selector switch. Closing from local shall be possible only in test position whereas closing from remote shall be possible in either service or test position. Tripping from local shall be possible only when local/remote selector switch is in local position. Tripping from remote shall be either breaker in service position or selector switch being in remote position.

4.06.03 Meters and Transducers for 415 Volts MCCs

For incomers feeders following Meters and transducers shall be provided:

- Current transducer on 'Y' phase
- Voltage transducer on 'Y-B' phase
- 1.0 class digital multi-function Meter.

For Bus Coupler following Meters and transducers shall be provided:

- Current transducer on 'Y' phase
- 1.0 class digital multi-function Meter.

For Bus PT following Meters and transducers shall be provided:

- Digital Voltmeter measuring all three phases
- Voltage transducer on three phases

For contactor motor feeders 15 kW & above following Meters and transducers shall be provided:

- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase
- Electronic overload relay with current display in switchgear.

For contactor motor feeders less than 15 kW following Meters and transducers shall be provided:

- Electronic overload relay with current display in switchgear.

Meters and Transducers for 415 Volts DBs

For incomers feeders following Meters shall be provided:

- Digital voltmeter measuring all three phases
- Digital ammeter measuring all three phases

For Bus PT following Meters shall be provided:

- Digital Voltmeter measuring all three phases

Energy accounting and audit meters shall meet CEA regulation. For details refer cl.7.00.00, chapter 1.

Transducers shall be of dual output type, class 0.5, 4-20 mA DC linear output & 750 ohm load.

Transducers shall be provided in all the buses so that algebraic summation in electrical system shall be Zero.

4.07.00 Control from Remote

Closing/ opening of the incomer and bus coupler breakers and starting/ Stopping of all motors/ outgoing feeders shall be from DCS/EDMS based control system through interposing relays only. The status (ON/OFF/TRIP), voltage and current of incomers & bus couplers shall be indicated in DCS/PLC. The required transducers shall be provided.

Necessary hardware shall be provided in the switchgear panel like coupling relays (24V DC, with max. burden of 2.5VA), auxiliary relays, current/voltage transducers (4-20 mA, dual output) etc. to effect interlocks, exchange information / status and exercise control from remote.

4.08.00 Normal/ Emergency (N/E) Switchgear

4.08.01 During auto changeover of the supply, the contactors in the affected bus would have dropped off. The services, which shall be restarted immediately and automatically without time lapse to keep unit running, are considered essential service. (For e.g. seal oil pumps, lube oil pumps, auxiliary cooling water pumps etc.). Such auxiliaries shall restart automatically after an auto changeover. These modules shall have additional hardware like timer, auxiliary contactors & associative circuitry in the module. Such essential services shall be identified during the detailed engineering stage & suitable module/Scheme shall be provided.

The modules of some of the critical application motors like baring gear motor, air heater motor, lube oil pump, jacking oil pump etc irrespective of their KW rating shall be provided with a CT, ammeter & a current transducer with remote metering in DCS.

Normal / emergency switchgear (N/E) shall be normally fed by 415V unit service switchgear & incomer from DG set will remain open. A bus coupler shall be provided in the N/E bus so that either DG set can feed the emergency loads.

The N/E switchgear shall be located adjacent to CCR.

5.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

5.01.00 All 415V switchgear motor control centers (MCCs), ACDB, etc shall have following features:

1) Shall be of metal enclosed, fully draw out, indoor, floor mounted and free standing type.
2) Incomer modules and bus coupler modules of all the switchgear shall be fully draw out air circuit breaker type, controlled from local/ DCS/EDMS.

3) All frames and load bearing members shall be fabricated using mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2 mm.

4) Frame shall be enclosed in cold rolled sheet steel of thickness not less than 1.6mm.Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Removable gland plates of thickness 3mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material) shall be provided for all panels.

5) All switchboards/panels shall be of dust and vermin proof. All cutouts shall have synthetic rubber gaskets.

6) For motors above 90 kW, remote controlled electrical circuit breakers (ACB), and for smaller motors and all other feeders, MCCBs shall be provided.

7) All switchboards, MCCs and DBs shall have following distinct vertical sections.

   a) Completely enclosed bus bar compartment for horizontal and vertical bus bars.
   b) Completely enclosed switchgear compartments (one for each circuit housing circuit breakers, motor starter or MCCB feeders).
   c) Compartment for cable alley or cable box for power and control cables. In case of cable box, they shall be segregated with complete shrouding for individual feeders at the rear for direct termination of cables.
   d) For cable connection to circuit breaker, a separately enclosed cable compartment shall also be acceptable.
   e) Compartment for relays and other control devices associated with a circuit breaker, wherever necessary.
   f) All 415 V switchgears, MCC's, AC & DC distribution boards etc. shall be painted by powder coating process. Paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards.

8) Busbars shall be of high conductivity aluminium alloy suitable for required current ratings with maximum temperature rise of 40°C over design ambient

temperature for plain joints and 55°C for silver plated joints. The Busbars shall be provided with Double decker Lyra type contacts for better connection.

9) Minimum air clearance in air between phases and phase-earth shall be 25 mm for busbars and cable terminations. For all other components, the Clearances shall be at least 10mm. Wherever above is not possible except for horizontal and vertical busbars, insulation shall be provided by anti tracking sleeving or barriers. However for horizontal and vertical busbars, clearances specified above shall be maintained even when busbars are insulated/ sleeved.

10) Busbar insulators shall be of track-resistant high strength non-hydro- scopic, non-combustible type and suitable to withstand stresses due to over-voltages and short circuit current. Insulators and barrier of inflammable material such as Hylam shall not be accepted.

11) All numerical relays and timer shall be subject to Owner's approval. They shall be flush mounted with connections from inside, and shall have transparent & dust tight cover, removable from front, draw out construction for easy replacement and testing facility. The auxiliary relays and timer may be provided in fixed cases.

12) Maxi terminal /cage clamp type terminal blocks shall be provided for signals to be interfaced with DDCMIS. The details of interfacing with DCS/EDMS shall be referred in Annexure B, Volume V (C&I).

13) The switchgears/MCC shall be designed to offer adequate level of safety to operating/ maintenance personnel. Means shall be provided to prevent access to the live part to avoid accidents during service as well as maintenance period. Contractor shall bring out the safety means provided to achieve above. A detailed instruction plate suitable for wall mounting shall be provided for each switchgear/MCC room describing various safe operating procedure/safety precautions for safe operation and maintenance of switchgear/MCC.

14) All current and voltage transformers as required for metering & protection specified shall be completely encapsulated cast resin insulated type. Incomers from transformers shall have CTs for transformer REF protection. All current and voltage transformers as required for metering and protection specified shall

be completely encapsulated cast resin insulated type. Incomers from transformers shall have CTs for transformer restricted earth fault protection.

The accuracy shall be as follows:

	CTs	PTs
Protection	5P20	3P
Metering	1.0	1.0
REF	PS	

15) Indicating lamps shall be cluster LED type.

16) 20% spare feeders of each type used in the MCC with a minimum one (1) number on each bus section shall be provided.

5.02.00 **DC Distribution Board (DCDB)**

For feeding the DC loads, following DC switchboards shall be provided.

a) 220VDC Main plant and Station Switch Board (one for each unit)

b) 220VDC Coal Handling Plant Switch Board

c) 220V DC 400 kV Switchyard Switch Board

d) 220VDC Ash Handling Plant Switch Board

e) 220VDC Raw water plant and RO Plant Switch Board

f) 220VDC ECHS Switch Board

The switch board shall be provided with suitably rated incomers & bus couplers, required quantity and type of outgoing feeders for the auxiliaries, control supply to various panels / systems in accordance with the number of 220 VDC supplies enumerated in the respective equipment specification. For Each load and auxiliaries separate feeders shall be provided. In addition, the following feeders shall be provided in each switchboard.

(a) Minimum of two nos. feeders of each type and rating as spare and the same is the minimum quantity at the time of handing over the plant. Any additional quantity required for increase/adjustment during detailed

engineering stage shall also be duly considered.

(b) 1 No. switchboard for 230V single phase space heating modules.

(c) 1 No. alarm module for common alarm of outgoing feeder fault.

05.02.01 Current Rating

The short circuit current rating of the switchboard shall be arrived considering the contribution from charger and battery with 5% margin, with minimum 25 kA

The continuous current rating of the bus bars, incomers, ties for 220V DC switchboards shall be the maximum DC load (excluding the momentary load) on the bus due to any operating condition, when unit system additionally feeds station system or vice-versa plus 20% margin rounded off to the next higher standard rating.

5.02.02 Specific Requirements

The constructional features of all DC switchboards shall comply with the requirements of 415V AC switchgear as applicable. DCDB shall be sectionalized and loads are to be distributed for easy maintenance and isolation during earth leakages.

Positive and negative bus bars in the DC switchgear shall be completely segregated from each other by sheet steel partitions.

5.02.03 Module details

(a) Incomer

The incomer modules shall be breaker controlled. Each incomer shall be provided with:

- Ammeter & voltmeter
- Earth fault relay with contact for remote indication (only for 220V DC switchboards)
- Under voltage relay with timer
- Indicating lamps for ON, OFF, earth fault, under voltage conditions
- One no. each of current and voltage transducers for remote indication
- Necessary hardware and circuitry for fault alarm, lamp test and reset.

(b) Outgoing feeders and tie Feeders/bus coupler

These feeders shall be provided with suitably rated DC MCBs with feeder on and fault indicating lamps.

The feeders rated 200 Amps and above shall be provided with a shunt and ammeter.

(c) Motor modules

(i) The motor starters shall be housed within DC switch boards. Separate DC starter panels are to be provided near the Motors. The starting current of the motor shall be limited to 200 % of full load current.

(ii) The motor modules shall be provided with:

- Switch, fuses, air break contactors
- Thermal overload relays
- Starting resistors with associated timers
- ON, OFF, FAULT indicating lamps.
- Necessary auxiliary contactors for fault alarm circuit
- 230V space heating circuit
- ON, OFF PBs for testing purposes
- One shunt with ammeter and one shunt for remote indication (if required)
- Appropriate circuitry for receiving the ON, OFF commands from remote panels/systems, interlocks, etc.
- MCB for space heating circuit

(d) Space Heating Module

230V, 1 space heating module shall be provided with incoming side switch fuse, suitably rated 415/230V cast resin type transformer (expected heating loads of the switchgear and the connected motors + 30% margin), secondary fuse, supply indicating lamp and connection to space heating buses. The 415V power supply for these modules shall be obtained from the unit service switchgear.

5.02.04 Technical Requirements Table

(a) DCDB Details

(i) Ref ambient temperature : 50 deg C

(ii) Degree of protection for enclosure IP54 enclosure

(iii) Type of construction Indoor, single/ double front, non draw out type

(b) Alarm module

(i) Alarm module for outgoing feeder faults shall be provided with switch fuse, alarm accept, reset PBs, 'supply ON' lamp, 'fault detected' lamp, hooter, necessary auxiliary contactors, control circuit for detecting, annunciating, accepting, resetting the fault in any module of the particular bus section. Contacts from this module for common feeder fault and its own module supply failure shall be provided and used for annunciation in control desk.

(ii) Alarm module for incomers/bus coupler faults shall be similar to the above except that it shall work on 230V AC supply.

5.02.05 Control room alarms/indications/SER points

(a) Following indications /alarms shall be available in the control room OWSs.

- Incomer, bus coupler, ties – ON & OFF
- Incomer current
- Alarm module supply failed
- Outgoing feeder fault
- Incomer alarm supply fail
- Bus under voltage
- Bus earth fault
- Bus voltage

(b) For the annunciation in control desk, alarms of a particular bus shall be grouped as one window. The requirement of contacts to SER shall be duly considered and provided.

5.02.06 Metering

1. All meters / shunts / transducers in DC system shall be class 1.00 only
2. Ammeters shall be provided on all incomer to DCDB with remote indication at UCR / DCS
3. Center Zero Voltmeters with Earth fault detection relay shall be provided in Bus PT of DCDB with remote indication at UCR / DCS.
4. Center zero ammeters shall be provided on bus coupler and ties
5. Charger DC output ammeter and voltmeter shall be provided with remote indication at UCR /DCS.

6.00.00 INSTALLATION

6.01.00 This shall be applicable to all LV switchgear panels, MCCs and other power & lighting distribution boards, DCDB, etc.

6.02.00 Manufacturer's instructions, drawings and instructions of the Site Engineer shall be strictly followed during handling, erection, testing and commissioning of the switchgear. The switchgear shall be handled with care, avoiding impact to the equipment by using experienced riggers under the guidance of a competent supervisor. Dragging of the panels shall be avoided and use of a crane and trailer shall be made for handling purposes while transporting to various sites. The switchboard shall be properly supported on the truck or trailer by means of ropes to avoid any chances of damage or tilting due to heavy vibration. The switchboards should be lifted by making use of lifting eyebolts only, fully tightened after ensuring that panel supports, nuts and bolts are all intact and tightened. When panels are to be lifted in packed conditions, utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall preferably be kept inside the packing cases till foundations are ready.

6.03.00 Base channels shall be grouted, leveled, in cement concrete pad for 415 V switchgear panels and other cubicle panels. Pedestal type panels and MCCs shall be erected by grouting base channels by bolts. A proper bonding surface should be made by chipping the floor while making cement concreting. All foundations, grouted bolts shall be cured for a minimum period of 48 hours.

6.04.00 The switchboard panels should be taken out from the packed cases and moved one by one to a proper place. All the panels should be assembled aligned leveled and it

should be ensured that panel to panel coupling bolts, bus bars links fit properly without any strain on any part. It should also be checked up that lowering, lifting, racking in and out operation of the breaker and all other motions are free from any obstruction. The fixing bolts should be grouted only after satisfying all these requirements.

6.05.00 LV switchgear panels can be tack welded at suitable intervals for each shipping section.

6.06.00 After completion of the panel erection, all the cubicles should be cleaned and checked for tightness of all the components. All loosely supplied items shall be fitted up. All the wiring connections should also be checked with drawings and tightened. Metering and protection C.Ts. alarm, indications and protective relays should be fitted up. Phase sequence & polarity of PTs and CTs should be checked. Contact resistance of all busbar joints should be checked up. Every part or insulator should be checked for any possible damage. All the starters, switches, contacts should be cleaned using carbon tetrachloride. Silver tipped contacts should be checked for easy and free movement. Hinges of panel doors should be lightly lubricated to give free and noiseless movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

6.07.00 Individual feeder functional scheme verification should be carried out and minor wiring modifications in the panel wirings, as per requirement at site, should be done as per the directions of TANGEDCO Site Engineer.

6.08.00 In case the switchgear is wet or having a low IR value due to bad wiring, insulators, bushings or any other insulated parts, the entire switchgear should be dried-up according to the instructions of the Site Engineer and the IR value should improve to a safe level for commissioning the same. Care should be taken to protect the surrounding insulation from direct local heating during the drying up process.

6.09.00 All the control wiring, PTs, bushings, busbars, other live parts of switchgear, and incoming and outgoing cables should be meggered with 500/1000V megger.

6.10.00 Electrical simulation tests should be carried out for all the protective, alarm and annunciation relays along with the manual operation of the circuit breaker.

6.11.00 Panels must be cleaned with vacuum cleaner.

6.12.00 All switchgear rooms shall be located on same floor (as far as possible) and shall have epoxy flooring.

6.13.00 Provision of store room shall be given in all switchgear rooms.

7.00.00 LIST OF TESTS TO BE CONDUCTED

7.01.00 ROUTINE TESTS

The switchgear panel shall be subjected to routine tests in accordance with the relevant IS/IEC standards. The tests shall include the following:

- Power frequency voltage dry test on the main circuit
- Voltage test on control and auxiliary circuits
- Measurement of resistance of the main circuit
- Mechanical operating tests

The circuit breakers, contactors, switches, local push buttons, local motor starters, VTs, CTs and control transformers shall be subjected to routine tests in accordance with the relevant IS/IEC standards. Routine test reports shall be furnished by the Vendor for Owner's review.

For circuit breaker, the list of routine tests shall include the following:

- Dielectric tests on the main circuit
- Dielectric tests on the control circuit & auxiliary circuit
- Measurement of the resistance of the main circuit
- Mechanical operating tests
- Design and visual checks

7.02.00 TYPE TESTS

The following type test certificates on each type & rating of L.V. switchgear, MCC panel and distribution boards shall be submitted.

(a.) Short time withstand test with circuit breaker mounted inside the switchgear panel.
(b.) Temperature rise test.
(c.) Type II - Short circuit co-ordination test for any three ratings of MCC module as selected by the Purchaser.
(d.) Test sequence –1 & combined test sequence shall be carried out on each rating of circuit breaker mounted inside the panel.

(e.) Degree of protection tests

7.03.00 Site Tests

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

a) General

- Check name plate details according to specification
- Check for physical damage
- Check tightness of all bolts, clamps and connecting terminals
- Check earth connections
- Check cleanliness of insulators and bushings
- Check heaters are provided
- HV test on complete switchgear with CT and breaker/ contactor in position
- Check all moving parts are properly lubricated
- Check for alignment of busbar with the insulators to ensure alignment and fitness of insulators
- Check for interchange ability of breakers/ contactors
- Check continuity and IR value of space heater
- Check earth continuity for the complete switchgear board

b) Circuit Breaker/ Contactors

- Check alignment of trucks for free movement
- Check correct operation of shutters
- Check slow closing operation (if provided)
- Check control wiring for correctness of connections, continuity and IR values
- Manual operation of breakers completely assembled
- Power closing/ opening operation, manually and electrically at extreme condition of control supply voltage
- Closing and tripping time
- Trip free and anti-pumping operation
- IR values, resistance and minimum pick up voltage of coils
- Simultaneous closing of all the three phases
- Check electrical and mechanical interlocks provided

- Checks on spring charging motor, correct operation of limit switches and time of charging
- Check SF6 pressure/ vacuum (as applicable)
- All functional checks

c) Current Transformers

- Insulation resistance between windings and winding terminals to body
- Polarity tests
- Ratio identification checking of all ratios on all cores by primary
- injection of current
- Magnetisation characteristics and secondary winding resistance
- Spare CT cores, if any to be shorted and earthed

d) Voltage Transformers

- Insulation resistance test
- Ratio test on all cores
- Polarity test
- Line connections as per connection diagram

e) Cubicle Wiring

- Check all switch developments
- It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked
- Insulation resistance of all wires with respect to earth
- Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component/ equipment
- Check terminations and connections
- Wire ducting
- Gap sealing and cable bunching

f) Relays

- Check internal wiring
- Insulation resistance between all terminals and body
- Insulation resistance between AC and DC terminals
- Check operating characteristics by secondary injection
- Check minimum pick up voltage of DC coils
- Check operation of electrical/ mechanical targets
- Check CT connections with particular reference to their polarities for differential type relays
- Relay settings

g) Meters

- Insulation resistance of all insulated portions
- Check CT and VT connections with particular reference to their polarities for power type meter

TECHNICAL DATA SHEET OF CENTRIFUGAL FAN FOR GIS HALL

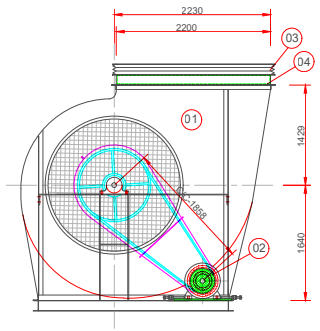
Sr. No.	ITEM	UNIT	PARTICULARS
1	Manufacturer		
2	Model No.		
3	Selected Capacity	CMH	240000
4	Quantity	Nos.	2
5	Static pressure	mmWG	50
6	Outlet Velocity	m/s	11.86
7	Location		Ventilation fan room of 400kV GIS
8	Type of fan		Centrifugal (DIDW)
9	Type of Impeller		Backward Curved
10	Impeller Dia	mm	1854
11	Rated Speed	RPM	399
12	Critical Speed	RPM	499
13	Fan GD2 Value	Kg m2	37.61
14	Density of Air Temperature	Kg/m3	1.2
15	Fan Static efficiency at 20 deg c	%	75
16	Fan Total efficiency at 20 deg c	%	65
17	Fan BKW at 20 deg C	Kw	52
18	Fan BKW at 50 deg C	kW	47.23
19	Outlet air Velocity for Fan	m/sec	11.86
20	Outlet air Velocity with evase	m/sec	10
Material of Construction			
21	Casing Side Plate	MOC	3 mm Thickness CRC (IS:513) Sheet with Spray galvanized
22	Casing Scroll Plate	MOC	3 mm Thickness CRC (IS:513) Sheet with Spray galvanized

TECHNICAL DATA SHEET OF CENTRIFUGAL FAN FOR GIS HALL

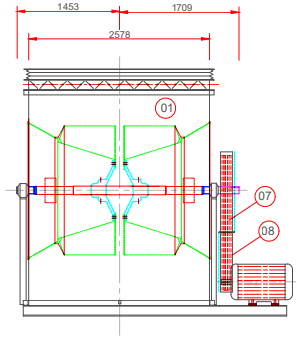
Sr. No.	ITEM	UNIT	PARTICULARS
23	Impeller Hub Disc	MOC	5 mm Thickness (IS:2062) with Spray galvanized
24	Impeller Blade	MOC	3 mm Thickness CRC (IS:513) Sheet with Spray galvanized
25	Impeller Shroud	MOC	MS
26	Shaft	MOC	EN-8
27	V-pulley For fan	MOC	CI
28	V-pulley for Motor	MOC	CI
29	Base Plate	MOC	MS,IS2062
30	Inlet Bird Screen		Galvanized wire mesh of 25mm sq
31	Foundation Bolts		MS Galvanized /Epoxy Painting
32	Flexible Connection Mterial		Fire Retardant Canvass with M.S flange & Cleat 3 mm thick
33	Fan Designe Temperature	•C	20
34	Fan Operating temperature	•C	50
35	Specific Weight of air at 20 °C temperature	Kg/m³	1.2
36	Density of Air temperature	Kg/m3	1.2
37	Class of Construction		Class - I
38	Bearing Type		Roller
39	Bearing Life		≥ 20,000 hours
40	Vibration Isolator		Yes
41	Efficieny of Vibration Isolator		75
42	Fan Balancing		Statically & Dyanamically balanced As per ISO 1940 Gr.3
43	Vibration of Fan		5.0mm sec
44	Type of fan drive		Belt Drive
Motor Details			

TECHNICAL DATA SHEET OF CENTRIFUGAL FAN FOR GIS HALL

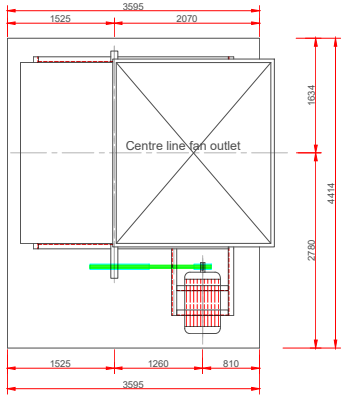
Sr. No.	ITEM	UNIT	PARTICULARS
45	Motor rating	KW/Pole	75 /4
46	Fan Efficiency at Rated Speed	%	75
47	Motor Frame Size	F/S	280
48	Motor RPM	RPM	1440
49	Type of Drive		VFD Drive
50	Method of Mounting		Horizontal foot Mounting
Other Details			
51	Inspection & Testing		As per Approved QAP
52	Performance Chart		Enclosed
53	Painting		Spray Galvanized (38 to 40 Micron) (EQ.IS 277 Class 275)
54	Testing standard		As per IS -4894 ,ISO 1940



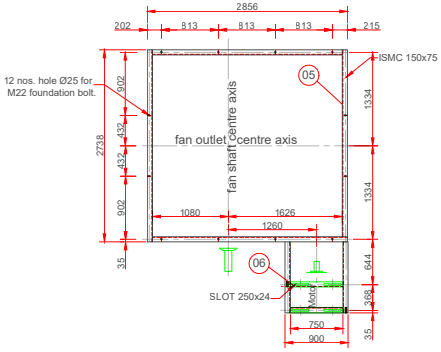
DRIVE END ELEVATION



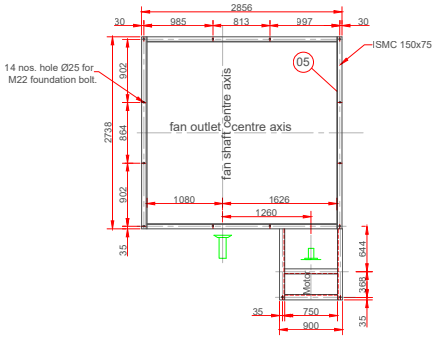
SIDE ELEVATION



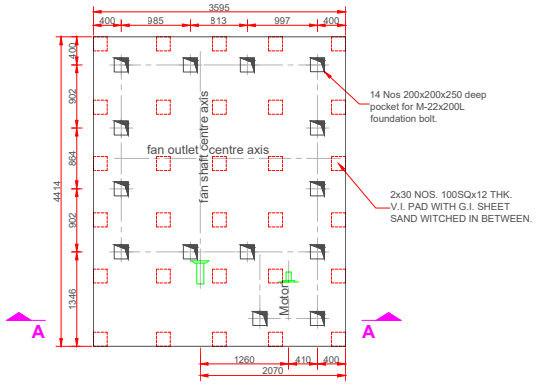
FAN & MOTOR ASSEMBLY PLAN



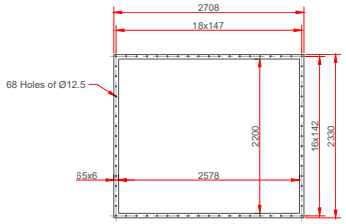
COMMON BASE FRAME
(TOP FLANGE)



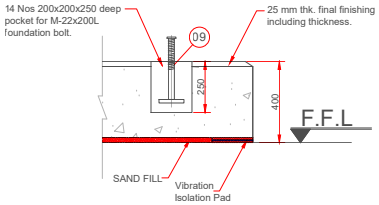
COMMON BASE FRAME
(BOTTOM FLANGE)



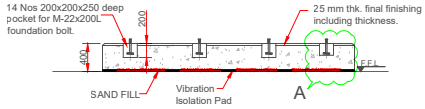
PLAN OF FLOATING FOUNDATION



FAN OUTLET FLANGE DETAIL



DETAIL-A



SECTION - A A

Note:-
1. FAN SHALL BE STATICALLY & DYNAMICALLY BALANCED AS PER ISO-1940,GR 6.3.
2. NOISE LEVEL AT 1 MTR DISTANCE :-85 DB IN FREE FIELD CONDITION WITHOUT CONSIDERING ANY BACKGROUND NOISE ,REFLECTION, REVERBERATION EFFECT.

Part No.	Description	Size	Qty.	Mat'ls/Make
10.	VI PAD	100x100x12	60	M.S /
09.	Foundation Bolt	M 22x150 L	28	M.S /
08.	Belt Guard	-	1 set	M.S /
07.	V-Belt Drive Set	-	1 set	FENNIER
06.	Motor Slide Rails	734x16 thk.	1 set	M.S /
05.	Common Base Frame	ISMC-150x75	01	M.S /
04.	Volume Control Damper	2200x2578x150	01	
03.	Outlet Flexible Connection	2200x2578x150	01	
02.	Motor 55 Kw/4 Pole	F/S-250 M	01	-
01.	Supply Air Fan Arr-Y(s) Type-A2	AdLD-185	01	M.S /

NOTES:-
1. ALL DIMENSIONS ARE IN MM.

EQUIPMENT LOAD DETAIL:-

CENTRIFUGAL FAN	: 2800 Kgs.
MOTOR 75 Kw/4 POLE	: 687 Kgs.
V-BELT DRIVE SET	: 50 Kgs.
BELT GUARD	: 30 Kgs.
BASE FRAME (ITSELF)	: 170 Kgs.
MOTOR SLIDE RAILS	: 4 Kgs.
DYNAMIC LOAD	: 1.80 times

FAN MODEL : AdLD -185 Type-A2 Arr-Y(s)
AIR FLOW CAPACITY : 2,40,000 CMH
FAN STATIC PRESSURE : 50 MMWG

V-BELT DRIVE SET DETAIL:-

MOTOR SPEED	: 1440 rpm
FAN SPEED	: 399 rpm
MOTOR PULLEY	: 250 x 3SPC
TLB FOR MOTOR PULLEY	: 3020
FAN PULLEY	: 900 x 3SPC
TLB FOR FAN PULLEY	: 5050
V- BELTS	: 5600 x 3nos.
SHAFT C/C DISTANCE	: 1858 mm
FAN SHAFT DIA.	: 100 MM.
MOTOR SHAFT DIA.	: 65 MM.

REV	DATE	DRAWN	CHECKED	APPROVED	NOTE

PROJECT
2X660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASHE DYKE OF NCTPS, CHENNAI - 400 KV GIS

OWNER
TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LTD.

CONSULTANT
DESIN PRIVATE LIMITED
New Delhi

PURCHASER
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP, NOIDA

PACKAGE
AIR CONDITIONING AND VENTILATIONS SYSTEMS FOR SWITCHYARD AREA

DRAWING TITLE
GENERAL ARRANGEMENT DRAWING OF CENTRIFUGAL FAN FOR GIS HALL

DRG.NO
TB-378-316-123-024

	NAME	DATE	SCALE	PAGE	REV
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CHECKED					
APPROVED					

Q = 2,40,000 CMH, Pst. = 50mm, 69.1 bhp, 75kw motor, 399 rpm

advance

Double Width (AdLD) Limit Load Fans

FAN SIZE **185**

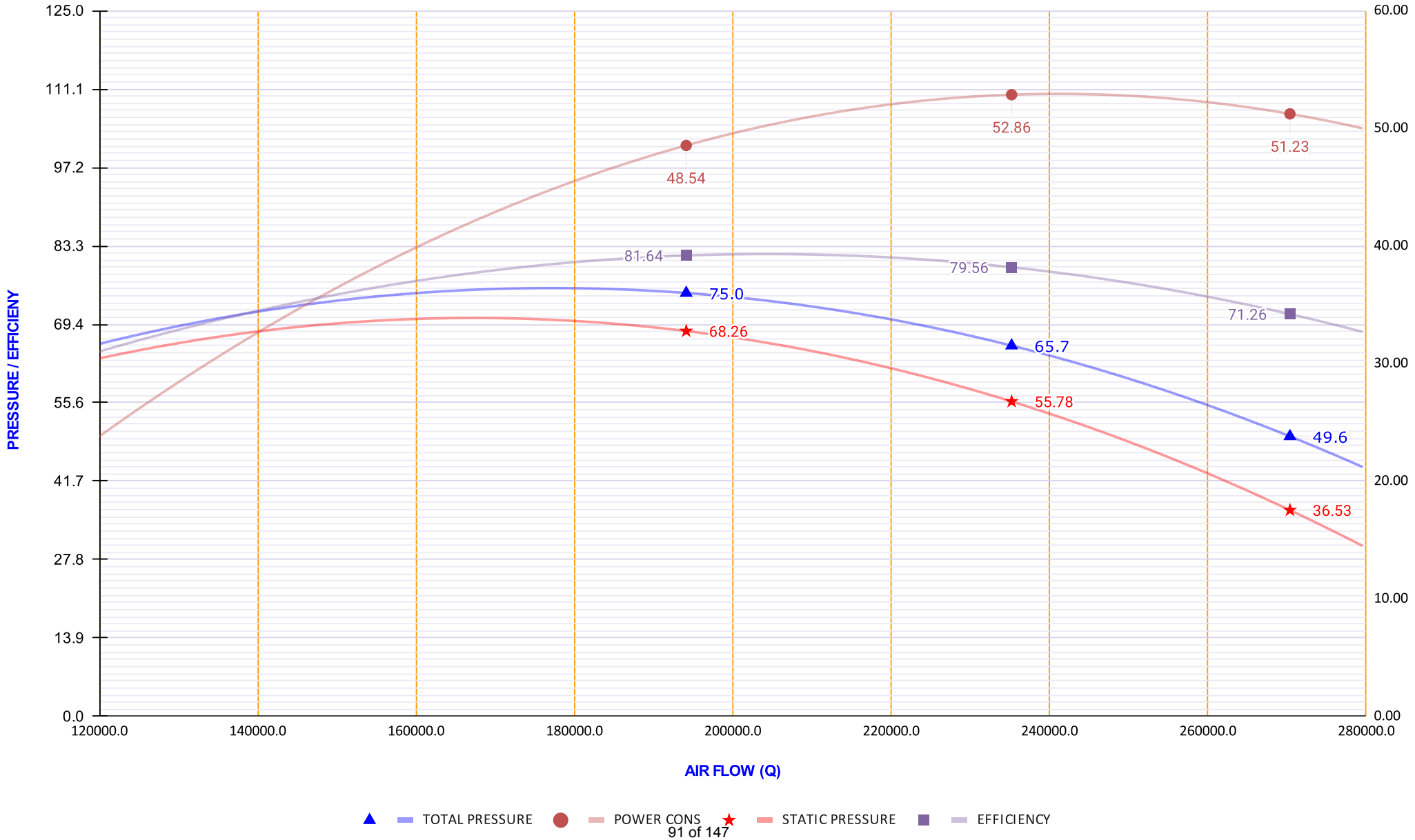
Wheel Diameter : **1854 mm** Overall Wheel Width : **1705 mm** Outlet Area : **5.11 sq mts**

OUTLET VELOCITY M./SEC.	CAPACITY M^3/HR.	STATIC PRESSURE, mmWC MILIMETERS OF WATER COLUMN																Limit Load	
		12.5 (1/2")		20 (3/4")		25 (1")		30 (1.1/4")		37.5 (1.1/2")		50 (2")		62.5 (2.1/2")		75 (3")			
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
5.08	93500	181	6.1	208	8.9	234	11.9	257	15.1	278	18.4							185	7.3
5.59	102850	188	7.0	214	9.9	238	13.0	261	16.3	281	19.8							200	9.2
6.10	112200	194	7.9	220	11.0	243	14.3	265	17.7	285	21.1							215	11.4
6.61	121550	202	8.9	227	12.2	249	15.7	270	19.2	290	23.1							230	14.0
7.12	130900	209	10.1	233	13.5	255	17.2	275	20.9	294	24.9	330	33.2	362	42.3	393	51.8	245	16.9
7.62	140250	217	11.4	240	15.0	262	18.8	281	22.7	299	26.9	334	35.5	366	44.7	396	54.3	260	20.2
8.13	149600	226	12.8	248	16.6	268	20.5	287	24.6	305	29.0	339	37.9	369	47.5	399	57.5	275	23.9
8.64	158950	234	14.4	255	18.2	275	22.3	294	26.7	311	31.2	344	40.4	374	50.3	403	60.6	290	28.0
9.15	168300	243	16.1	263	20.2	282	24.5	301	28.9	318	33.6	349	43.3	379	53.3	408	64.0	305	32.5
9.66	177650	251	18.0	271	22.3	290	26.6	308	31.3	325	36.2	356	46.2	384	56.5	412	67.4	320	37.6
10.17	187000	260	20.1	279	24.4	297	29.0	315	33.8	332	38.9	362	49.2	390	59.9	416	71.0	335	43.2
11.19	205700	279	24.9	297	29.3	314	34.3	330	39.4	346	44.8	375	55.9	403	67.5	429	79.2	350	49.1
12.20	224400	299	30.5	314	35.3	330	40.4	346	45.9	361	51.5	388	63.1	415	75.5	440	88.2	365	55.9
	240000											399	69.1					380	63.0
																		395	71.0
																		410	79.0
																		430	91.2
																		450	104.5

830264/2022/TBG-TB_ENG_SR

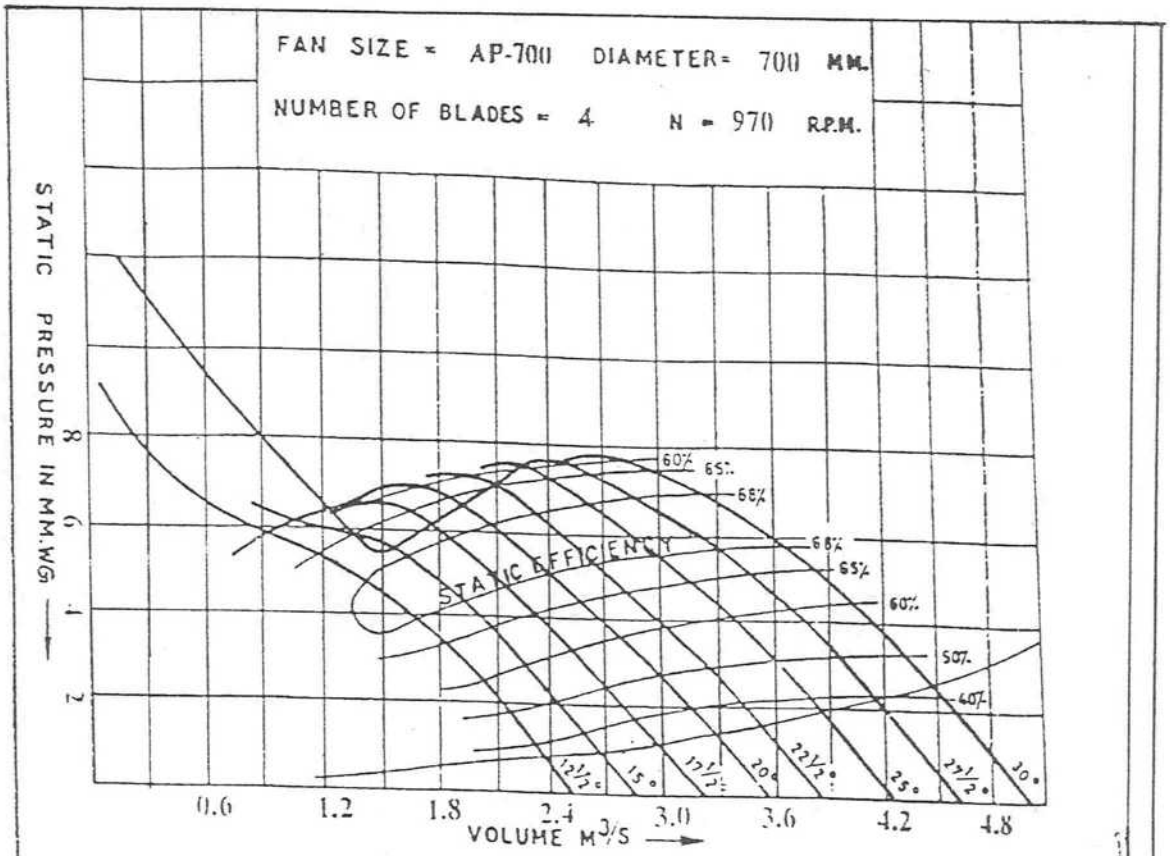
REPORT NO

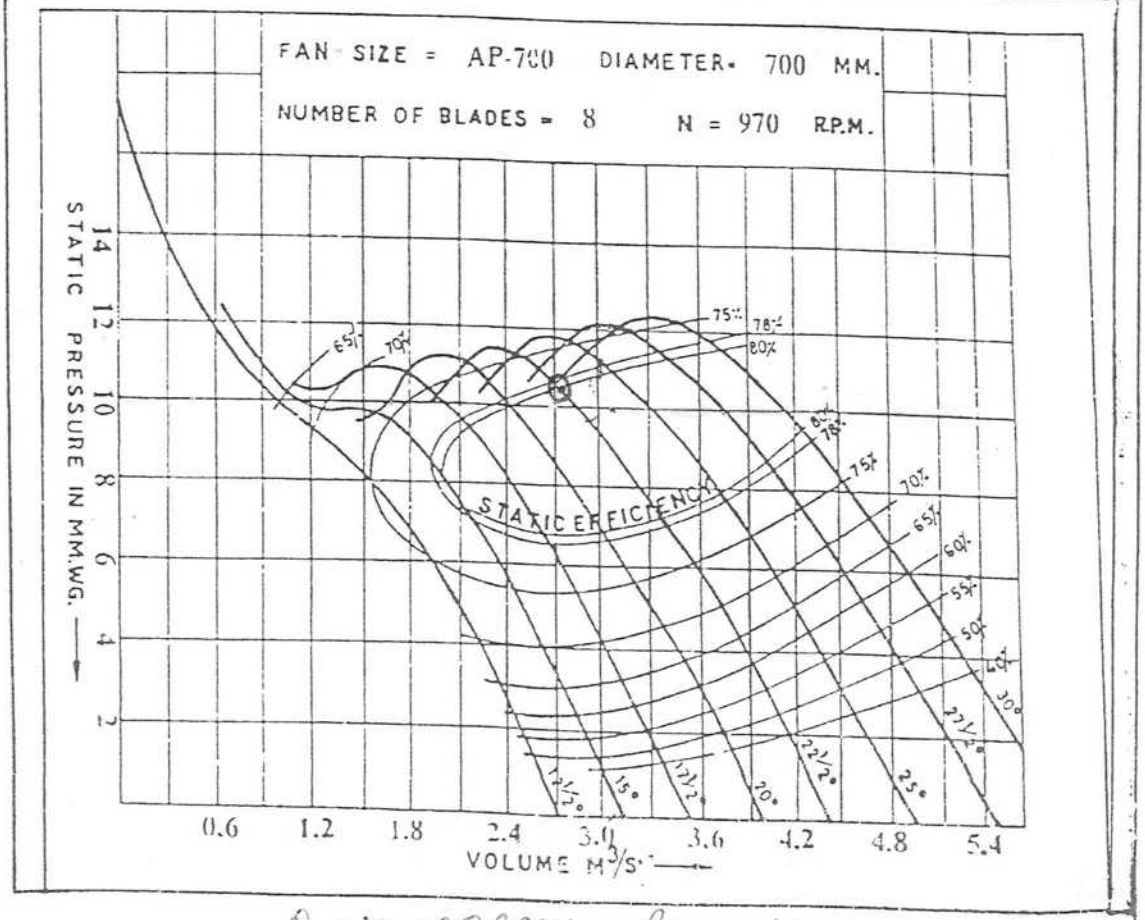
PERFORMANCE CURVES & DETERMINATION OF OPERATING POINT



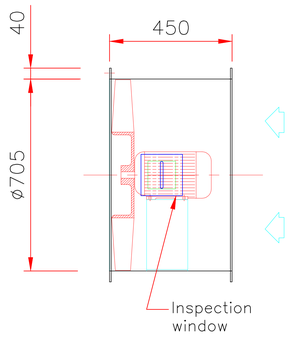
TECHNICAL DATA SHEET & GA DRAWING FOR AXIAL FLOW EXHAUST FANS			
Sr. No.	**Description**	**Unit**	Particulars
1	Manufacturer		
2	Model No.		
3	Type of Fan		**Axial Flow Exhaust Fans**
4	Capacity	CMH	10000
5	Quantity		2Nos. (Transformer room)
6	Static pressure	mmWG	10
7	Total pressure	mmWG	12.5
8	Impeller Diameter	mm	700
9	Type of blade		Fixed/variable pitch Cast Aluminium blade
10	No. of blade	Nos.	8
11	Blade angle	Degree	22.5
12	Drive Arrgt.		Impeller mounted directly on the motor shaft
13	Fan/Impeller Speed	RPM	925
14	Shaft Power	BkW	0.58
15	Fan Efficiency	%	60
16	Bearing Type		Ball Bearing
17	Selection curves enclosed (yes/No)		yes
18	Motor Data		
	a) Rating	kW/Pole	0.75/6
	b) Speed	RPM	925
	c) Type of Mounting		B3
	e) Direction of Rotation		Clockwise / Anti-clockwise
19	Material		
	a) Impeller		Cast Aluminium
	b) Casing		MS
	c) Casing thickness (mm)		3
	d) Shaft		Motor Shaft (EN-8)
20	Accessories		Rain protection cowl, birdmesh
21	Painting		As per specification
22	Noise Level	dB((A)	≤ 85 dB(A)
23	Inspection & Testing		COC basis
24	GA Drawing	Attached	

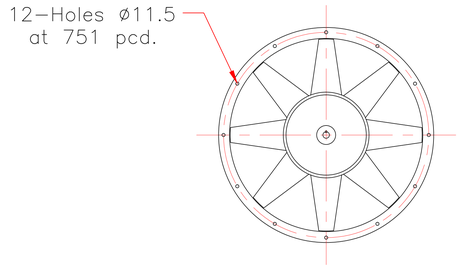
Fan characteristics curves



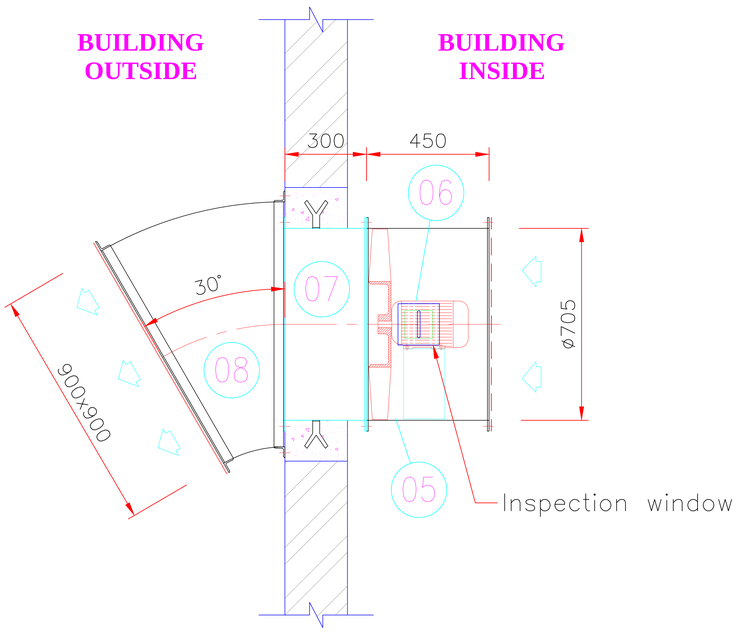


$Q = 10,000$ CMH, $P_{ST.} = 10$ mm

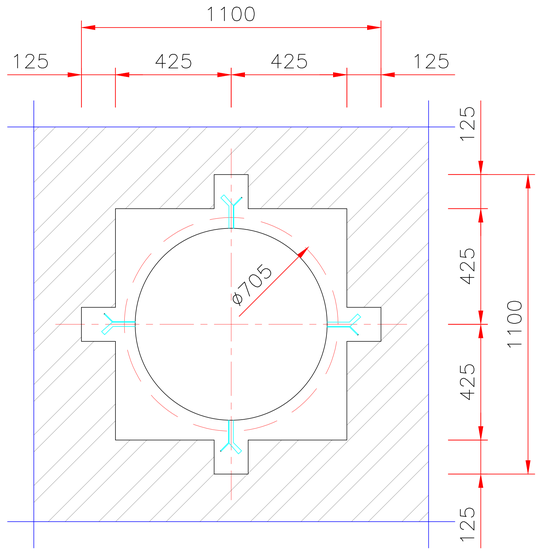




FAN SIDE VIEW



IMPELLER END VIEW



FAN ASSY. DETAIL

FAN SLEEVE GROUTING DETAIL

Air Capacity (CMH)	S.P. (mmWC)	Fan Model	Fan Speed (RPM)	Qty. (Nos.)	Motor Kw/Pole	Fan Dynamic Load (Kg.)
10,000	10	[illegible]	925	*	0.75/6	150

PART NO.	DESCRIPTION	QTY	MAT'LS / MAKE
08.	AIR DISCHARGE COWL : 900x900x30°	1	GI
07.	FAN MOUNTING SLEEVE : ø700x300 Long	1	M.S.
06.	MOTOR 0.75 KW/6 POLE	1	–
05.	TUBE AXIAL EXHAUST AIR FAN : AdTV–700/8B	1	M.S.

REV	DATE	DRAWN	CHECKED	APPROVED	NOTE

PROJECT

2X660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASHE DYKE OF NCTPS, CHENNAI - 400 KV GIS

OWNER

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LTD.

CONSULTANT

DESIN PRIVATE LIMITED
New Delhi

PURCHASER

BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP, NOIDA

PACKAGE

AIR CONDITIONING AND VENTILATIONS SYSTEMS FOR SWITCHYARD AREA

DRAWING TITLE

GA of Ventilation Fans (

DRG.NO

	NAME	DATE	SCALE	PAGE	REV
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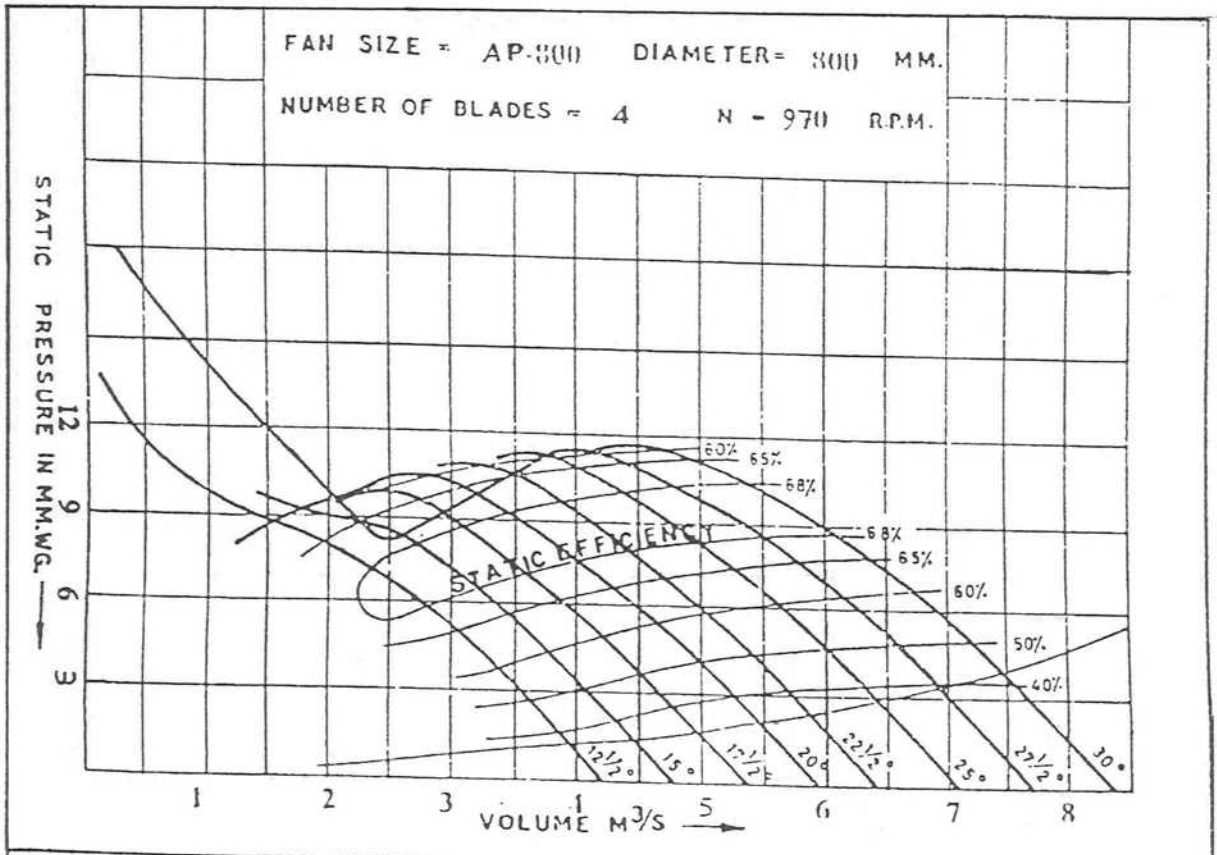
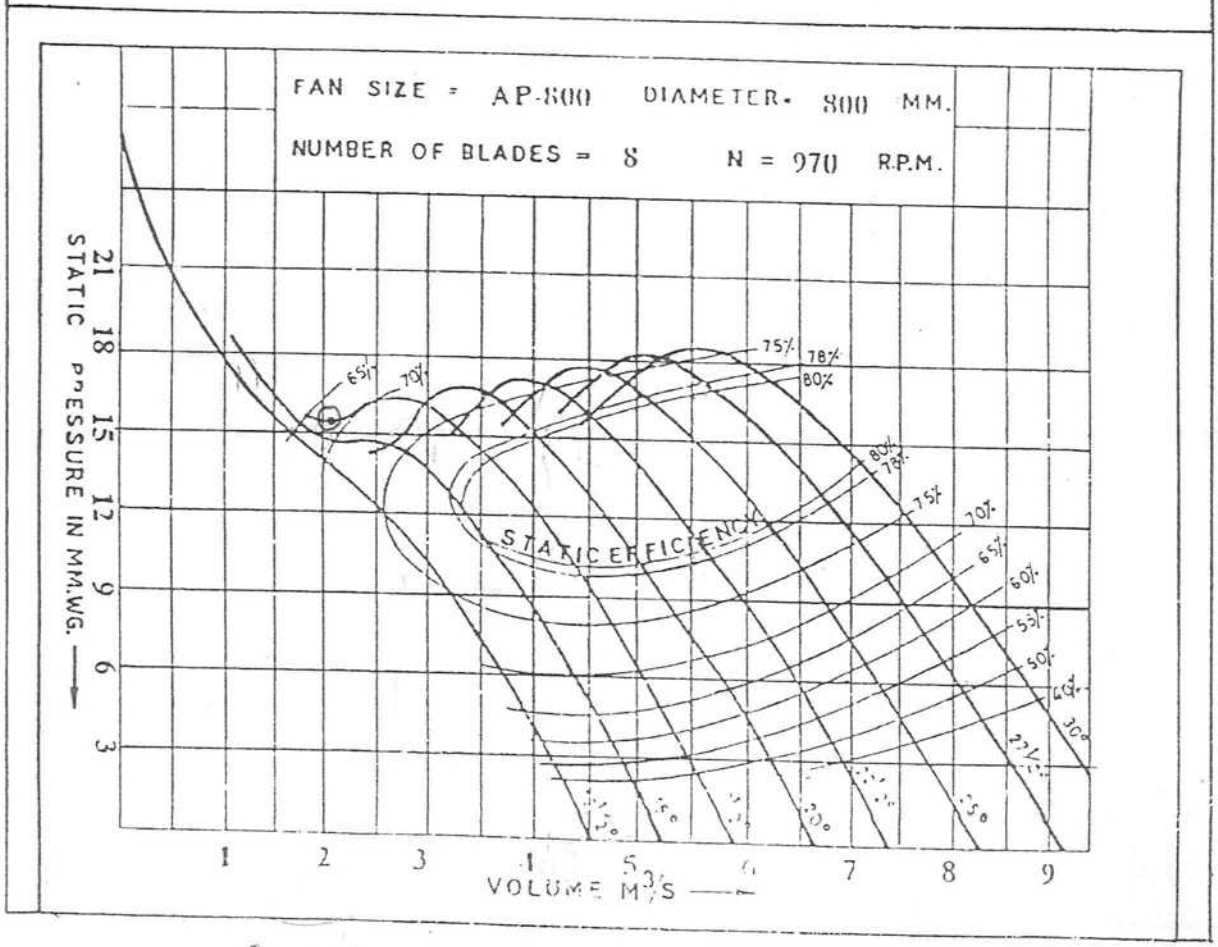
APPROVED					

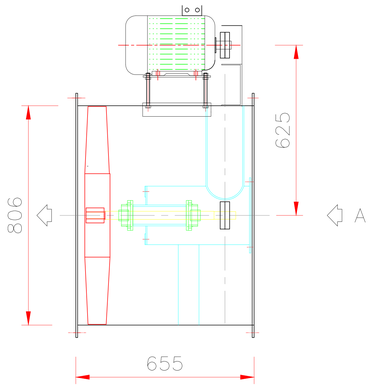
TECHNICAL DATA SHEET & GA DRAWING FOR AXIAL FLOW EXHAUST FANS FOR BATTERY ROOMS			
Sr. No.	**Description**	**Unit**	Particulars
1	Manufacturer		
2	Model No.		
3	Type of Fan		**Axial Flow Exhaust Fans for battery rooms**
4	Capacity	CMH	7500
5	Quantity		2Nos. (Battery room)
6	Static pressure	mmWG	15
7	Total pressure	mmWG	16.5
8	Impeller Diameter	mm	800
9	Type of blade		Fixed/variable pitch Cast Aluminium blade
10	No. of blade	Nos.	8
11	Blade angle	Degree	17.5
12	Drive Arrgt.		Bifurcated type
13	Fan/Impeller Speed	RPM	930
14	Shaft Power	BkW	0.60
15	Fan Efficiency	%	57
16	Bearing Type		Ball Bearing
17	Selection curves enclosed (yes/No)		yes
18	Motor Data		
	a) Rating	kW/Pole	0.75/6 (FLP)
	b) Speed	RPM	930
	c) Type of Mounting		B3
	e) Direction of Rotation		Clockwise / Anti-clockwise
19	Material		
	a) Impeller		Cast Aluminium
	b) Casing		MS
	c) Casing thickness (mm)		5
	d) Shaft		Motor Shaft (EN-8)
20	Accessories		Rain protection cowl, birdmesh
21	Painting		As per specification
22	Noise Level	dB(A)	≤ 85 dB(A)
23	Inspection & Testing		COC basis
24	GA Drawing	Attached	

Fan characteristics curves

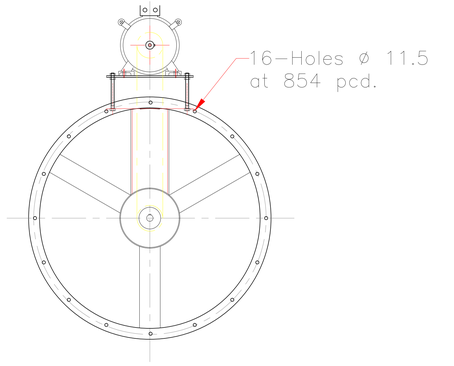




Q = 7,500 CMH, $P_{ST.}$ = 15mm

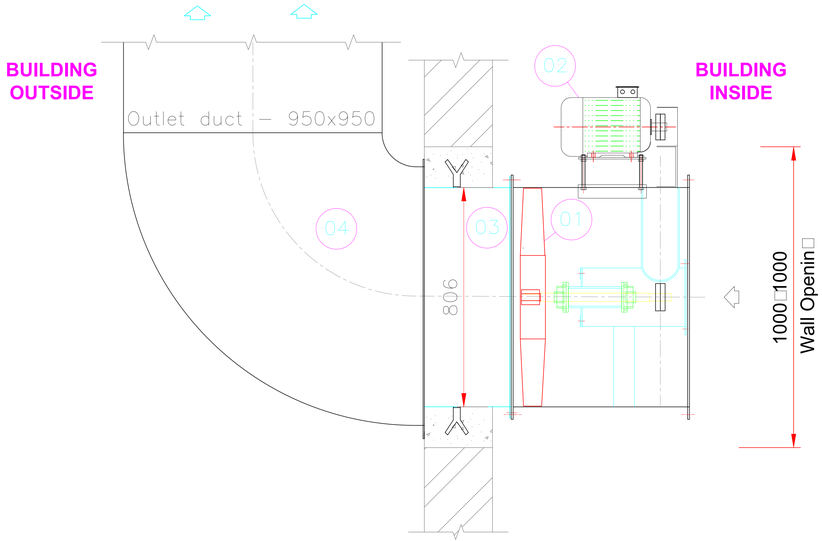


SIDE ELEVATION

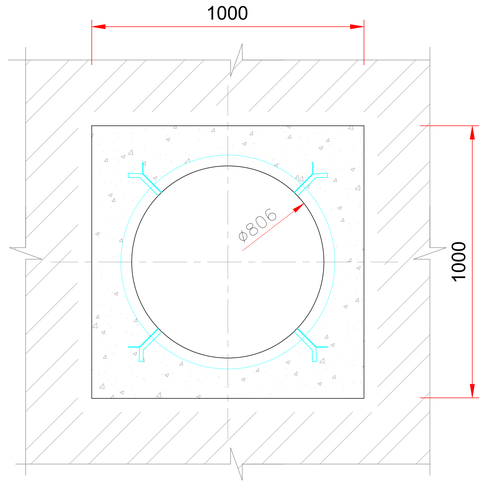


IMPELLER END VIEW

PART NO.	DESCRIPTION	SIZE	QTY.	MAT'LS/MAKE
04.	EXHAUST AIR DUCT	950x950	1	GI
03.	FAN MOUNTING SLEEVE	ø800x300L	1	MS
02.	MOTOR 0.75kW/6POLE	–	1	–
01.	EXHAUST AIR FAN	AdTV 800/8B	1	MS



FAN ASSEMBLY DETAIL



FAN GROUTING DETAILS

Air Capa□ity (CMH)	S.P. (□ □WC)	Fan Model	Fan Speed (RPM)	□ty. (Nos.)	Motor (Kw□Pole)	Fan Dyna□i□ Load (K□.)	Motor Pulley	Fan Pulley	V-Belts
7,□00	1□		□30	□	0.7□6P FLP	14□	□□ □2 SPA	□□ □2 SPA	1□00 □2 SPA

NOTES:-

1. ALL DIMENSIONS ARE IN MM.

REV	DATE	DRAWN	CHECKED	APPROVED	NOTE

PROJECT

2X660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASHE DYKE OF NCTPS, CHENNAI - 400 KV GIS

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PACKAGE

AIR CONDITIONING AND VENTILATIONS SYSTEMS FOR SWITCHYARD AREA

DRAWING TITLE

GA of Ventilation Fans

DRG.NO

	NAME	DATE	SCALE	PAGE	REV
DRAWN			1:100 A1	1 OF 1	0
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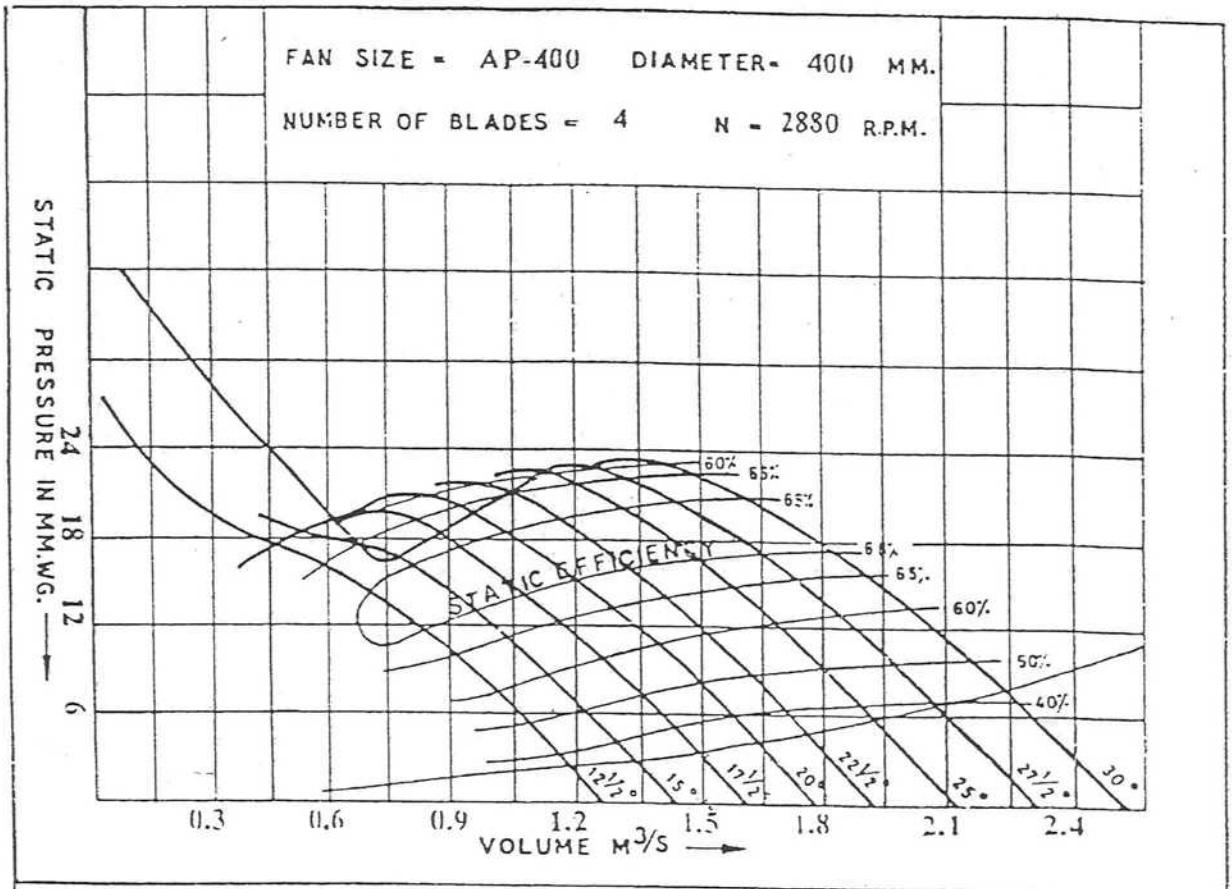
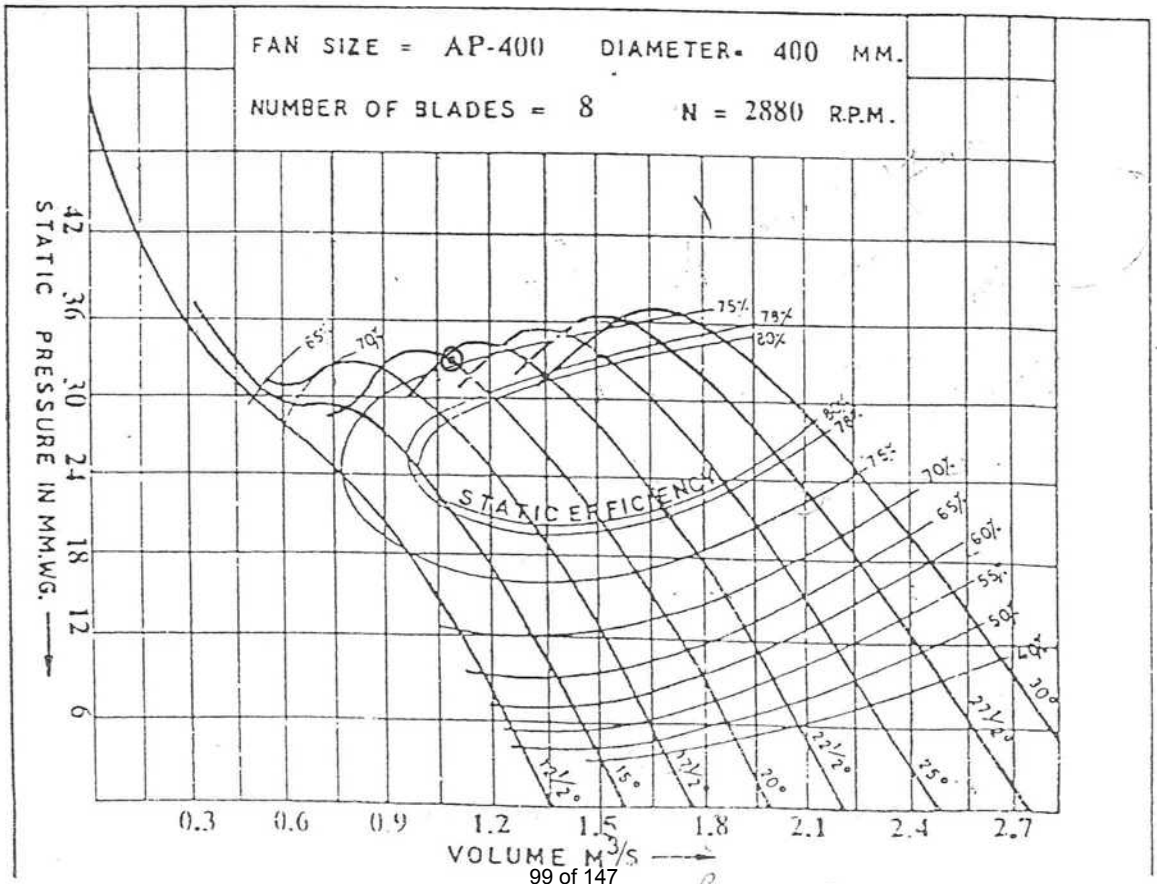
APPROVED					

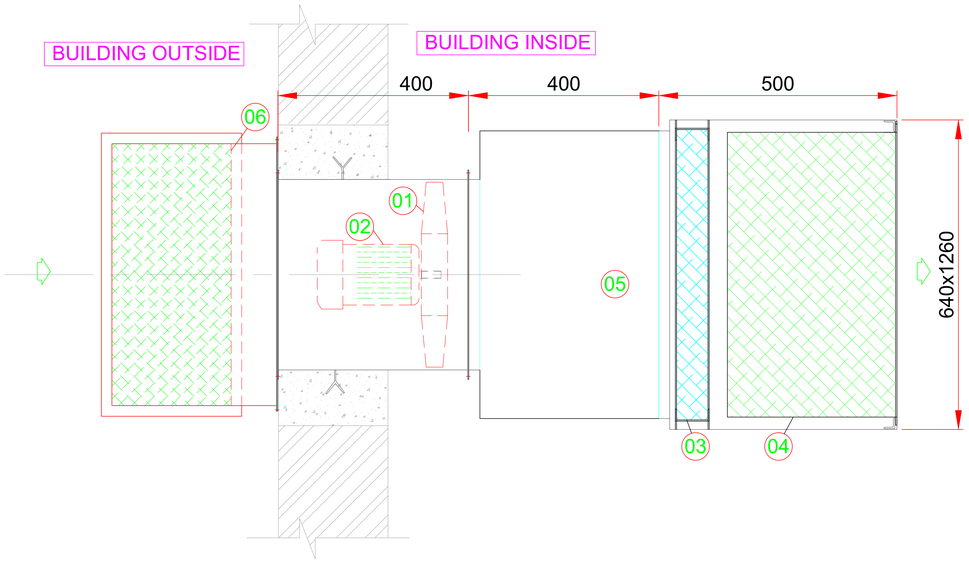
TECHNICAL DATA SHEET & GA DRAWING FOR AXIAL FLOW SUPPLY FANS WITH PRE AND FINE FILTER			
Sr. No.	**Description**	**Unit**	Particulars
1	Manufacturer		
2	Model No.		
3	Type of Fan		**Axial Flow Supply Fans with pre and fine filter**
4	Capacity	CMH	4000
5	Quantity		5Nos. - ACDB/DCDB MCC Room, 7Nos. - Cable Vault
6	Static pressure	mmWG	30
7	Total pressure	mmWG	37.5
8	Impeller Diameter	mm	400
9	Type of blade		Fixed/variable pitch Cast Aluminium blade
10	No. of blade	Nos.	8
11	Blade angle	Degree	20
12	Drive Arrgt.		Impeller mounted directly on the motor shaft
13	Fan/Impeller Speed	RPM	2830
14	Shaft Power	BkW	0.64
15	Fan Efficiency	%	65
16	Bearing Type		Ball Bearing
17	Selection curves enclosed (yes/No)		yes
18	Motor Data		
	a) Rating	kW/Pole	0.75/2
	b) Speed	RPM	2830
	c) Type of Mounting		B3
	e) Direction of Rotation		Clockwise / Anti-clockwise
20	Material		
	a) Impeller		Cast Aluminium
	b) Casing		MS
	c) Casing thickness (mm)		3
	d) Shaft		Motor Shaft (EN-8)
19	Accessories		Rain protection cowl, birdmesh
20	Filter		
	20.1 Filter type		Pre-filter
	a) Filter size		610 X 610 X 50
	b) No. of filters		2
	c) Filter efficiency		Average arrestance efficiency (65-80)%
	20.2 Filter type		Fine-filter
	a) Filter size		610 X 610 X 305
	b) No. of filters		2
	c) Filter efficiency		Average arrestance efficiency (80-90)%
21	Painting		As per specification
22	Noise Level	dB(A)	≤ 85
23	Inspection & Testing		COC BASIS
24	GA Drawing	Attached)	

Fan characteristics curves

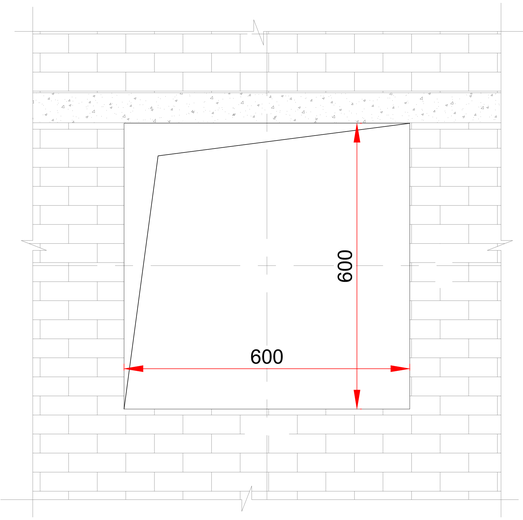




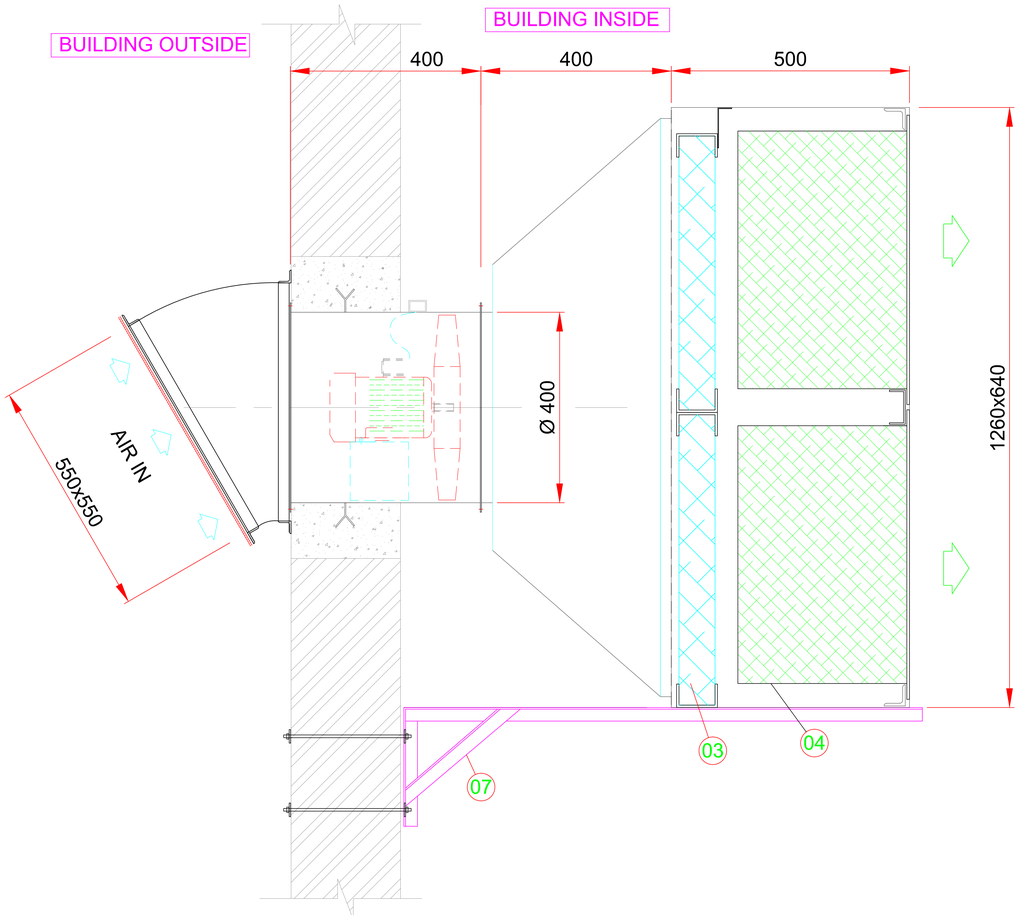
Q = 4000 CMH, $P_{ST.}$ = 30 mm



TOP VIEW

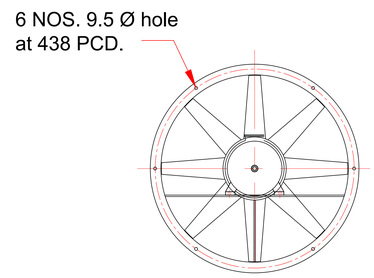


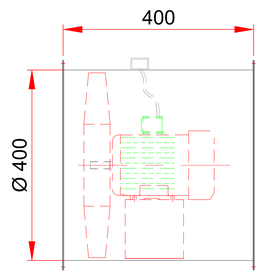
WALL OPENING DETAILS



SIDE ELEVATION

07.	FRESH AIR UNIT SUPPORT	ISA-40□□	1	MS
06.	COWL WITH BIRDMENSH	□□0□□□0	1	GI
0□.	CONNECTION DUCT	1160□□40□600□600	1	GI
04.	FINE FILTER (FLANGE TYPE)	610□610□30□	2	-
03.	PRE- FILTER (BOX TYPE)	610□610□□0	2	-
02.	MOTOR 0.7□□w□2POLE	-	1	
01.	SUPPLY AIR FAN		1	-
PART NO.	DESCRIPTION	SIZE	□TY.	MAT□LS□MAKE





FAN ASSEMBLY

NOTES:-

1. ALL DIMENSIONS ARE IN MM.

Air Capa□ity (CMH) - 4,000 CMH
Stati□Pressure - 30 MMWG
Fan Stati□Load - 120 K□.
Fan Operatin□Load - 1□0 K□.

REV	DATE	DRAWN	CHECKED	APPROVED	NOTE

PROJECT

2X660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASHE DYKE OF NCTPS, CHENNAI - 400 KV GIS

OWNER

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LTD.

CONSULTANT

DESIN PRIVATE LIMITED
New Delhi

PURCHASER

BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP, NOIDA

PACKAGE

AIR CONDITIONING AND VENTILATIONS SYSTEMS FOR SWITCHYARD AREA

DRAWING TITLE

GA of Ventilation Fans

DRG.NO

AVPL-SAF-4000CMH

	NAME	DATE	SCALE	PAGE	REV
DRAWN			1:100 A1	1 OF 1	0
CHECKED					
APPROVED					

TECHNICAL DATA SHEET FOR PROPELLER FANS FOR TOILET AND PANTRY AREAS IN SWITCHYARD CONTROL ROOM BUILDING			
Sr. No.	**Description**	**Unit**	**Details**
1	Manufacturer		CG Make
2	Model No.		EXHD300-6
3	Type of Fan		Propeller Fan
4	Capacity	CMH	1145
5	Quantity	Nos.	6
6	Location	Area	Toilet & Pantry
7	Static pressure	mmWG	5
8	Impeller Diameter	mm	300
9	Type of blade		Cast Aluminium Blade
10	No. of blade	Nos.	4
11	Type of Fan Drive		Direct Drive
12	Fan/Impeller Speed	RPM	950
13	Selection curves enclosed (yes/No)		yes
14	**Motor Details**		
14.1	Motor Make	kW/Pole	Inbuilt Motor
14.2	Motor Rating		
14.3	Related Voltage of Motor	V	220
14.4	Insulation Class		Class-F
14.5	Related freq of Motor		50
15	Painting		Pre-Coated GI Sheet
16	Noise Level	dB((A)	< 85
17	Manufacturer Catalogue		Attached

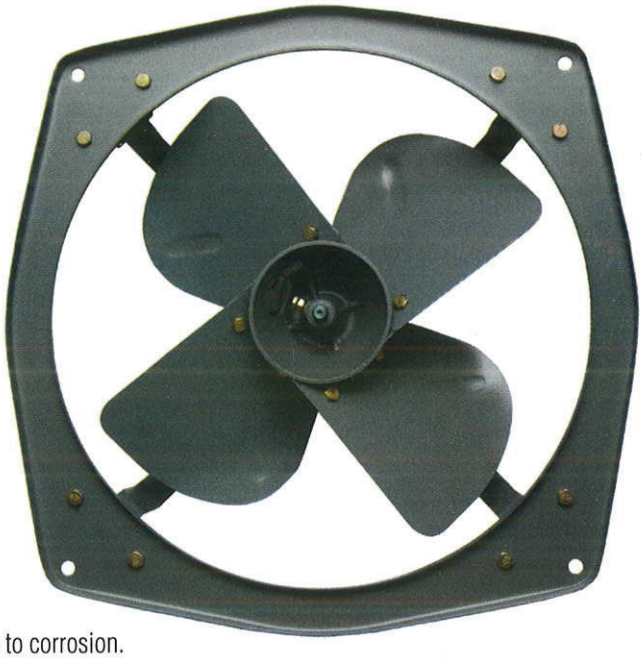
HEAVY DUTY EXHAUST FANS

Selecting the right exhaust fan for your needs:

The size, number of exhaust fans required for a particular application is directly dependent upon location, and the number of air changes required per hour.

In order to determine correct size and number of fans, the following factors need consideration:

- Size of room
- Number of occupants and their activities,
- Heat generated from sources like solar radiations, machineries, & processes etc.
- Relative humidity and outside temperature.



Features:

- Totally enclosed, continuously rated highly efficient heavy-duty motor with pressure die cast aluminum rotor mounted on two ball bearings.
- Aerodynamically contoured blades handle maximum air with minimum power consumption.
- Rigid frame with rubber mountings for silent operation.
- Epoxy powder coating with specially pretreated components for better resistance to corrosion.
- Degree of protection against dust & water entry is IP55.
- Both hub and impeller are balanced & frame and arms are mounted on rubber bushings through M.S. Clamps. Hence, vibrations are virtually eliminated.

SELECTION CRITERIA AND RECOMMENDED MINIMUM FRESH AIR SUPPLY

SELECTION CRITERIA	
APPLICATIONS	NUMBER OF AIR CHANGES /HR
RESIDENCES, STORAGE AREAS	1 - 2
LIBRARIES, CLASS ROOMS	2 - 4
ASSEMBLY HALLS, LABS	4 - 6
LAVATORIES, BARS, HOSPITALS WARDS	6 - 8
THEATRES, WORKSHOPS, GARAGES	6 - 10
CAFES, CANTEENS	8 - 12
RESTAURANTS, LAUNDRIES	10 - 15
BAKERIES, CANTEEN KITCHENS	15 - 30
BOILER HOUSES, ENGINE ROOMS	15 - 30
FOUNDARIES & FURNACE ROOMS	30 - 60

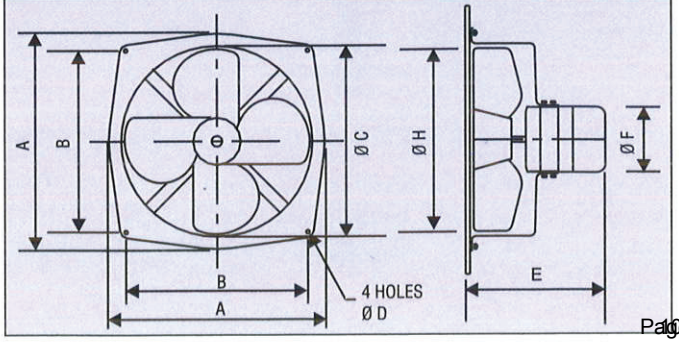
RECOMMENDED MINIMUM FRESH AIR SUPPLY		
AIR SPACE / PERSON	AIR SUPPLY / PERSON	AIR CHANGES / HR
3 CUM	61 CUM/HR	20
6 CUM	40 CUM / HR	6.5
9 CUM	29 CUM / HR	3.2
12 CUM	21 CUM / HR	1.8

GENERAL ARRANGEMENT DETAILS FOR EXHD SERIES

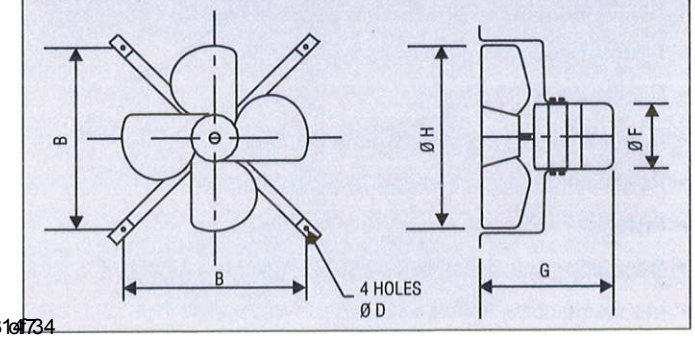
DIMENSIONAL SPECIFICATION

SIZE	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm
030	385	315	327	9.5	300	125	255	300
038	470	375	405	9.5	310	127	285	380
045	570	450	482	10.5	360	162	345	450
060	720	600	635	11.5	405	162	385	600
090	1060	836	952	17.5	375	215	360	900

WITH FRAME



WITHOUT FRAME



HEAVY DUTY EXHAUST FANS/ AIR CIRCULATORS

EXHAUST FAN PERFORMANCE GUIDE

MODEL NAME	IMPELLER (DIA) MM	PHASE	POLE	SPEED (RPM)	CURRENT (AMP)	POWER INPUT (WATTS)	AIR DELIVERY CMH	AIR DELIVERY CFM	NOISE LEVEL (DBA)
EXHD300-4-1*	300	Single	4 Pole	1400	0.43	90	1710	1005	56
EXHD300-6-1*	300	Single	6 Pole	950	0.26	55	1145	670	54
EXHD380-4-1*	380	Single	4 Pole	1400	0.72	150	3250	1910	63
EXHD380-4-3	380	Three	4 Pole	1400	0.3	150	3250	1910	63
EXHD380-6-1	380	Single	6 Pole	950	0.48	100	2000	1175	56
EXHD380-6-3	380	Three	6 Pole	950	0.22	100	2000	1175	56
EXHD450-4-1*	450	Single	4 Pole	1400	1.98	410	6120	3600	65
EXHD450-4-3	450	Three	4 Pole	1400	0.94	410	6120	3600	65
EXHD450-6-1	450	Single	6 Pole	950	0.7	145	3900	2290	63
EXHD450-6-3	450	Three	6 Pole	950	0.33	145	3900	2290	63
EXHD600-6-1	600	Single	6 Pole	950	2.65	550	9400	5525	65
EXHD600-6-3	600	Three	6 Pole	950	1.27	550	9400	5525	65
EXHD600-8-1	600	Single	8 Pole	700	1.23	255	7100	4175	63
EXHD600-8-3	600	Three	8 Pole	700	0.56	255	7100	4175	63
EXHD900-8-3	900	Three	8 Pole	700	2.6	1200	25200	14820	68

* Selective Range ISI Marked
Rated Voltage 230 V,50 Hz AC for single phase & 415 V, 50 Hz for three phase

Applications

- Heavy duty exhaust fans are ideal for use in industrial set ups, industrial canteens, kitchens, paint shops, hotels, theatres and auditoriums.
- It is also extensively used by OEM customers for room coolers, flour mills, milk dairies, food and processing units, battery rooms for exhausting stale hot air and supplying fresh air, paint booths, welding equipment, cold storage units, strong rooms etc.
- EXHD Ragne goes a long way in providing a healthy environment and making life more comfortable.

AIR CIRCULATORS

These are heavy-duty oscillation type propeller fans used for air movement generally in humid atmospheres demanding air circulation.

Special Features :

- Aerodynamically designed blades for higher air delivery & minimum noise level.
- Sturdy brazed wire guards with powder coating to ensure corrosion resistance.
- Epoxy powder coated.
- Indexing to different positions at 360 degrees for flexibility.
- Dynamically balanced blades.
- Height adjustment provided in pedestal type air circulators.
- Double ball bearings to ensure longer life.
- Oscillation to 85 degrees.
- Robust base to ensure absolute stability.
- Power consumption limited to bare minimum.
- Attractive aesthetic design to suit your décor.
- Generally conforming to IS:2997-1964.
- Insulation class is Claas B

TECHNICAL DATA SHEET FOR FILTER		
S.NO.	**DESCRIPTION**	**SPECIFICATION**
A.	**PRE-FILTER**	
1	Item	Pre-Filter
2	Application	Air Filtration
3	**MAKE**	**AS PER APPROVED VENDOR LIST**
4	Product Image	
5	Standard	As Per ASHRAE-52-79/EN-779
6	Type of Construction	Cassette Type/Box Type
7	Media Used	Non Woven Synthetic
8	Efficiency of Filter	Average arrestance of 65 to 80% As BS-6540 / ASHRAE-52-76
9	Filter Grade	EU-4/G-4
10	Thickness	50 MM
11	Material of Filter Frame	GI sheet (min 18 gauge) / Aluminum alloy (min. 16 gauge)
12	Media Support/Separator	Galvanized steel wire Mesh of 10MM with Handle
13	Filter Media	High Density Poly Ethylene (HDPE)
14	Standard Size	610MM x 610MM x 50MM
		610MM x 305MM x 50MM
15	Face Velocity	Not more than 2.50 m/sec (Max)
16	Pressure Drop (Initial/Final)	≤04.50 MM/≤7.5 MM
17	Mode of Cleaning of Filter	By Water Or By Detergent at Low Pressure((less than 5kg/cm^2)
18	Spaces	Suitable Aluminum Spaces shall be provided for uniform air flow
19	Sealing in casing	Casing shall be provided with Neoprene sponge rubber sealing
20	Temperature Resistance	70 Degree C
B.	**FINE FILTER**	
1	Item	Fine Filter
2	Application	Air Filtration
3	**MAKE**	**AS PER APPROVED VENDOR LIST**
4	Product Image	
5	Standard	As Per ASHRAE-52-79/EN-779
6	Type of Construction	Flange Type
7	Media Used	Non Woven Synthetic

8	Efficiency of Filter	Average arrestance of 80-90% As BS-6540 / ASHRAE-52-76
9	Filter Grade	EU-7/F-7
10	Thickness	305 MM
11	Material of Filter Frame	Aluminum alloy (min. 16 gauge)
12	Media Support/Separator	Heavy Corrugated Aluminum spaces
13	Filter Media	High Density Poly Ethylene (HDPE)
14	Standard Size	610MM x 610MM x 305MM
		610MM x 305MM x 305MM
15	Face Velocity	Not more than 2.4 m/sec (Max)
16	Pressure Drop (Initial/Final)	≤07.50 MM/≤18.00 MM
17	Mode of Cleaning of Filter	By Compressed Air at Low Pressure (less than 5kg/cm^2)
18	Sealing in casing	Neoprene sponge rubber sealing shall be provided on either face of filter frame
19	Temperature Resistance	70 Degree C
C.	**HEPA FILTER**	
1	Item	HEPA Filter
2	Application	Air Filtration
3	**MAKE**	**AS PER APPROVED VENDOR LIST**
4	Product Image	
5	Standard	As Per ASHRAE-52-79/EN-779
6	Type of Construction	Flange Type/Box type
7	Media Used	Micro fibre Glass paper
8	Efficiency of Filter	99.97% Down to 0.3 Micron
9	Filter Grade	EU-13/F-13
10	Thickness	305 MM
11	Material of Filter Frame	Aluminium Alloy (Min 16 Gauge) with Handle
12	Media Support/Separator	Aluminium
13	Standard Size	610MM x 610MM x 305MM
		610MM x 305MM x 305MM
14	Face Velocity	Not more than 1.2 m/sec (Max)
15	Pressure Drop (Initial/Final)	≤20.00 MM/≤60.00 MM
16	Mode of Cleaning of Filter	By Compressed Air at Low Pressure(less than 5kg/cm^2)
17	Sealing in casing	Neoprene sponge rubber sealing shall be provided on either face of filter frame
18	Temperature Resistance	70 Degree C

TECHNICAL DATA SHEET

GI COLLAR DAMPER

S.No.	DESCRIPTION	DETAILS
1	MAKE	SYSTEMAIR
2	SIZE	NECK- AS PER SITE REQUIREMENT
3	MODEL	GI OBSS(COLLAR DAMPER FOR GRILLES/DIFFUSER)
4	MATERIAL OF COLLAR DAMPER	GI SHEET
5	THICKNESS OF MATERIAL	BLADE – over all thickness of blade 6mm Aero foil type blade28G(0.38+0.38)mm , FRAME - 22 G,
6	TYPE OF VCD	KEY OPERATED OPPOSED BLADE TYPE
7	FINISH	BLACK PAINTED
9	MOUNTING	DUCT COLLARS
10	WIDE	MINIMUM SIZE 100 X 100 MM (NECK) IN SINGLE MODULE
		MAXIMUM SIZE 600 X 600 MM (NECK) IN SINGLE MODULE
		SIZE ABOVE THAN MAX WILL BE IN TWO MODULE

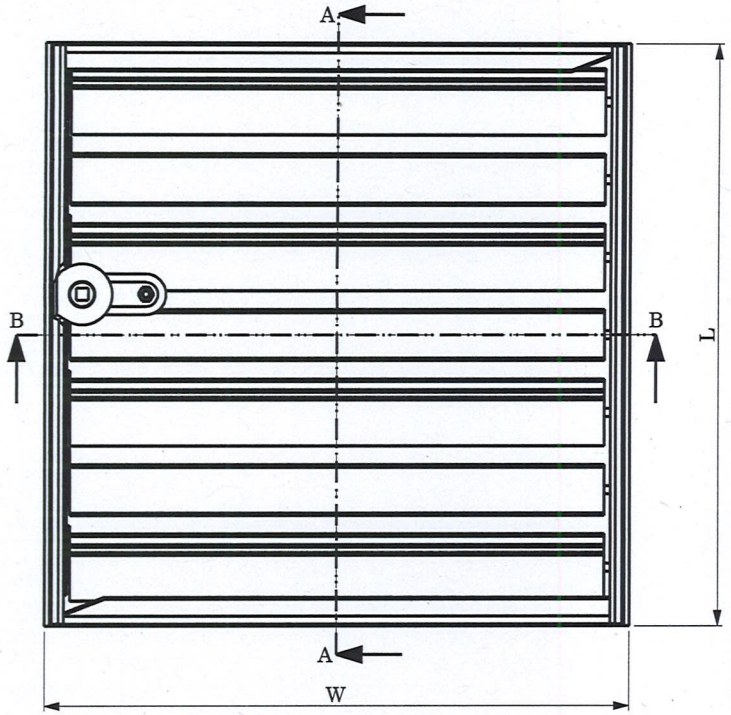
Prepared By

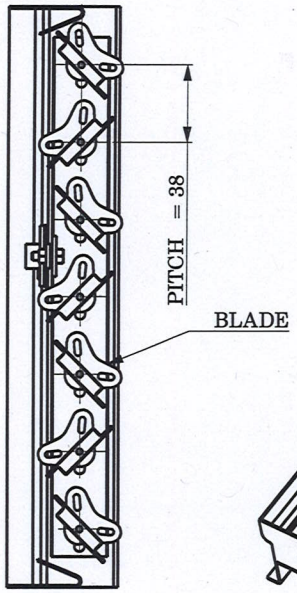
Systemair India Private Limited Plot No. 2 Sector 37, Kasna Greater Noida

FORMAT NO: SIPL/8.3/F12A/R0

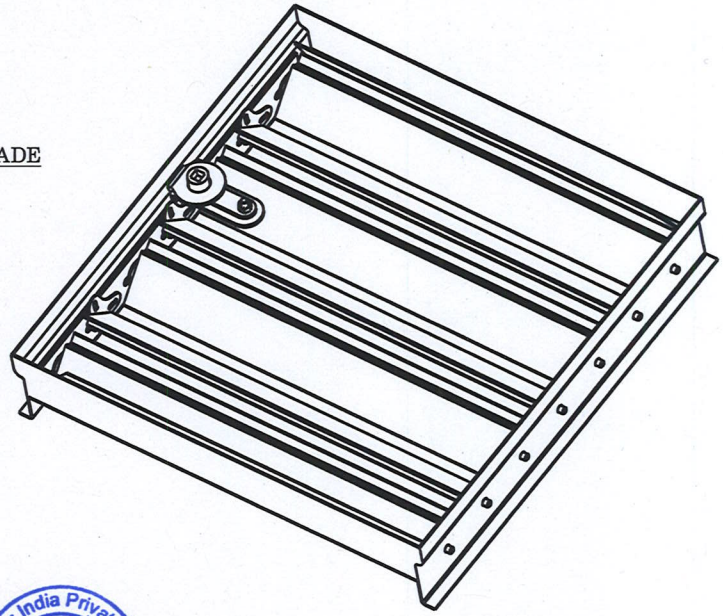
UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN m.m.

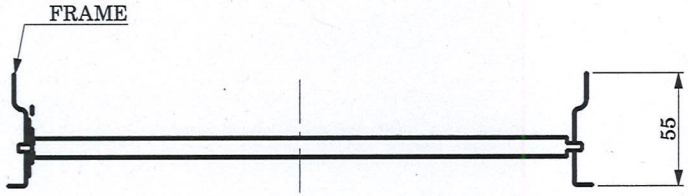
REV NO.	DATE	REVISION	REV. BY





SECTION A-A





SECTION B-B

Systemair India Private Limited ★ Greater Noida ★ Plot No. 13, Sector 3, Kasna

Note:- This is only General arrangement drawing, the actual product supplied may deviate from the drawing.

TOLERANCE LIMIT UNLESS SPECIFIED		MASS PROPERTIES:	
LINEAR DIMENSIONS		WEIGHT (kg)	-
0.5 - 6 = ±2.0	>120 - 400 = ±8.0	VOLUME (mm³)	-
>6 - 30 = ±4.0	>400 - 1000 = ±12	SUR. AREA (mm²)	-
>30 - 120 = ±6.0	>1000 - 2000 = ±16		
Over 2000 = ±20		No. of SC/CC	
ANGULAR DIMENSIONS		SC	-
0 - 10 = ±8°	>50 - 120 = ±4°	CC	-
>10 - 50 = ±6°	>120 - 400 = ±2°		
Over 400 = ±0°40'			

PART DESCRIPTION:	REMOVE SHARP EDGES	DRAWING No.:	REV NO.:
GI - OBSS	DATE: 09-Oct-2018	SIPL/ADP/GA/2576	00

MATERIAL:	M. STANDARD:	SCALE:	DRN. BY:	CHKD. BY:	APPD. BY:
-	-	N.T.S.	BBM	DALIP	A.BHARDWAJ

systemair

SYSTEMAIR INDIA PVT.LTD.

FILE PATH: Y:\Plants\Greater_Noida\CAD_Team\D240BRBM\DESIGN DATA\GAD\ADP\04). DAMPER\G.I O.B.S.S

A3 OCT 17 GAD

TECHNICAL DATA SHEET

DOUBLE LOUVERED ADJUSTABLE GRILLES

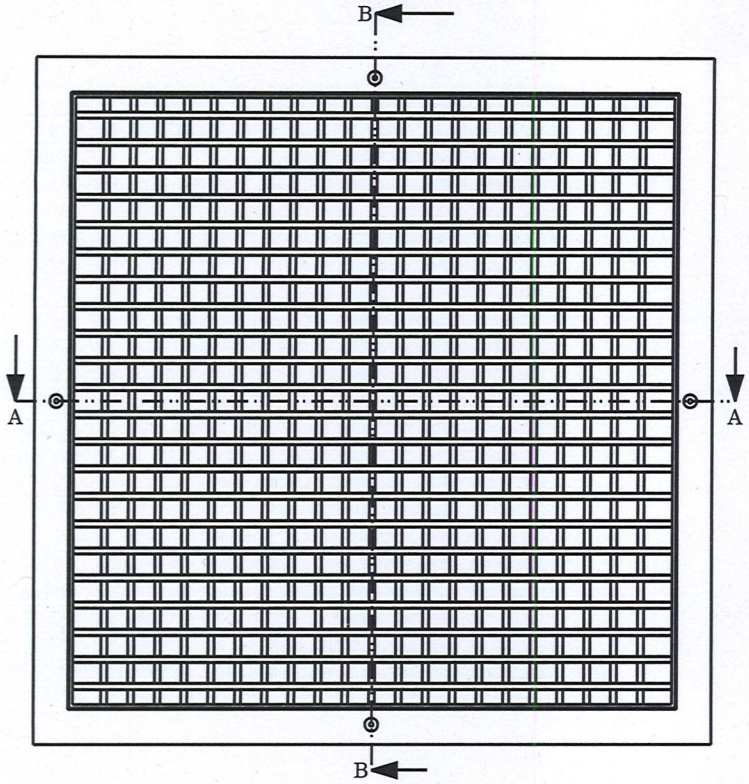
S.No.	DESCRIPTION	DETAILS
1	MAKE	SYSTEMAIR
2	SIZE	NECK- AS PER SITE REQUIREMENT
3	MODEL	2H(FRONT HORIZONTAL BLADE & REAR VERTICAL BLADE)
4	MATERIAL OF GRILLE	EXTRUDED ALUMINIUM CONSTRUCTION
5	THICKNESS OF MATERIAL OF GRILLES	FRAME 1.2(+/-0.1) MM, 25MM FLANGE BLADE 4 MM FROM FRONT
6	COLOUR OF GRILLES	OFF WHITE
7	FINISH	POWDER COATED
8	MOUNTING	DUCT COLLAR
9	WIDE	MINIMUM SIZE 150 X 150 MM (NECK)
		MAXIMUM SIZE 1800 X 600 MM (NECK)

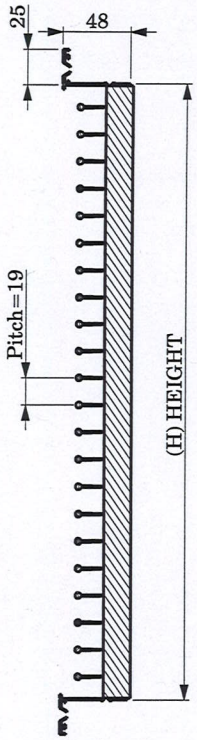
Prepared By

Systemair India Private Limited Plot No. 3, Sector 31, Kasna Greater Noida

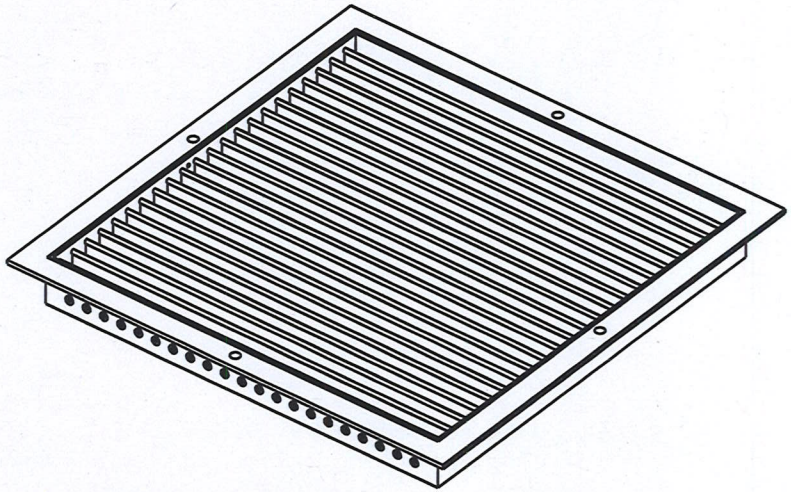
UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN m.m.

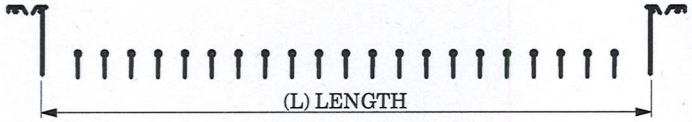
REV NO.	DATE	REVISION	REV. BY





SECTION B-B





SECTION A-A

Systemair India Private Limited Plot No. 5, Sector 31, Kasna Greater Noida

TOLERANCE LIMIT UNLESS SPECIFIED		MASS PROPERTIES:	
LINEAR DIMENSIONS		WEIGHT (kg)	-
0.5 - 6 = ±2.0	>120 - 400 = ±8.0	VOLUME (mm³)	-
>6 - 30 = ±4.0	>400 - 1000 = ±12	SUR. AREA (mm²)	-
>30 - 120 = ±6.0	>1000 - 2000 = ±16		
Over 2000 = ±20		No. of SC/CC	
ANGULAR DIMENSIONS		SC	-
0 - 10 = ±8°	>50 - 120 = ±4°	CC	-
>10 - 50 = ±6°	>120 - 400 = ±2°		
Over 400 = ±0°40'			

Note:- This is only General arrangement drawing, the actual product supplied may deviate from the drawing.

PART DESCRIPTION:				REMOVE SHARP EDGES	DRAWING No.:	REV NO.:
GRILL - 2H				DATE: 25-Fab-2019	SIPL/ADP/GA/2743	R0
MATERIAL:	M. STANDARD:	SCALE:	DRN. BY:	BBM	CHKD. BY: DALIP	APPD. BY: A.BHARDWAJ
-	-	N.T.S.				

systemair

SYSTEMAIR INDIA PVT.LTD.

systemair

TECHNICAL DATA SHEET GRILLE		
S.No.	DESCRIPTION	DETAILS
1	MAKE	SYSTEMAIR
2	SIZE	NECK- AS PER SITE REQUIREMENT
3	MODEL	ALG(RS2)
4	MATERIAL OF GRILLE	EXTRUDED ALUMINIUM SECTION
5	THICKNESS OF MATERIAL	ALUMINIUM -1.2MM (+/- 0.1 MM) THICK
6	BLADE ANGLE	15 DEGREE
7	BLADE THICKNESS	3MM
8	FINISH	POWDER COATED
9	WIDE	MINIMUM SIZE 150 X 150 MM (NECK)
		MAXIMUM SIZE 1800 X 600 MM (NECK)
		OR SIZE AS PER SITE REQUIREMENT.

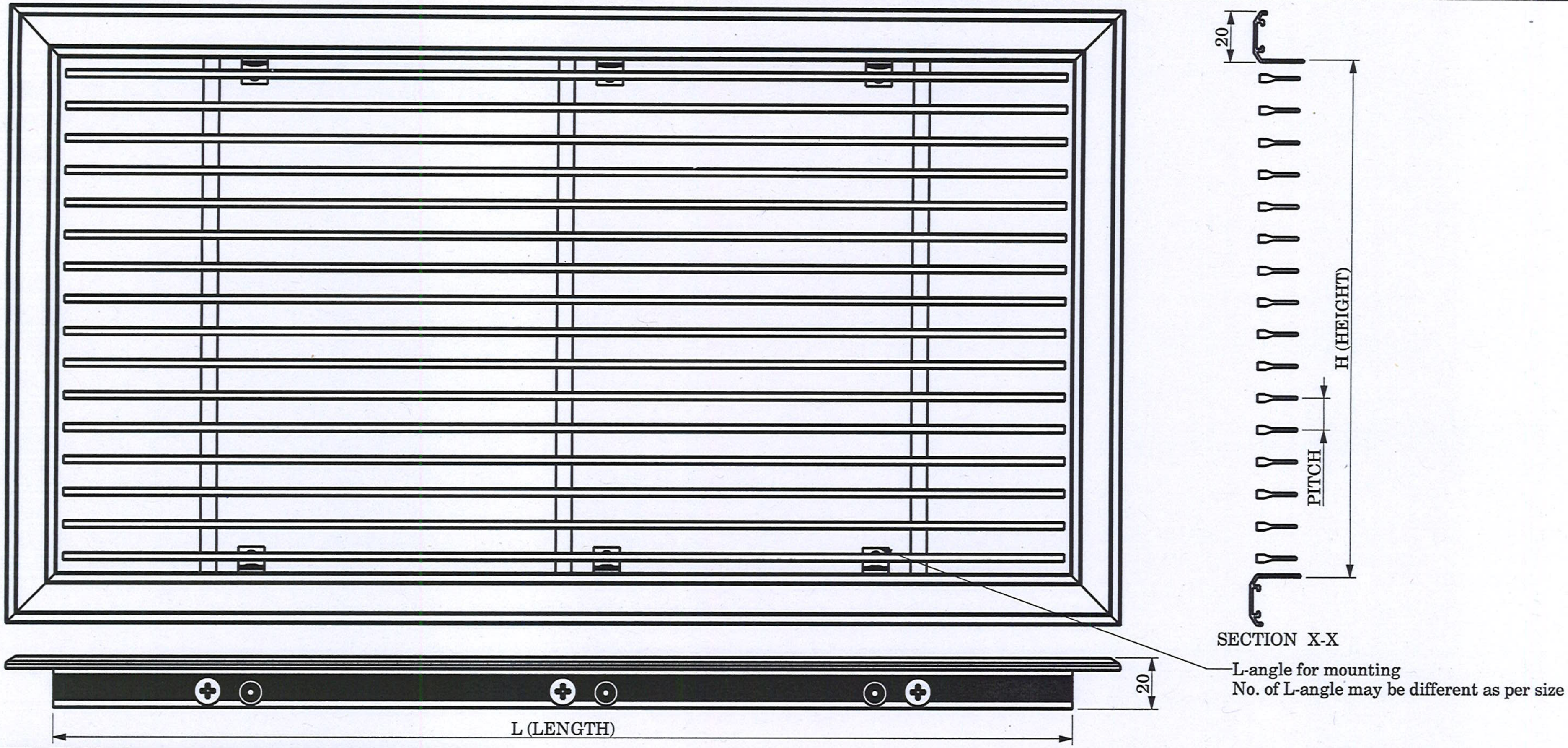
Prepared By

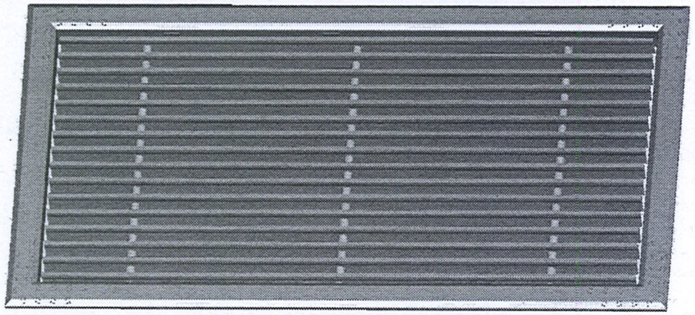
Systemair India Private Limited Plot No 3 Sector 81, Kasna Greater Noida

FORMAT NO: SIPL/7.3/12A/R1

UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN m.m.

REV NO.	DATE	REVISION	REV. BY





Systemair India Private Limited, Plot No. 8, Sector 3, Kasna, Greater Noida

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TOLERANCE LIMIT UNLESS SPECIFIED	
0.5 - 6 = ±0.3	>120 - 400 = ±2.0
>6 - 30 = ±0.5	>400 - 1000 = ±3.0
>30 - 120 = ±0.8	>1000 - 2000 = ±4.0

MASS PROPERTIES:	
VOLUME (mm³)	-
WEIGHT (kg)	-
No. of SC/CC	
SC	-
CC	-

PART DESCRIPTION:	REMOVE SHARP EDGES	DRAWING No.:	REV NO.:
ALG (RS2)	DATE: 15-Jul-2016	SIPL/ADP/GA/1887	00

MATERIAL:	M. STANDARD:	SCALE:	DRN. BY:	P.K	CHKD. BY:	DALIP	APPD. BY:	A.BHARDWAJ
-	-	N.T.S.						

systemair

SYSTEMAIR INDIA PVT.LTD.

FILE PATH: -

A3 OCT 15 A

Sl. No	DESCRIPTION	SPECIFICATION
1	Make	SYSTEMAIR
2	Type	Motorized and spring return fail safe type
3	Size	As per approved layouts.
4	Louver Blade	GI, 16G
5	Casing	GI, 16G
6	Shaft	18mm x 14mm dia circular rod
7	Fabrication Type	Box Type
8	Working	Normally open, in case of no power damper will be closed by spring action
9	Fire Rating	90 minutes (minimum)
10	Leakage Class	Class-1
MOC of The Following Material		
11	Spring	Spring steel grade 2
12	Linkage	GI
13	Bearing	GI
14	Gland Packing	Jamb Seal
15	Reference Code/ Standard	UL-555, 1955 (certified by CBRI)
16	Quantity	As per Approved Layout.
17	GA Drawing	Enclosed
Single Phase Actuator		
1	Make of Actuator	Belimo
2	Model No.	NFA S2 for 10MM and SFA S2 for 20 MM
3	Actuator Voltage	AC 240 V, 50 HZ, Single phase
4	Power Consumption	10 watt (max.)
5	Angle of rotation	95 degree (max.)
6	Switch Type	SPDT 2 Set
7	Torque	10 Nm/ 20 Nm
	Contact Rating	As per Technical specification
8	Degree of Protection	IP 54
9	**Running Time**	
a)	Motor	75 Seconds
b)	Spring Return	20 Seconds
10	Sound level	
a)	Motor	45 dB (max.)
b)	Spring Return	62 Db (max.)
11	Auxiliary Contacts	Limit switches for open & close position
12	Mode of Control	Open - Actuator energised
		Close - Actuator de-Energise & spring action

Principle of operation of motorized fire damper

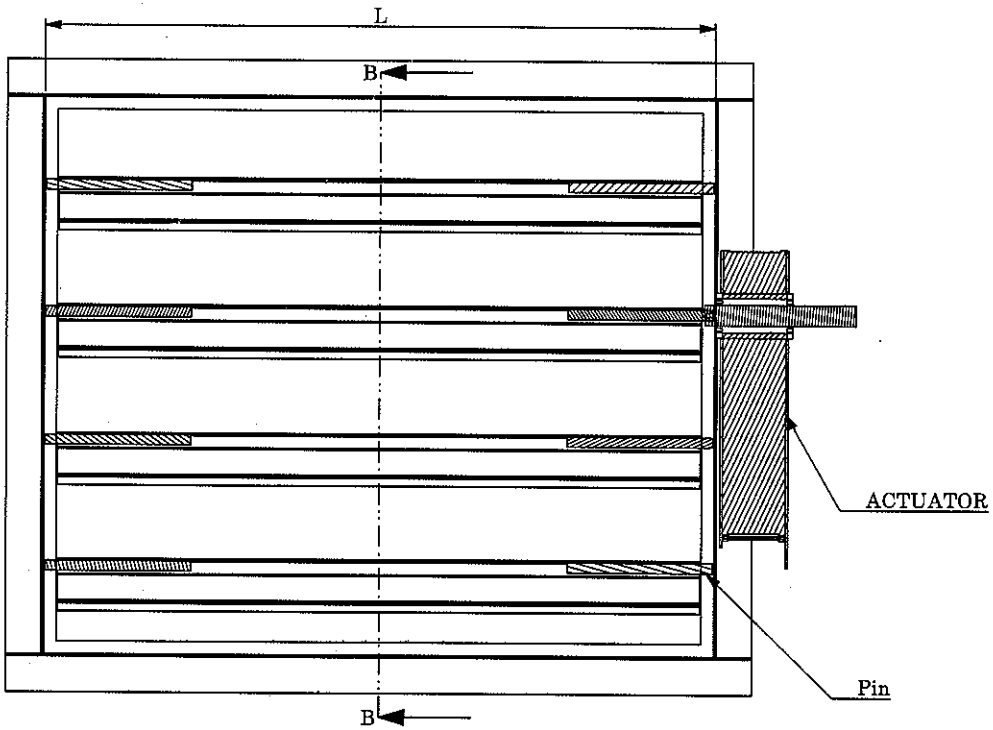
1. Operator will give the open command to each Motorized Fire Damper through the graphics/ face plate.

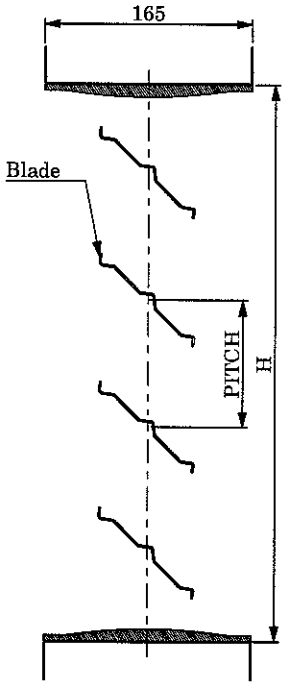
2. The open command will be issued by DDCMIS to Skidmounted power distribution board in which a relay will be energized which is turn supplies the required voltage to Fire Damper.

3. On availability of power Fire Damper will be opened, thus a feedback will be generated through limit switch which will be indicated in DDCMIS through LOCAL STARTER PANEL.

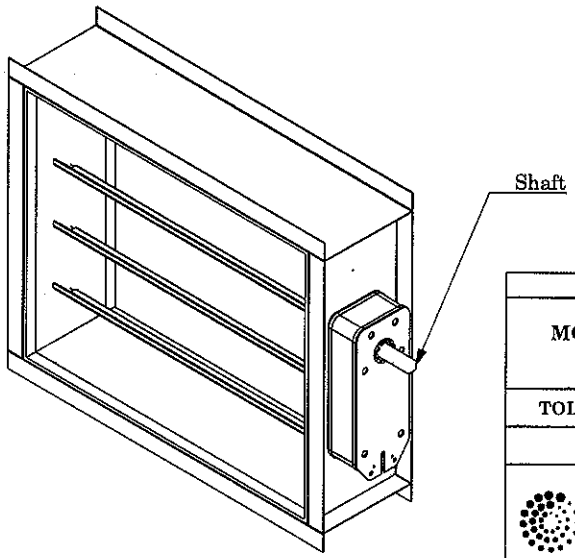
4. In the event of Fire, signal will be generated from Fire Alarm Panel (BHEL Scope) which will be interfaced to DDCMIS thus withdrawing the open command. The relay in LOCAL STARTER PANEL will be de-energized and power supply will be cut-off. Being the spring return damper, the damper will immediately close, giving the close feedback to DDCMIS through LOCAL STARTER PANEL.

ALL DIMENSIONS ARE IN M.M. (IF IN DOUBT PLS. ASK DON'T SCALE THE DRAWING)





SECTION B-B



PART/No.:-	MATERIAL:-	DATE:-	DRAWING No.:-
MOTORIZED FIRE DAMPER WITHOUT SLEEVE	G.I.	18-Mar-2011	

TOLERANCE:-	SCALE:-	DRN. BY:-	CHD. BY:-	APPD. BY:-
±2	N.T.S.	RAVI		

systemair RAVISTAR

RAVISTAR INDIA PVT.LTD.

BELIMO

Technical data sheet SFU-S2

Damper actuator for operating air control dampers in ventilation and air-conditioning systems for building services installations

- Torque: 20Nm
- Nominal voltage: AC 24...240V
  DC 24...125V
- 2 x SPDT auxiliary switches build-in
- Control: Open/Close

Technical data

Electrical data	Nominal voltage		AC 24...240V, 50/60Hz, DC 24...125V
	Nominal voltage range		AC 19.2...264V / DC 21.6...143V
	Power consumption		7.0W @ running / 3.5W @ holding
	Wire/transformer sizing		7.0VA @ AC 24V 8.5VA @ AC 120V 18.0VA @ AC 240V
	Auxiliary switch		2 x SPDT, 1mA...3(0.5)A, AC 250V one fixed at 10%, one adjustable 10%... 90%
	Connection	Motor Auxiliary switches	Cable 1m, 2 x 0.75mm² Cable 1m, 6 x 0.75mm²
Functional data	Torque	Motor Spring return	Min. 20Nm @ nominal voltage Min. 20Nm
	Direction of rotation		Selectable by mounting L/R
	Manual override		By manual override key
	Angle of rotation		Max. 95°, limited on both sides by means of adjustable, mechanical end stops
	Running time	Motor Spring return	Max. 75s (0...20Nm) Max. 20s @ –20...50°C / max. 60s @ –30°C
	Sound power level	Motor Spring return	Max. 45dB(A) Max. 62dB(A)
	Position indication		Mechanical
Safety	Protection class		II Totally insulated
	Degree of protection		IP54
	EMC Low voltage directive		CE according to 2004/108/EC CE according to 2006/95/EC
	Control Pollution Degree		3
	Rated Impulse Voltage		Supply: 4kV Switch: 2.5kV
	Mode of operation		Type 1.AA.B
	Ambient temperature range		–30...+50°C
	Non-operating temperature		–40...+80°C
	Ambient humidity range		95%RH, non-condensing
	Maintenance		Maintenance-free
Dimensions / Weight	Dimensions		See «Dimensions» on page 2
	Weight		Approx. 2200g

Safety notes

- The Damper Actuator is not allowed to be used outside the specified field of application, especially not in aircraft or any other form of air transport.
- Caution: Power supply voltage !
- Assembly must be carried out by trained personnel. Any legal regulations or regulations issued by authorities must be observed during assembly.
- The device may only be opened at the manufacturer's site. It does not contain any parts that can be replaced or repaired by the user.
- The cable must not be removed from the device.
- When calculating the required torque, the specifications supplied by the damper manufacturers (cross section, design, installation site), and the air flow conditions must be observed.
- The device contains electrical and electronic components and is not allowed to be disposed of as household waste. All locally valid regulations and requirements must be observed.

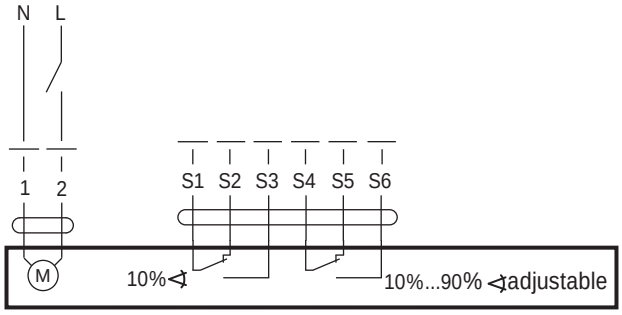
Product features

Simple direct mounting	Simple direct mounting on the damper spindle with a universal spindle clamp, supplied with an anti-rotation strap to prevent the actuator from rotating.
Manual override	Manual operation is possible with the manual override key.
Signalling	Two microswitches with fixed settings are installed in the actuator for indicating the damper end positions. The position of the damper blade can be read off on a mechanical position indicator.
Adjustable angle of rotation	Adjustable angle of rotation with mechanical end stops.
High functional reliability	The actuator is overload-proof, requires no limit switches and automatically stops when the end stop is reached.

Electrical installation

Wiring diagrams

Note
- Caution: Power supply voltage !
- Other actuators can be connected in parallel. Please note the performance data.



Dimensions [mm]

Dimensional drawings

Standard :
¾"- clamp (with insert)

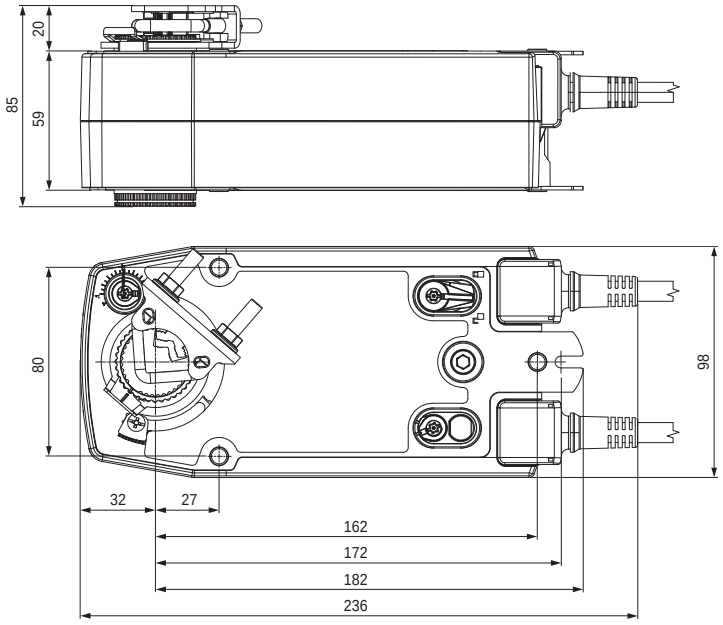
Damper shaft	Length			
	≥85	10...22	10	14...25.4
	≥15	10...22	10	14...25.4

Option 1:
1"- clamp (without insert)

Damper shaft	Length		
	≥85	19...25.4	12...18
	≥15	19...25.4	12...18

Option 2:
½"- clamp (optional via configuration)

Damper shaft	Length			
	≥85	10...19	–	14...20
	≥15	10...19	–	14...20



BELIMO

Technical data sheet Damper Actuator NFU-S2

Damper Actuator for operating air control dampers in ventilation and air-conditioning systems for building services installations

- Torque 10Nm
- Nominal voltage AC 24...240V/DC 24...125V
- 2 SPDT auxiliary switches build-in
- Control: Open/Close

Technical data

Electrical data	Nominal voltage		AC 24...240V, 50/60Hz, DC 24...125V
	Nominal voltage range		AC 19.2...264V/DC 20.4...126.5V
	Power consumption		6.0W @ running/2.5W @ holding
	For wire sizing		9.5VA
	Auxiliary switch		2 SPDT, 1mA...3(0.5)A, AC 250V ⧈ one fixed at 10°, one adjustable 10°...90°
	Connection		Cable 1m, 2x0.75mm²
Functional data	Torque	Motor Spring return	Min. 10Nm @ nominal voltage Min. 10Nm
	Direction of rotation		Selectable by mounting L/R
	Manual override		By manual override key
	Angle of rotation		Max. 95° ◁, limited on both sides by means of adjustable, mechanical end stops
	Running time	Motor Spring return	<75s (0...10Nm) <20s @ –20...50°C/Max. 60s @ –30°C
	Sound power level	Motor Spring return	Max. 50dB(A) ~62dB(A)
	Position indication		Mechanical
	Life time		> 60'000 full cycles
Safety	Protection class		II Totally insulated ⧈
	Degree of protection		IP54
	EMC Low voltage directive		CE according to 2004/108/EC CE according to 2006/95/EC
	Control Pollution Degree		3
	Rated Impulse Voltage		Supply: 4kv Switch: 2.5kv
	Mode of operation		Type 1.AA.B
	Ambient temperature range		–30...+50°C
	Non-operating temperature		–40...+80°C
	Ambient humidity range		95RH, non-condensing
	Maintenance		Maintenance-free
Dimensions / Weight	Dimensions		See «Dimensions» on page 2
	Weight		Approx. 1700g

Safety notes

⚠

- The Damper Actuator is not allowed to be used outside the specified field of application, especially not in aircraft or any other form of air transport.
- Caution: Power supply voltage !
- Assembly must be carried out by trained personnel. Any legal regulations or regulations issued by authorities must be observed during assembly.
- The device may only be opened at the manufacturer's site. It does not contain any parts that can be replaced or repaired by the user.
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Simple direct mounting — Simple direct mounting on the damper spindle with a universal spindle clamp, supplied with an anti-rotation strap to prevent the actuator from rotating.

Manual override — Manual operation is possible with the manual override key.

Signalling — Two microswitches with fixed settings are installed in the actuator for indicating the damper end positions. The position of the damper blade can be read off on a mechanical position indicator.

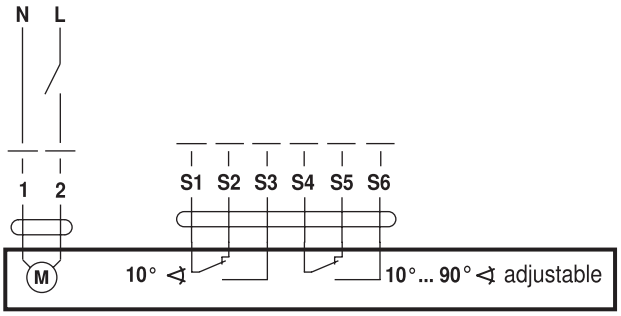
Adjustable angle of rotation — Adjustable angle of rotation with mechanical end stops.

High functional reliability — The actuator is overload-proof, requires no limit switches and automatically stops when the end stop is reached.

Electrical installation

Wiring diagrams

Note
- Caution: Power supply voltage !
- Other actuators can be connected in parallel. Please note the performance data.



Dimensions [mm]

Dimensional drawings

Standard :
¾"-clamp (with insert)

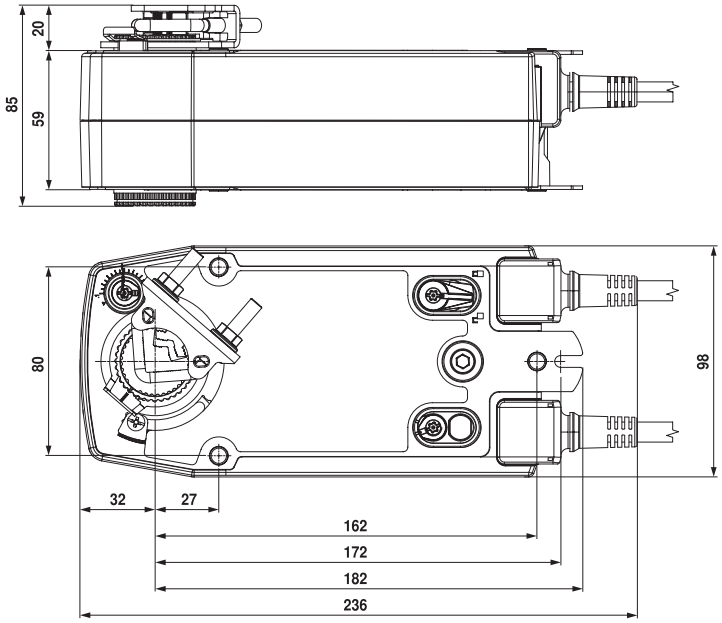
Damper shaft	Length	⌀	□	◇
	≥85	10...22	10	14...25.4
	≥15	10...22	10	14...25.4

Optional 1:
1"-clamp (without insert)

Damper shaft	Length	⌀	□
	≥85	19...25.4	12...18
	≥15	19...25.4	12...18

Optional 2:
½"-clamp (optional via configuration)

Damper shaft	Length	⌀	□	◇
	≥85	10...19	–	14...20
	≥15	10...19	–	14...20



SECTION -3

PROJECT INFORMATION AND GENERAL REQUIREMENTS

Tamilnadu Generation and Distribution Corporation owns the proposed green-field 1320 MW (2 units of 660 MW each) Coal Based Thermal Power Station at Katupalli. This is an expansion of North Chennai Thermal Power Station (NCTPS) and located on some portion of the ashdyke of NCTPS.

The proposed site for main power plant is located near Ennore port (approx 5 kms).
The nearest Railway station is at Athipattu Pudunagar (approx 5 kms)
All weather road from Pattamandri on the Thiruvottiyur-Ponneri district highway is the nearest road access.
The nearest airport is at Chennai at a distance of 60 km.

PROJECT INFORMATION

Project Title- 2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS

Owner- TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)

LOCATION

The site is located near Vayalur Village, Ennore		
Latitude	:	13017’ N to 13018’ N
Longitude	:	80018’ E to 80019’ E
Distance from Chennai City	:	35 km
Nearest Airport is at Chennai at a Distance of	:	60 km

Nearest Seaport is : Ennore
Nearest Railway Station is : Athipattu Pudunagar (approx 5 kms)

Meteorological Condition
Climate: Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data	:		
Ambient temp. (0C)	:	Annual Maximum Mean Temp	41.5(0C)
		Annual Minimum Mean Temp	24(0C)
		Design Ambient temperature	50(0C)
Relative Humidity	:	Maximum 100% Minimum 36% Design 75%	
Annual Rainfall	:	Maximum 2540 mm Average 1600 mm	

		Minimum 1175 mm	
Prevailing Wind Direction	:	Nov to Jan – From NW & NE Feb to Mar – From East & SE Apr to May – From South & SE June – From SW July to Aug – From NW Sept to Oct – From SE & SW Wind Speed 11.8 kmph (avg) 50 kmph (max)	
Seismic Zone	:	Seismic Zone III as per IS:1893-2002 minimum 0.16 g horizontal	

Access to Site

Site is well connected to all weather road from Pattamandri on the Thiruvottiyur – Ponneri district highway. Site is located adjacent to the Chennai – Howrah broad gauge line and thus well connected by rail also.

GENERAL TECHNICAL REQUIREMENTS

ELECTRICAL SYSTEM PARTICULARS

Standard voltage levels

The standardized voltage levels as shall be adopted as specified elsewhere in this specification.

Permissible variations:

The system unit/plant equipment shall be designed suitable for continuous operation with variation in voltage and frequency as indicated below:

Variation in voltage and frequency

	Voltage	Frequency
Permissible variation for power supply with rated Performance /rated current and control effectiveness Maintained	+/- 10%	-5% to +3%
Permissible variation for control and regulation equipment With rated Performance and control quality maintained		

Basic insulation levels

Equipment shall be designed suitable for basic insulation levels as given below:

Nominal Voltage (kV)	**BIL kV (peak)**
400 kV	1425
33 kV	170
11 kV	75
3.3 kV	40

Symmetrical short circuit ratings

The three phase symmetrical short circuit ratings of the switchgear at different voltage levels shall be as indicated in the Table below:

S. No.	Voltage level	Symmetrical Breaking Capacity	Making Capacity
1	400 kV	63 kA for 1 sec	163 kA
2	33 kV	25 kA for 3 sec	62.5 kA
3	11 kV	50 kA for 3 sec	125 kA
4	3.3 kV	40 kA for 3 sec	100 kA
5	415 V	50 kA for 1 sec	125 kA
6	220 V DC	25 kA for 1 sec	-
7	48 V DC	10 kA for 1 sec	

Criteria for selection of voltage levels for motors

Sr. No	Rating	Voltage Level
1	LV Motors- Up to 160 kW	415 V, 3 phase, 50 Hz
2	MV Motors- More than 160 kW and up to 1500 kW	3.3 kV, 3 phase, 50 Hz
3	HV Motors- Above 1500 kW	11 kV, 3 phase, 50 Hz

System Earthing

33kV/11 kV and 3.3 kV : Resistance grounded.
415 V : Solidly grounded.

Degree of Protection:

Degree of protection for various electrical equipment shall be as follows:

S.No.	Equipment	Degree of Protection
1	Marshalling Boxes, Panels, Motors located outdoor	IP55
2	Electrical Equipment of CH System	IP55 with dust proof enclosure
3	HV Switchgear	IP-4X for bus bar chamber, IP-6X for other compartments
4	LV Switchgear	IP52 up to 1600 A and IP42 above 1600 A

GENERAL TECHNICAL PARTICULARS FOR EHV SYSTEM

(a)	Rated voltage	400 kV
(b)	Rated frequency	50 Hz
(c)	Rated short time current withstand capacity	63 kA rms for one (1) second
(d)	Rated one minute power frequency withstand voltage	650 kV rms between live terminals and earth b) 815 kV rms across isolating distance
(e)	Rated lightning impulse withstand voltage	a) 1425 kVp between live terminals b) 1425 (+240) kVp across isolating distance & earth.
(f)	Rated Switching Impulse withstand voltage	a) 1575 kVp (between phases) b) 900 (+345) (across isolating distance)
(g)	Phase to phase spacing	4000 mm

(h)	Rated terminal load	Adequate to withstand 100 kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.
(i)	System neutral earthing	Effectively earthed
(j)	Support structure height	Adequate so that lowest part of support insulator of equipment is 2550 mm (minimum) from ground and/or plinth level.
(k)	Creepage distance	Minimum 31 mm / kV
(l) Electrical Clearances Clearances shall be as given below and as per relevant statutory rules/codes.		
1.	Phase to earth	3500 mm
2.	Phase to phase	4000 mm
3.	Sectional clearance	6500 mm
4.	Ground clearance	8000 mm

COMPLETENESS

Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.

All equipment furnished by the Bidder shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.

Codes & Standards

In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

Bureau of Indian Standards (BIS)

Indian electricity act

Indian electricity rules

Indian Explosives Act

Indian Factories Act and State Factories Act

Indian Boiler Regulations (IBR)

Regulations of the Central Pollution Control Board, India

Regulations of the Ministry of Environment & Forest (MoEF), Government of India

Pollution Control Regulations of Department of Environment, Government of India

State Pollution Control Board.

Rules for Electrical installation by Tariff Advisory Committee (TAC).

Any other statutory codes / standards / regulations, as may be applicable.

EQUIPMENT FUNCTIONAL GUARANTEE

The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.

DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS

Design of Facilities

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.
The Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling.
Maintenance and Availability Considerations

Equipment offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely the minor and major overhauls shall be specified in maintenance manuals, clearly defining the spare parts and man-hour requirement for each stage.

DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

Each of the equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided as per the scope.

The Bidder shall furnish engineering data/drgs. in accordance with the schedule of information as specified in Technical Specification and data sheets.

The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

Basic Engineering Documentation

	Prior to commencement of the detailed engineering work, the Bidder shall furnish an Equipment Definition Manual within 4-6 weeks from the date of the Purchase Order. This manual shall contain the following as a minimum:
	System description of all the mechanical, electrical, control & civil systems.
	Technology scan for each system / sub-system & equipment.
	Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
	Sizing criteria of all the systems, sub-systems including various equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
	Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
	Operation Philosophy and the control philosophy.
	General Layout plan.
	Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
	Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
	Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.
	Detailed design calculations for components, system/sub-system, etc., wherever applicable including sizing calculations as per criteria specified elsewhere in specification.
	Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
	Interconnection diagrams.
	Cable routing plan.

	Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring diagrams of panels and enclosures etc.
	Alarm and annunciation list and alarms & trip set points.
	Sequence and protection interlock schemes.
	Type test reports
	Control system configuration diagrams and card circuit diagrams and maintenance details.
	Detailed software manuals & source software listing.
	Detailed flow chart for digital control system.
	Mimic diagram layout.
	Civil Task drawings (for the Engineering by BHEL), Design and Drawings.
	Model study reports wherever applicable.
	Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
	Documentation in respect of commissioning as listed out elsewhere in this specification.

Instruction Manuals

The Bidder shall submit, draft Instruction Manuals for all the equipment covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the BHEL / OWNER the Instruction Manuals shall be submitted as indicated in Chapter-4. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals with As Built drawings have been supplied. The Instruction Manuals shall comprise of the following.

Tools and Tackles

The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the BHEL/OWNER.

Guarantee Tests

a)	The final test as to prove the Functional Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up Purchaser shall make the unit ready to conduct such test. Such test will be commenced and completed as per schedule.
b)	These tests shall be binding on both the parties of the Contract to determine compliance

	of the equipment with the functional guarantee.
c)	For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition, the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
d)	Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
e)	The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

TAKING OVER

Upon successful completion of Initial Operations and all the tests other than guarantee tests conducted to the Owner's satisfaction, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Owner delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Bidder of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

SECTION 4

LIST OF DRAWINGS & DOCUMENTS

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

DRAWING NAME
Ventilation fan layout for GIS Control building areas- ACDB/DCDB MCC Room, Battery room, Transformer room, Cable vault, pantry and toilets
Schematic, GA & SLD for wall mounted fuse board for ventilation fans in control building
Ventilation equipment & Ducting layout for GIS building
Schematic, GA & SLD of PDB/MCC panel for GIS Ventilation
P&I diagram for GIS Hall Ventilation system showing all the instruments with KKS TAG No.
DATA SHEETS NAME
TDS For GI Sheet for Ducts
TDS For Supply Air Grills and PRD
TDS For Fire Damper
TDS For Volume Control Damper
TDS For Air Intake Louvers & Non-Return Damper
TDS For Pre-filter & Fine filter
TDS For Measuring Instruments
TDS For Supply Air Fans
TDS For Exhaust Fans
TDS for Centrifugal fans
TDS of Propeller fans
List of AI/AO and DI/DO for DCS interfacing
Cable schedule for complete Ventilation system for GIS building and Control building
BOQ – Ventilation system
PG Test procedure for ventilation system
Operation and Maintenance manual for Ventilation system

SECTION 5

ENCLOSURES TO SPECIFICATION

SCHEDULES TO BE FILLED UP BY THE BIDDER

Schedule 1 **Schedule of Deviations**

Schedule 2 **Details of contact persons (technical & commercial)**

Schedule 3 **Enclosures to Specification**

a. ANNEXURE-A Drawings

SCHEDULE-1

SCHEDULE OF TECHNICAL DEVIATION

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

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

1) In case, this schedule is not submitted, it will be presumed that the equipment /material to be supplied under this contract is deemed to be in compliance with the specification.

2) If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**

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

Place

Date

Signature of the authorized representative of Bidder

Name ----------

Designation----------

Company seal----------

SCHEDULE-2

DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL

Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

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

SCHEDULE – 3

ENCLOSURES TO SPECIFICATION

(ANNEXURE-A)

DRAWINGS

1. Ventilation Fan Calculation
2. Ventilation Fan Layout of Control Building
   DRG. NO. **TB-378-316-123-18**
3. Ducting Layout Drawing for GIS Hall
   DRG. NO. **TB-378-316-123-014**
4. Ventilation Equipment and Foundation Layout of GIS Hall Ventilation System
   DRG. NO. **TB-378-316-123-016**
5. Architecture drawing - Switchyard control room building
   DRG. NO. **TB-0-378-607-620-1**
6. Architecture drawing - GIS Building
   DRG. NO. **TB-378-607-640-1**

- Above drawings are already prepared and the wall openings are provided as per the same at site. Contractor shall ensure the location and sizes of such openings while preparing the layout drawings during detailed engineering to minimize the changes at site.

Ventilation Calculations for rooms														
S.No.	Description of area	Length(m)	Breadth (m)	Height (m)	Area (sq.m)	Volume (cu.m)	Based on air change		Based on inside temp.3deg.C above the design DBT during summer				Air flow selcted (cmh)	Selected fans
							ACPH	Air flow (cmh)	Electrical load (kW)	Lighting load (kW) = 2W/sq.feet X room area (sq.feet)/1000	Net Load	Air flow (cmh)*		
1	ACDB/DCDB MCC Room	17	8	5	132	675	25	16871	12.5	2.85	15.35	16606	20000	Wall mounted Supply air axial fan with pre-filter and fine filter of 4000cmh (5 X 20%)
2	Battery room	14	7	4	90	371	30	11131	4.5	1.95	6.45	6976	15000	Wall mounted Exhaust air axial fan (with flame proof motor) of 7500cmh (2 X 50%)
3	Cable Vault	31	8	4	242	993	25	24817	0	5.21	5.21	5637	28000	Wall mounted Supply air axial fan with pre-filter and fine filter of 4000cmh(7X14.3%)
4	Transformer room	8	7	4	53	215	15	3230	16	1.13	17.13	18536	20000	Wall mounted Exhaust air axial fan of 10000cmh(2X 50%)
5	Pantry room -FF	4	2	5	5	27	15	412	0	0.12	0.12	125	1000	Wall mounted propeller fan of 1000cmh(1X 100%)
6	Pantry room - GF	4	2	4	7	27	15	408	0	0.14	0.14	155	1000	Wall mounted propeller fan of 1000cmh(1X 100%)
7	Gents toilet - GF	-	-	4	10	43	15	640	0	0.22	0.22	242	1000	Wall mounted propeller fan of 1000cmh(1X 100%)
8	Gents toilet - FF	-	-	5	10	53	15	796	0	0.22	0.22	242	1000	Wall mounted propeller fan of 1000cmh(1X 100%)
9	Ladies toilet - GF	3	2	4	4	17	15	248	0	0.09	0.09	94	1000	Wall mounted propeller fan of 1000cmh(1X 100%)
10	Ladies toilet - FF	3	2	5	4	21	15	308	0	0.09	0.09	94	1000	Wall mounted propeller fan of 1000cmh(1X 100%)
11	400kV GIS hall	75	17	13	1256	15892	15	238373	188	0.00	188.00	203423	240000	Centrifugal supply DIDW fans with pre & fine filters of 2,40,000cmh (1W+1S)

***Air flow (cmh) = (NET LOAD X 3600)/((rho) X (Cp) x (dt))**

rho = Density of air at ambient conditions 47 deg.C =1.1035 kg/cu.m
Cp = Specific heat of air at constant pressure = 1.005 kJ/(kg.K)
dt = temperature difference = 3 deg. C

TECHNICAL PRE QUALIFICATION REQUIREMENT

Name of Project	**2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS. CHENNAI - 400 KV GIS**
Name of Customer	**TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)**
Name of Consultant	**DESEIN PVT. LTD. NEW DELHI**
Name of Package	**VENTILATION SYSTEM**

TECHNICAL PRE QUALIFICATION REQUIREMENT
The bidder should have designed, supplied, erected, tested & commissioned at least one number of Ventilation System containing supply/exhaust fans having total installed capacity of 2,00,000 CMH or more with ducting type air distribution system in installations such as power plants, sub-stations, electricity boards, transmission utility, refineries, fertilizer plants, commercial, institutional or other industrial installations. Bidder should have executed the above system **during the last ten (10) years as on original scheduled date of bid opening of this tender**. The systems should have been in **#successful operation for at least one (1) year prior to original scheduled bid opening date of this tender.** (#) Successful operation means certificate issued by the Customer/ end user certifying the operation without any adverse remark.

SUPPORTING DOCUMENTS TO BE ATTACHED		
Sr	**Required Criteria**	**Supporting Documents to be submitted by bidder along with technical bid**
1	Design	Approved drawings/GTP/BOQ etc.
2	Supply	Copy of PO/Work order/Material receipt certificate at site, etc.
3	Commissioning/ETC/ Execution	Pre commissioning report / commissioning report and final work completion or handing over report/certificate for complete system.
4	Successful Operation	Performance Certificate/ Letter/ MOM from customer for satisfactory/successful operation for the same projects for which PO/WO are being submitted.

Notes (General points):

1. Consideration of offer shall be subject to customer's approval of bidder as approved vendor for this package.

2. Bidder to submit all supporting documents in Hindi/English. If documents submitted by bidder are in language other than Hindi/English, a self- attested English translated document should also be submitted.

3. Notwithstanding anything stated above, BHEL reserves the right to assess the capabilities and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of BHEL.

4. After satisfactory fulfilment of all the above criteria / requirement, offer shall be considered for further evaluation as per NIT and all the other terms of the tender.

12/5/22
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12/5/22
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