



भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LIMITED
पारेषण व्यापार अभियांत्रिकी प्रबंधन
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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	परियोजना/ PROJECT	1 x 800 MW KOTHAGUDAM TPS – 400KV SWITCHYARD							
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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 **Air-Conditioning and Ventilation System** as detailed in this section and in various other sections of this specification for **Switchyard Control building of 1 x 800 MW Kothagudam Thermal Power Station, Khammam Distt., Telangana** of Telangana State Power Generation Company (**TSGENCO**).
- 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.
- 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 lump sum basis for the package. Within the scope of the contract no variation shall be admissible to the contractor so far the inputs remain unchanged. The Contractor shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of ensuring operability, maintainability and the



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reliability of the complete work covered under this specification. In case of change in the input after placement of order the additions / deletions to the scope shall be settled on the basis of mutually agreed rates.

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

2.0 HVAC REQUIREMENTS FOR VARIOUS AREAS

2.1.0 AIR CONDITIONING REQUIREMENTS

2.1.1 Air Conditioning for Switchyard Control building

Following type of AC system is required in different areas:

Sl no.	Name of the Area	Min. Tonnage to be ensured (TR)	AC Equipment Type
1.	Control room	19.0	Precision PAC
2.	AHU room	5.0	
3.	Conference room	14.0	Split AC unit
4.	Office room - 1	4.0	Split AC unit
5.	Office room - 2	4.0	Split AC unit
6.	Electronic Test Lab	4.0	Split AC unit
7.	Staff room	6.0	Split AC unit

Air-conditioning shall be provided on continuous basis to maintain the specified inside conditions for above rooms in the building

AC equipment for various areas shall be provided as per Heat load estimates to be worked out during detailed engineering stage, however minimum capacity of AC units for various rooms shall be as per the table above.

A. Precision Package AC (Air cooled)

DX type air cooled precision package AC units shall be provided on 3 x 50% basis to cater the air conditioning heat load of control room.

DX type air cooled precision package AC units shall be top discharge type designed specifically for high sensible heat ratio applications such as control room.

Air cooled Precision AC shall be top discharge type designed specifically for high sensible heat ratio applications complete with scroll compressors (suitable for R407C/ R410a refrigerant only), motors complete with suction and discharge shut off valves, high pressure cut out, low pressure cut out, built in automatic capacity control, humidifier, strip heaters etc.



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One (1) No. fan and fin type air cooled condenser vapor inlet and liquid outlet connection for refrigerant, drain connection etc. One (1) no. evaporator coil and fan having direct expansion type copper tubes and aluminium fins. The evaporator fan shall be DIDW forward curved centrifugal fan.

The precision PAC unit shall have electronic expansion valve for superheat control.

The packaged AC units shall be kept in AHU room whereas condensing unit shall be kept outside nearby AHU room and the two are connected with suitably insulated copper refrigerant piping.

Outlet of all the package units shall be collected in a common plenum chamber through flexible canvass connection & volume control dampers. The conditioned air is then distributed to various AC areas through supply air duct along with diffuser (with volume control damper) running above false ceiling. The return air from all these areas shall be collected above false ceiling & shall be taken back to the AHU room. The return air to AHU room will be mixed with a fixed amount of fresh air before being circulated again.

On/ Off trip indications for Precision AC unit components shall be available at the unit mounted micro-processor based local panel.

B. Split type air conditioning unit

Non Duct-able Split Air Conditioners shall be provided in the rooms mentioned above.

Air Cooled Non Duct-able Split Air Conditioners shall be of minimum three star rating. These AC units shall be complete with hermetically sealed rotary compressors and air cooled condensers in the outdoor units with powder coated GI casing, built-in electrical items & supports and Indoor units housing dry panel type HDPE filters, cooling coils, evaporator fans with two speed drive motors, all encased in powder coated GI casings with swiveling type supply air grilles and decorative RA grilles and interconnecting refrigerant piping (duly insulated) between outdoor and indoor units and insulated drain piping, microprocessor based cordless remote control panel and 240V, single phase MCB with connecting cable for each split unit.

2.1.2 Design Criteria:

Ambient Conditions	DB in °C	WB in °C
Summer	42.6	26.6
Monsoon	30.9	25.8
Winter	20.8	18.4



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Desired Inside Condition	22 °C±1 °C 55%±5% RH	
Floor Area	As per control building layout- TB-3-377-316-008 R3	Sqft
Exposed glass area	As per control building layout- TB-3-377-316-008 R3	Sqft
Exposed wall area	As per control building layout - TB-3-377-316-008 R3	Sqft
Illumination Heat load	2	Watt per sq. ft
Equipment heat load	2.5 (Control room)	kW
Occupancy	As per heat load summary below	people
Fresh Air requirement	1.5	ACPH

- ✓ Additional design margin of 10% on grand total peak heat load has been considered while calculating the AC capacity as tabulated above.
- ✓ Heat load for the individual rooms shall be furnished by the contractor during the detailed engineering stage. Monsoons reheat and winter heating calculations shall also be furnished for approval.

2.1.3 SYSTEM DESCRIPTION

- a. GSS duct shall be of lock forming grade, zinc coated conforming to IS 277 with coating grade of 180 g/m². The ducting thickness shall be as follows:-

Large dimension of duct	Gauge
Up to 750 mm	24 G
From 751 to 1500 mm	22 G
From 1501 to 2250 mm	20 G
Above 2251 mm	18 G

- b. Duct sizing and fabrication shall comply with requirements of IS 655. Air distribution velocity shall be 7.62 m/s. (max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.5 m/s. for the diffusers/grills. In case of space constraint in certain areas velocity restrictions shall be relaxed.
- c. Ducting shall include damper with control arrangement at each branch off and wherever necessary.
- d. Supply air diffusers/ grilles (Frame and Louvers of Diffuser/ Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no volume control Damper.
- e. Acoustic insulation 25 mm thick of first 6 m of ducting after AHUs but limited to plenum.



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f. **Insulation**

S. N.	Surface	Insulation material	Insulation form	Thickness (mm)	Finish
1	AC Duct	Al foil faced Nitrile rubber	Roll / Slab	13	Al Foil Facing
2	Acoustic insulation of first 6M of ducting after AHUs but limited to plenum	Nitrile rubber foam (140 Kg/Cu.m density)	Roll / Slab	25	Perforated Al Sheet
3	Refrigerant Piping	Al foil faced Nitrile rubber	Roll / Slab	39	Al Cladding

g. Necessary air balancing shall be achieved through volume control dampers in the ducts.

h. Strip heater shall be provided in the common plenum in case the same is not standard part of PAC.

i. The pre- filters shall be of HDPE construction with G.I. frames of adequate thickness but not less than 20 SWG. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10 micron size particles.

j. The fine filters shall be having efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sandwiched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness. The filters may be in panels of size about 600 x 600 for easy handling.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall not exceed 1.5 m/sec. these high efficiency filters shall be provided with differential pressure switch with alarm.

k. Motorized fire damper with sensors, control etc. at strategic locations, as required. Provision of manual overriding operation through latch shall also be kept with the Motorized Fire Damper.

l. Supply air diffusers/ grilles (Frame and Louvers of Diffuser/Grilles shall be of at least 20 SWG GI sheet and 22 SWG M.S. No grilles should by any chance make any rattling sound during continuous operation. All grilles shall match the decor of the space duly powder coated) with volume control dampers.



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- m. 1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for AHU Room.
- n. MS brackets, M.S. frame & PVC drain piping for indoor & outdoor units respectively and fixing hardware like anchor bolts, nuts, fittings etc. as would be necessary for installation of above equipment shall be provided by the contractor.

2.1.4 OPERATION PHILOSOPHY

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

- i. The Precision Air Conditioners shall have following operating controls:
 - ON/ OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
 - Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.
- ii. The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:
 - High refrigerant pressure cutout.
 - Low refrigerant pressure cutout.
 - Cutout due to overload of all drive motors.
 - Stopping of evaporator fans in case of fire in the respective zone.
 - Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/ room mounted fire/ smoke detector through zonal fire panel.
- iii. Interlocks

The system components shall be interlocked with one another in the following way:
The compressor shall not start unless:

 - The condenser fans are running.
 - The evaporator fans are running.
- iv. The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

2.2.0 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



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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 15 air changes per hour (ACPH) for LT Switchgear room, Repair bay room, 5 ACPH for Store room & Record room, 20 ACPH for battery room, toilet & pantry rooms, 5 ACPH for cable spreader room.
- c) 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.
- d) Supply air fans of suitable capacity (CMH) & required static head (WC) each having pre filter/fine filter, rain protection cowl, bird screen and mounting arrangement shall be provided for positive pressurization of the LT Switchgear room. Back draft dampers will be provided at the air outlet areas of this room.
- e) Exhaust fans of suitable capacity (CMH) each having rain protection cowl, bird screen and mounting arrangement shall be envisaged for the following rooms:
 - i. Record room
 - ii. Store Room
 - iii. Repair bay
 - iv. Cable spreader
 - v. Toilet & Pantry rooms
 - vi. Battery room - Motors for the fans of this room shall be flameproof with epoxy painting.

These exhaust fans shall be of bifurcated construction with motor away from the air stream. These fans shall have spark proof construction.

Supply of washed air to battery room shall be through intake louvers provided in wall opposite to the exhaust fan.

✓ **Notes:**

- i. The axial fans for auxiliary buildings shall be of tube axial type / & propeller type (for toilets).
- ii. Ventilation fan calculation sheet and design criteria shall be submitted for customer/ Purchaser approval during detailed engineering stage.
- iii. Painting of all equipment and structures shall be provided and the colour & quality shall be subject to approval by the Client / Engineer.

2.3.0 ELECTRICAL REQUIREMENTS

- a. One (1) no. HVAC power distribution board (PDB) for extending power supplies to precision packaged units, fresh air fan, ventilation fans shall be provided in AHU Room. Two nos. incomers, each of 250 Amps, 3 ph. 4 wire rating from the ACDBs will be terminated in HVAC power distribution panel with a mechanical changeover switch and castle key interlock. Spare feeders shall be provided in the PDB as per customer specification.



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- b. Split AC units will be fed through DPMCBs for each of the units in the individual rooms.
- c. Ventilation fans of bigger size rooms such as Battery room, Cable spreader room, LT switchgear room & repair bay will be fed from PDB directly through three phase MCBs. Power supply points (single phase) for fans in other rooms will be provided by purchaser.
- d. Interlocking of PDB shall be done with Fire alarm panel to trip HVAC system in case of fire.

2.4.0 MANDATORY SPARES

Following mandatory spares shall be provided:

S. N.	Item	Qty
A	Precision PAC unit	
1.	Filters	1 set for each PAC unit
2.	Bearings	1 set for each rating of PAC unit (both for condenser & Indoor Unit)
3.	Expansion valve	1 set for each rating of PAC unit
4.	Refrigerant gas in a non-returnable cylinder	15% of installed charge
B.	Split AC unit	
6.	Vibration Isolators	1 set each for outdoor unit & Indoor unit for each SAC Unit
7.	Filter	1 set for each SAC unit
8.	Expansion valve	1 set for each rating of SAC unit
5.	Fan-motor bearing for outdoor unit	1 set for each rating of SAC unit
C	Electrical Spares	
9.	Air Break Switches	1 No. of each rating
10.	Control, Isolating and selector switches	1 No. of each rating
11.	MCB/ MCCB	10% of installed quantity
12.	Indicating Lamps	10% of installed quantity
13.	Indicating lamps cover of different colour and holders	5% of installed quantity
14.	Push Buttons of various colours	10 nos. of each type and colour
15.	Terminal Blocks	5% of installed quantity

*PAC- Package AC unit, SAC – Split AC unit



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3.0.0 SCOPE

The requirement(s) mentioned under this clause are indicative and minimum for the system. Any other item / service required to complete the work for safe and sound operation of system shall be provided and installed by the bidder at no extra cost to the purchaser / owner. The bidder may bring out such requirement(s) suitably.

3.1.0 SCOPE OF SUPPLY

3.1.1 Complete supplies for Air-conditioning & Ventilation system (as per clause no. 2.0)

The equipments and services to be furnished under this contract are detailed here under for reference. Bidders shall work out the actual requirement based on the building layout enclosed with this specification. The items though not specifically mentioned but required for safe and satisfactory operation of the system will also be treated as included and the same shall be supplied at **NO EXTRA COST** to BHEL.

- a) Air cooled Precision package units on 3 x 50% basis each complete with all components, pre-filters, controls, interlocking & other accessories.
- b) First charge of refrigerant and oil.
- c) One (1) lot of refrigerant piping, liquid line, discharge, suction valves as required.
- d) One (1) lot of insulation for refrigerant piping (suction line) as per Cl. No. 2.1.3 (f) of section-1.
- e) One (1) lot of pan humidifier complete with all accessories for control and interlocks.
- f) One (1) set of heaters in plenum chamber complete with controls.
- g) One (1) lot of GSS duct of lock forming grade, zinc coated conforming to IS 277 coating grade 180.
- h) One (1) lot of supply air diffusers with volume control dampers and necessary splitters.
- i) One (1) lot of return air diffusers without volume control dampers.
- j) One (1) lot of suitable fixtures for grills/ diffusers and support for ducting
- k) One (1) lot of Thermal insulation of supply air & return air ducting as per Cl. No. 2.1.3 (f) of section-1.
- l) One (1) lot of Acoustic insulation of supply air & return air ducting as per Cl. No. 2.1.3 (f) of section-1.
- m) One (1) no. fresh air unit as per Cl. No. 2.1.3 (m) of section-1
- n) One (1) lot of pre & fine filters as per Cl. No. 2.1.3 (i) & (j) of section-1.
- o) One (1) lot of Motorized fire damper as per Cl. No. 2.1.3 (k) of section-1



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- p) One (1) lot of 25 NB piping “B” class for the following:
 - i. Disposal of PAC’s condensate to nearest drain point.
 - ii. Water inlet to Pan Humidifier and connection of pan humidifier overflow to the nearest drain point.
- q) Non ductable Split AC units as per Cl. No. 2.1.1 B
- r) One (1) lot of ventilation fans for non AC areas as per Cl. No. 2.2.0
- s) One (1) no. Power distribution board for AC & Ventilation system having 2 incomers with mechanical interlock
- t) One (1) lot of cable accessories like lugs, glands, markers etc for power and control cables.
- u) One (1) lot of MS brackets, M.S. frame & PVC drain piping for indoor & outdoor Split AC units respectively and fixing hardware like anchor bolts, nuts, fittings. Base plates and foundation bolts including anchor bolts, nuts, loose fittings etc. for equipment and as would be necessary for installation of the all the above equipments.

3.1.2 Besides, the Bidder shall take a note of the following while preparing his offer:

- a) Supply of power & control cables have been excluded from contractor’s scope of supply. Bidders shall submit the requirement of power & control cables (cable size, type & quantity) for HVAC system alongwith their respective bids. BHEL will provide power & control cables to the vendor as free issue item. Contractor shall have to choose their cables from the available sizes as listed in Annexure – I to section-1 and necessary modifications in their equipment for termination of these cables shall be made by contractor.
- b) Purchaser will lay two incomer cables upto contractor’s PDB in AHU room. Termination of the same shall be done by the contractor. Cabling (laying & termination) further to other equipments, panels etc and for control & interlocking of various equipments shall be in contractor’s scope. Supply of cable accessories such as lugs, glands, cable tags & markers etc. shall be included by the bidders in their offers.
- c) Necessary cable trays will be supplied on free issue basis to the contractor, however necessary hardware for fixing the same on walls or elsewhere shall be included by the bidders in their offers.
- d) Earthing material viz. (GS flat 75 x 10, 50 x 6 & 25 x 3 mm) will also be supplied on free issue basis to contractor; however requirement shall be given by the bidders in their respective bids.
- e) Contractor shall submit valid Type test report for approval by owner. Fresh type test of equipment is not envisaged. It is presumed that equipment offered is duly type tested.
- f) In case the type test reports are found un-satisfactory, tests shall be carried out afresh by contractor without any additional cost implication to BHEL.



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- g) Bidder shall provide makes for all items for this system as per the makelist provided in Annexure – B to section-5 of this specification. All such makes shall be subjected to acceptance of TSGENCO during detailed engineering stage. No additional price implication shall be made to BHEL on account of non-acceptance of proposed makes by TSGENCO.
- h) Bidder shall submit quality plan of the items of this system during detailed engineering stage in standard BHEL quality plan format for customer approval.
- i) Obtaining, "As Built" certification from purchaser or owner on applicable drawings. Completing documentation as per specification requirement shall be in contractor scope of services.

3.1.3 SCOPE OF SERVICES

3.1.3.1 Erection, Testing & Commissioning (ETC) requirements

- i. The scope of ETC shall include receipt of material at site, 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. All material, consumables plus tools & tackles required for completion of ETC work shall be arranged by the Bidder.
- ii. Conducting performance guarantee tests to the satisfaction of Owner / Purchaser and handing over of the system to Owner / Purchaser. Bidder shall submit the PG test procedure at the time of detailed engineering for approval by owner/ purchaser.
- iii. It is the responsibility of the Bidder to maintain the system till it is handed over to Owner / Purchaser.
- iv. Cables laying for incomers to the HVAC Power distribution board (PDB) shall be done by the purchaser. The contractor has to lay and terminate all the other power and control cables supplied under the present scope.
- v. Earthing of all installation under the present scope shall be done by the contractor.
- vi. All machinery - tools & tackles and consumables required for erection / commissioning of the system shall be arranged by the bidder.
- vii. 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.
- viii. Piping from water tap-off to inlet of pan humidifier. Water tap-off shall be provided by the purchaser at one point inside the AC plant room.
- ix. Piping from overflow of pan humidifier & packaged unit (disposal of condensate) to the nearest drain point.



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- x. Cable laying & termination between Fire Alarm Panel (FAP) & PDB for HVAC system in order to switch off the system in case of fire.
- xi. Laying & fixing of cable trays on walls or elsewhere. Necessary hardware for the same shall be included by the bidder in their offer.
- xii. Painting of all the equipments shall be as per customer specification.
- xiii. Refrigerant piping, liquid line valves, suction, discharge valves, HP gauge provision shall be as per the standards and customer requirement.
- xiv. 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.

3.1.3.2 Civil Works

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

- a. Wall openings at suitable locations for duct, refrigerant/drain piping, Fresh Air unit & 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.
- b. Furnishing of details for construction of outdoor unit's mounting arrangement.
- c. Providing necessary guidance to/ coordination with civil contractor so that appropriate sized / correctly located cut outs are made (by civil contractor) in false ceiling for installation of grilles / diffusers / return air.
However in case wall openings / cut outs have not been provided for either duct laying, louver fixing, ventilation fan(s) or fresh air fan, the same shall have to be made by the Contractor.
- d. Minor modifications, alterations in system installation as per customer's specific requirements shall be done without any extra cost to purchaser.

3.2 Exclusions

- i. Supply of Cable trays for laying cables. Installation wherever required is in contractor scope.
- ii. Supply of power and control cables. The bidder shall choose from the BHEL procured cables listed in Annexure-I to this section & furnish **quantity** and **type** of cables required complete system in their respective bids. Laying & termination is in contractor scope.
- iii. Various rooms and foundations for locating air conditioning equipments.
- iv. Supply & installation of false ceiling and openings in false ceiling for diffusers as required.
- v. Underdeck insulation of the air conditioned areas.



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vi. Supply of GI flat for earthing of equipments.

3.3 Utilities Available

Construction water and 415 V power shall be available at one point each at the site. The contractor shall be required to make own arrangement for taking supplies from there.

3.4 Engineering Drawing/ Documents

Engineering shall start immediately after the award of the contract.

Submission of all drg. / data sheet – Within 4 weeks from the PO date.

Approval of all drg. / data sheet – Within 10 weeks from PO date.

3.5 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 supply of the various items. The O&M manual shall contain the following information:

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

3.6 Handing & Taking Over

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

3.7 Inspection & Testing

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

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



3.9 Various Heads to be quoted for

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

TABLE-I

Sl. No.	Item Description	Unit	Qty	Supply (Exworks)		ETC	
				Unit Rate	Total Amt.	Unit Rate	Total Amt.
A.	Air Conditioning System						
i.	Precision PAC units complete with compressor, blower, expansion valve, outdoor condenser, filters, pan humidifier, heater, refrigerant piping, insulation with fittings, drain piping, other fixing hardware etc.	Nos.	3				
ii.	AC ducting fabricated from GSS having zinc coating 180g/m ² complete with hangers, supports, joints/washers, dampers, grills, diffusers (with or without VCD), motorized damper, other fixing hardware etc.	Lot	1				
iii.	Supply/ Return air grills/ diffusers with/ without VCD complete with fixing arrangement	Lot	1				
iv.	Acoustic Insulation	Lot	1				
v.	Thermal Insulation	Lot	1				
vi.	Split AC units of 2TR capacity	Nos.	16				
vii.	Power Distribution board	No.	1				
B.	Ventilation Fans						
i.	Supply air fans with Pre/ fine filters, rain protection cowl, bird screen other fixing hardware etc.	Lot	1				
ii.	Exhaust air fans with rain protection cowl, bird screen, other fixing hardware etc.	Lot	1				
C.	Mandatory Spares as per Cl. No. 2.4.0	Lot	1			NA	



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ANNEXURE - I

LIST OF THE CABLES PROCURED BY BHEL

2C x 2.5 sq mm PVC/Copper, Armoured
5C x 4 sq mm PVC/Copper, Armoured
5C x 2.5 sq mm PVC/Copper, Armoured
7C x 2.5 sq mm PVC/Copper, Armoured
14C x 2.5 sq mm PVC/Copper, Armoured
19C x 2.5 sq mm PVC/Copper, Armoured
2C x 10 sqmm XLPE/Aluminium, Armoured
4C x 10 sqmm XLPE/Aluminium, Armoured
4C x 16 sqmm XLPE/Aluminium, Armoured
3.5C x 35 sqmm XLPE/Aluminium, Armoured
3.5C x 70 sqmm XLPE/Aluminium, Armoured
3.5C x 300 sqmm XLPE/Aluminium, Armoured



SECTION -2

EQUIPMENT SPECIFICATION

1.0.0 The design, manufacture, inspection and testing of Air-Cooled Packaged Precision AC Units 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: 659 - Safety Code for Air-Conditioning
- IS: 8148 - Specifications for Package Air Conditioners
- 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 AC - Ventilation fans
- BS: 6540 Part I - Air Filters used in Air-Conditioning & General Ventilation
- IS: 4671 - Expanded polystyrene for Thermal Insulation purpose
- IS: 8183 - Bonded Mineral wool

1.0 GENERAL DESIGN AND CONSTRUCTIONAL REQUIREMENT

It is not the intent to specify herein all the details of design and manufacture. However, the equipment and the system 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 with technical specification.

Besides, the following shall be noted:

- a. All the equipment shall be capable of withstanding the stresses, which may be experienced during normal operation and test.
- b. All the equipment shall be designed to permit inter-changeability of parts and ease of access during inspection, maintenance, installation and repair of various parts.
- c. All parts subject to substantial temperature changes shall be designed and supported such as to permit free expansion or contraction without resulting in leakage, harmful distortion misalignment or play.



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- d. Proposal for repair or any similar operations involving the plugging welding, boring or addition of metal to the original castings shall be submitted to the Purchaser/Owner and approval shall be received before any such work is carried out. Drawing showing details and locations of such modifications shall be submitted to the Purchaser/ owner for his records.
- e. The separate pieces of equipment shall be marked with unit number the assembly drawings shall indicate part number of each equipment and unit number for easy correlation.
- f. Coupling guards and belt guards shall be furnished as applicable.

2.0 EQUIPMENT SPECIFICATION

2.1 PACKAGED AIR CONDITIONING UNIT

Unit shall be suitable for indoor and outdoor installation. GTP for PAC units shall be as per manufacturer's standard subject to acceptance of ultimate client. **Refer Cl. No. 6.12.02 of TSGENCO - DCPL- AC System specification provided as Annexure – I to section – 2 for detailed equipment specification.**

2.2 AIR DISTRIBUTION SYSTEM

2.2.1 Ductwork

The ductwork inside the building shall be manufactured from hot-dip galvanized sheet complying with IS-277 with coating grade of 180 g/m². Fabrication shall conform IS: 655.

Refer Cl. No. 3.08.00 & 6.10.00 of TSGENCO - DCPL- AC System specification provided as Annexure – I to section – 2 for detailed equipment specification

2.3 INSULATION

2.3.1 Thermal Insulation

The entire supply air and return air ducting for air conditioning system shall be insulated with at least 13mm thick aluminium foil faced Nitrile Rubber / XLPE Insulation.

Refer Cl. No. 6.11.00 of TSGENCO - DCPL- AC System specification provided as Annexure – I to section – 2 for detailed equipment specification

2.3.2 Acoustic Insulation

All supply air ducts in the air conditioning system shall be insulated with Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner.

Refer Cl. No. 6.11.02 of TSGENCO - DCPL- AC System specification provided as Annexure – I to section – 2 for detailed equipment specification



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2.4 FILTERS

2.4.1 Pre Filters

Refer Cl. No. 6.09.01 of TSGENCO - DCPL- AC System specification provided as Annexure – I to section – 2 for detailed equipment specification

2.4.2 High Efficiency Filters (Micro-vee fine filters)

Refer Cl. No. 6.09.01 of TSGENCO – DCPL- AC System specification provided as Annexure – I to section – 2 for detailed equipment specification

2.5 VALVES

2.5.1 Refrigerant Valves

All refrigerant valves as may be applicable shall have steel body with flange connection or sweat connection for welding to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. It is preferable to have the stem of rising stems inside screw type. The valve body and bonnet connection shall have bolted or welded connection.

It is preferable to have Teflon gland packing for the valves. The construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak tightness of the valves shall be tested at minimum 1.5 times the design pressure of the system.

2.5.2 Other Valves

All valves shall be suitable for service condition i.e. flow, temperature & pressure under which they are required.

2.6 AXIAL FLOW TYPE EXHAUST FANS FOR VENTILATION

Refer TSGENCO – DCPL- Ventilation System specification provided as Annexure–II to section – 2 for detailed equipment specification

2.7 PANELS

2.7.1 POWER DISTRIBUTION BOARD

Refer TSGENCO – DCPL- Switchgears specification provided as Annexure–III to section – 2 for detailed equipment specification



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3.0 QUALITY

3.1 Quality Plan

The Quality plan format for quality plan is given at section 5. Contractor shall submit duly filled in quality plans for approval of purchaser / owner.

3.2 Field Quality Plan

The bidder shall submit the field quality plan for approval of Purchaser / owner. Various checks required beginning receipt & storing of material to commissioning of system should be mentioned in field quality plan.

3.3 Performance Guarantee Test

After complete installation at site, the Air conditioning and Ventilation systems shall be subjected to tests to show achievement of guaranteed parameters in line with the requirements of specification/ standards/ codes and to the satisfaction of Purchaser/ Owner. **The contractor shall submit a detailed PG Test procedure for purchaser/ customer approval.**

Pre-Requisites to the PG Tests

- The responsibility for conducting the tests and arrangement of necessary instruments rests with the contractor.
- The contractor shall furnish a written statement to the effect that work covered in the contract has been completed for the system for which PG tests will be carried out.
- All the erection/ commissioning protocols in respect of alarm/annunciation/control system, vibration and noise level data of packaged unit commissioning shall be made available during PG test.
- All approved data sheets for the plant/system for which PG test is to be carried out, shall be made available during PG test.
- Uninterrupted Power supply within specified parameters for the duration of the tests.
- All instruments required for the PG test shall be provided by the contractor.
- Calibration of the testing equipments from a govt. approved laboratory shall be the responsibility of the contractor.
- Cleanliness of Plant/ System
- The plant/ system shall be jointly inspected by OWNER and contractor. A joint protocol shall be signed that the plant is fit for PG test.
- Joint protocol of overall record/ test shall be signed at the time of PG test.

ANNEXURE-I TO SECTION - 2

**TECHNICAL SPECIFICATION
FOR
AIR CONDITIONING SYSTEM**

VOLUME: IIID

SECTION - I

AIR CONDITIONING SYSTEM

CONTENTS

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2.00.00	SYSTEM DESCRIPTION
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4.00.00	CONTROL PHILOSOPHY
5.00.00	DESIGN CRITERIA
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12.00.00	SPECIAL CLEANING, PROTECTION & PAINTING
13.00.00	DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL
14.00.00	POST AWARD DOCUMENTS, DATA TO BE FURNISHED
15.00.00	LIST OF DRAWINGS

VOLUME: IIID
SECTION – I

AIR CONDITIONING SYSTEM

1.00.00 **INTRODUCTION**

1.01.00 The purpose of the system is to provide Air Conditioning System for the different areas of 1X800 MW Supercritical Thermal Power Plant, Stage – VII Unit #12 at Kothagudem Thermal Power Station, Telangana.

Various control rooms in power station, housing a group of sophisticated and precision control panels and desks call for controlled environment for proper functioning and for the comfort of working personnel.

2.00.00 **SYSTEM DESCRIPTION**

2.01.00 The air conditioning system shall cover the following areas as a minimum:

- a. ~~Power House Building including Control Room~~
 - i. ~~Unit Control Room~~
 - ii. ~~Control Equipment Room (CER)~~
 - iii. ~~Shift Charge Engineers' Rooms~~
 - iv. ~~Computer Room~~
 - v. ~~Uninterrupted Power Supply (UPS) Room~~
 - vi. ~~Steam and Water Analyzer (SWAS) Panel Room (Dry Panel)~~
 - vii. ~~Excitation room~~
 - viii. ~~AVR room~~
 - ix. ~~Relay panel room~~
 - x. ~~Other Office areas like Telephone Exchange Room, Conference Hall, library, Laboratory Rooms etc, if any, on the operating floor~~
- b. ~~Service Building~~
 - i. ~~Maintenance Office areas, conference rooms, lecture rooms and any other areas needs Air Conditioning.~~
 - ii. ~~AC plant control room (in Central AC plant equipment room proposed to be located in ground floor of Service Building)~~
- c. ~~ESP Control Room.~~
- d. ~~VFD Control Room (if applicable)~~
- e. ~~Ash Handling Plant Control Room~~
- f. ~~DM plant control room, office and Laboratory area.~~

- g. Switchyard Control Room.
- h. ~~Chemical Laboratory Building.~~
- i. ~~Coal Handling Plant control room~~
- j. ~~Any other Local Control Rooms / Cubicles of different Auxiliary Buildings housing Programmable Logic Controllers (PLC) Panels and other Input / Output (I/O) modules~~
- k. ~~Rooms having the equipment required controlled temperature by nature for their operating feature.~~
- l. ~~Any other area requiring Air conditioning as per manufacturer's recommendation.~~

~~All the buildings described above shall preferably be provided with separate air conditioning systems because they may be far apart from each other.~~

- 2.02.00 ~~For the Power House Building and the attached Service Building, one Common Central Chilled type Air Conditioning plant shall be provided with individual Air Handling Units / Fan-Coil Units (as applicable) for the Unit Control Room, Control Equipment Room, Shift Charge Engineer's Room, Computer Room, Uninterrupted Power Supply (UPS) Room, Excitation Room, AVR Room, Relay Panel Room, SWAS (Dry Panel) Room, all Laboratory Rooms and other Office areas, Telephone Exchange Room, Conference Hall, and Library etc, if any, on the operating floor.~~
- 2.03.00 ~~Water Cooled Precision air Conditioners of 3 x 50% capacity shall be provided for the ESP Control room, VFD Control Room (if applicable), AHP Control Room, DM Plant Control Room and its associated office and Laboratory and Chemical Laboratory Building. Condenser cooling water for these Air Conditioners shall be supplied from main plant ACW system through Non-Chemical Water Treatment Device. Provision of a Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.~~
- 2.04.00 ~~Air Cooled Packaged Units (Precision Type) will be used for air conditioning of the Switch Yard Control room and CHP Control room. Provision of a Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.~~
- 2.05.00 ~~Air cooled non duct able Split Air Conditioners shall be provided for Rooms / cubicles housing Programmable Logic Controllers (PLC) and other Input / Output (I/O) modules or any other area requiring for Air conditioning. Required no. of AC units of suitable capacity should be selected with 100% units as stand-by for AC areas having 24 hours operation. For AC areas with less than 12 hours operation, stand-by units may be avoided if multiple units are installed.~~

- 2.06.00 The systems described above are only minimum requirement. Any other area/areas, if felt by the Bidder himself or by the Purchaser/their consultant, or if demanded by the process/equipment should be air conditioned, shall be included in Bidder's scope of work.
- ~~2.07.00 The foregoing and subsequent clauses specify the equipment/system for general guidance only. Any other equipment and /or materials necessary to ensure safe and satisfactory erection, commissioning and operation of the plant shall be supplied.~~
- ~~2.08.00 The air conditioning requirement for different areas are as follows:~~
- ~~2.08.01 One Common Central chilled water Air Conditioning system consisting of 2x100% Packaged Screw type Chiller Units associated with 2 x 100 % capacity Chilled water pumps, 2 x 100 % capacity Condenser water pumps , 2 x 100 % capacity Cooling towers and controls & instrumentation to serve the Unit Control room, Control Equipment room, Computer room, UPS room, SWAS (Dry Panel) room and Shift Charge Engineer's room, AVR Room, Excitation Room, Relay Panel Room, Other Office areas, telephone exchange room, Conference Hall, library and Laboratory etc, if any, located in the Power House building and all the floors of the attached Service Building.~~
- Clarified water shall be used as the make-up to cooling towers. This condenser cooling water will be treated through the Non-Chemical Water Softening Equipment installed in the common header of Condenser water pump outlets.
- ~~2.08.02 Unit Control Room & Shift Charge Engineer's Room, Computer Room, Control Equipment Room and UPS room in the Control Building will be served by at least 2 nos. each of 50% capacity AHUs located in the AHU Room.~~
- ~~For SWAS (Dry Panel) Room and Shift Charge Engineer's Room, AVR Room, Excitation Room, Relay Panel Room, Other Office areas, Telephone Exchange Room, Conference Hall, Library and Laboratory etc, if any, and the attached Service Building individual AHUs/ Fan Coil Units shall be provided. Each floor of Service Building shall have separate AHUs. For each room / area at least 2 nos. AHU/FCU shall be provided.~~
- ~~However, the combination of areas to be served by AHUs / FCUs will depend upon the actual layout when the building drawings will be finalized.~~
- 2.08.03 1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each AHU Room serving critical areas like Control Room, Control Equipment Room, UPS room, AVR Room, Excitation Room, Relay Panel Room, Telephone Exchange Room, Laboratory, etc.
- For other non-critical areas like Office areas, Conference Hall, Library, various floors of Service Building fresh air will be inducted in the AHU room through the wall mounted rain protection cowl with bird screen and a volume control damper.

1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room serving critical areas like ESP Control Room, VFD Control Room (if applicable), Ash Handling Plant Control Room, Chemical Laboratory Building, DM Plant Control Room, Office and Laboratory area, Switchyard Control Room and Coal Handling Plant Control Room etc.

Fresh air for small areas like SWAS room, AC plant control room, small office and control rooms fresh air will be inducted through door opening.

2.08.04 1 x 100 % capacity Electrode Type Humidifier with associated controls and accessories shall be provided in each AHU room serving critical areas of Power House Building.

2.08.05 Provision of Duct mounted Electric Strip heater and High Efficiency Filter shall also be kept with the common supply duct from the AHUs serving critical areas like Unit Control Room, Shift Charge Engineer's Room, Computer Room, Control Equipment Room, UPS Room, AVR Room, Excitation Room, Relay Panel Room, telephone exchange room, Laboratory, etc.

Duct mounted Electric Strip heater shall be provided with the common supply duct for non-critical areas like Office, Conference Hall, library, various floors of Service Building etc.

2.08.06 Smoke Evacuation system consisting of smoke exhaust fans with ducting, motorized isolating dampers and rain protection cowl with bird screen shall be located in AHU rooms serving control room and associated areas of Power House building.

2.08.07 Exhaust fans of required capacity & quantity to be provided for Central AC plant equipment room.

3.00.00 **SCOPE OF WORK**

Scope has been defined under subsequent Clauses.

3.01.00 **Central Chilled Water Air Conditioning Plant** (Common for Power House Building and Service Building)

The central chilled water AC plant consists of the following equipment:

3.01.01 Two (2) Nos. (one as running and one as stand-by) Water Cooled Screw Chiller Unit of adequate capacity and each consisting of:

a) One(1) / Two(2) Nos. Screw Compressors (As per Manufacturer's standard).

Type: Rotary Screw type, hermetic/semi- hermetic, directly driven, R-134a duty.

Accessories include suction and discharge shut-off valves, discharge check valve, oil Separator, oil heater, HP, LP, Low oil level cutout, high winding temperature cutout through PTC sensors, Motor overload cutout, liquid Injection system, integrated pressure relief valve, oil service valve, Step less Automatic capacity control arrangement with automatic unloaded starting device, Anti Recycle device, Heater, Setting and Overhauling tools, foundation bolts, vibration isolating device etc.

Adequately sized Induction Motor (for the above compressors) suitable for $415V \pm 10\%$, 3 phase, $50Hz \pm 5\%$ AC. AC Supply.

b) One(1) No. Refrigerant Condenser.

Type :Water cooled, horizontal, shell and tube R-134a duty & capacity to match the above compressor with integrally finned copper tubes with steel shell having adequate surface area to cater to the requirement of the above compressor & to provide sub-cooling by 2 Deg. C at least.

Design fouling factor : Not less than .0002 Hr. Sq. M. $^{\circ}C/Kcal$ (.001 Hr-Sq. ft $^{\circ}F/BTU$).

Heat removal and water flow rate :To be calculated and furnished by be Bidder.

Accessories: Relief valve, vent connection with valve, De-scaling connection, charging connection, water flow switch, drain connection with valve. Thermo-well connections on water side, liquid trap etc.

c) One(1) No. Refrigerant Chiller.

Type : Horizontal shell and tube direct expansion/flooded type R-134a/water duty with copper tube having adequate surface area to provide superheating by 3 Deg.C.

Design fouling factor : Not less than 0.00013 hr-Sq. m. $C/Kcal$ (0.00065 hr-Sq. ft. Deg. $F./BTU$).

Heat removal and Water flow rate: To be calculated and furnished by the Bidder.

Accessories: Liquid and water connection provided with thermo-wells, water flow switch and pressure gauge connections.

At least 39 mm thick insulation of Aluminium foil faced Nitrile Rubber /XLPE or equal, with removable type insulated flange cover, water side drain connection with valve in every portion of the chiller isolated by baffle plates.

- d) Piping & Auxiliaries : Common base frame for compressor, condenser, chiller unit fabricated of M.S. angles, channels etc. anchor bolts, nuts, hot gas piping, cold gas piping, liquid refrigerant piping all of seamless steel or ERW steel pipes, insulation of cold gas piping with minimum 39 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal liquid valves, muffler if needed, gauges and instrument piping, filters, drier, moisture indicator isolating valves etc. as may be required for safe and trouble free operation. The entire chiller package assembly shall be installed with spring type vibration isolation devices (One set for each chiller unit)

Equipment drain water connection with siphon and valves, fittings etc. up to the nearest drain point with proper insulation shall also be included.

- e) Controls: Electronic expansion valve, solenoid valve in the refrigerant circuit, operating temperature sensor and anti freeze thermostat/ sensor.

Microprocessor based control panel of each chiller unit will provide safety against high & low refrigerant pressure, low oil pressure, freezing of chilled water, overload, winding heating and single phasing and phase reversal of compressor by means of high & low pressure transmitter, oil pressure transmitter, temperature sensors & transmitter, O/L relays, Thermistor relays, etc. and other safety Controls including Over/Under voltage and voltage unbalance protection, over/under current and current unbalance protection and others as per manufacturer's standard.

It will also provide capacity control by sensing low chilled water return temperature through operating temperature sensor and motorized sliding valve. Other safety devices like flow switches for the condensers and chillers, compressor unloaded starting device shall also be provided through Microprocessor based control panel. (One set for each chiller). Such Microprocessor based Control Panel shall be provided with 20% extra properly wired I/O units.

- f) Oil and Refrigerant: First charge of refrigerant R-134a and oil for the above chiller units.

- 3.01.02 Condenser cooling water piping of MS ERW (heavy grade) complete with valves, fittings, hangers / supports. between cooling towers and condensers (of Screw Chiller Units) including the condenser cooling water pumps complete with valves, bends, strainers, fittings, instruments, hangers and supports etc. Equipment drain water connection and valves, fittings etc. up to the nearest drain point shall also be included. A single line diagram in this connection is to be furnished by the Bidder.

- 3.01.03 Chilled water piping connecting the chillers(of Screw Chiller Units), chilled water pumps and cooling coils of air handling units / FCUs and expansion tank, complete with valves, bends, strainers, fittings, instruments, hangers and supports, insulation etc. A single line diagram in this connection is to be furnished by the Bidder.
- The insulation shall be at least 39mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal (Refer elsewhere for detailed specification of insulation). For Chilled water drain pipes the insulation thickness shall be at least 26 mm.
- 3.01.04 Make up water piping of medium class GI complete with fittings, hangers / supports from Make-up Water tank through booster pumps (1R+1S) to various points of consumption like cooling tower sumps, expansion tank and Humidifiers.
- 3.01.05 Two (2) Nos. (1 working + 1 Stand-by) Condenser Cooling Water Pumps to meet the requirement of the Central Chilled Water plant.
- Type : Centrifugal, horizontally split casing / end suction type, single stage directly coupled to electric motor and mounted on a common base frame.
- Speed : Preferably not more than 1500 rpm.
- Capacity and Head : To be calculated and furnished by the Bidder.
- Duty : Continuously running.
- Accessories : Pressure gauges at suction and discharge, isolating valves, all integral piping, required for sealing, cooling etc. strainers, check valves, flexible coupling guard, foundation bolts and nuts etc. and other standard accessories as may be necessary for successful operation. Vibration isolators shall also be supplied. Condenser water pumps shall be provided with mechanical seals.
- Motor for the above : Adequately sized TEFC, squirrel cage induction motor, suitable for 415 V $\pm$ 10%, 3 pH, 50 Hz $\pm$ 5% supply.
- 3.01.06 Two (2) Nos. (1 working + 1 stand-by) Chilled Water Circulating Pumps for all areas.
- Type : Centrifugal, horizontally split casing / end suction type, single stage directly coupled to electric motor and mounted on a common base frame.
- Speed : Preferably not more than 1500 rpm.
- Capacity and Head : To be calculated and furnished by the Bidder.
- Accessories : Pressure gauges at suction and discharge, isolating valves, all integral piping required for sealing, cooling etc. strainers, check valves, flexible coupling guard, foundation bolts and nuts, complete insulation with minimum 39 mm thick Nitrile Rubber /XLPE or equal with 24G aluminium sheet cladding. For the pumps, vibration isolators shall also be supplied. Chilled water pumps shall be provided with mechanical seals.

Duty : Continuously running.

Adequately sized, TEFC squirrel cage induction motor suitable for 415 V $\pm$ 10%, 3 Phase, 50 Hz $\pm$ 5% supply for the above.

- 3.01.07 Two (2) Nos. (1 working + 1 stand-by) Cooling Tower Induced draft cross/counter flow type to meet the requirement of the Central Chilled water plant. Design Wet bulb temp. will be 27.6 $^{\circ}$ C with a approach (Maximum) of 4.0 $^{\circ}$ C.

Construction of various components will be as under:

Casing	:	FRP
Louver	:	FRP
Fill	:	PVC
Drift eliminator	:	PVC
Strainer	:	Brass wire mesh
Headers and pipe connection	:	G.I.
Basin	:	R.C.C./FRP
Nuts and Bolts etc.	:	Suitable corrosion resistant material i.e. G.I. or cadmium plated.

Accessories include supports, supporting structure, make-up water piping with float valve, drain connection with siphon and valve, over flow and quick fill connections etc.

- 3.01.08 Expansion Tank

The expansion tank shall be made of G.I or FRP and shall be of adequate thickness & suitably reinforced. It shall be complete with make-up connection with float valve, quick fill connection, overflow connection and drain connection with valve. The tank shall be provided with level gauge glass and shall be completely insulated with 6 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal. The capacity shall be selected based on 1.2% of circulated chilled water capacity. Filtered water shall be supplied as make-up.

- 3.01.09 Make-up water Tank

The Make-up water tank shall be made of G.I or FRP and shall be of adequate thickness & suitably reinforced. It shall be complete with make-up connection with float valve, quick fill connection, overflow connection and drain connection with valve. The tank shall be provided with level gauge glass. This tank will supply make-up water to Cooling towers, Expansion tank and

- humidifiers. The tank size is to be designed based on capacity to hold water for 15 minutes of make-up water requirement for above.
- 3.01.10 Two (2) Nos. (1R+ 1S) Make-up Water Booster pumps.
- Mono block type centrifugal pump to supply make-up water from the Make-up water tank to the Cooling towers, Expansion tank and humidifiers, each complete with drive motor, common base plate, isolating valves, non return valve etc.
- 3.01.11 One(1) No. on line Non-chemical water treatment equipment to suit the common condenser water header. The equipment shall be complete with flanges at ends and supports.
- 3.02.00 **Air Handling Units/Fan Coil Units with controls**
- Number and individual capacities of Air Handling Units/Fan Coil Units should be calculated and furnished by the Bidder. Each A.H.U. shall consist of the following:
- 3.02.01 DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor suitable for AC 415V $\pm$ 10%, 3 Ph, 50 Hz $\pm$ 5% supply shall be provided. M.S. Scroll casing of the fan will be suitably painted.
- Accessories include V-belts with pulleys, belt guard, supporting frame, volume control damper etc.
- NOTE: For small FCUs single phase motors shall be used.
- 3.02.02 1 No. Cooling Coil will be provided in each AHU. The cooling coil will be chilled water circulating type.
- Construction will be seamless copper tubes with aluminium fins, number of fins as per manufacturer's standard but not greater than five (5) per Cm. [thirteen (13) per inch].
- Design fouling factor will be 0.00013 hr-Sq. m.- $^{\circ}$ C/Kcal.
- 3.02.03 Panel type dry HDPE filter having an efficiency of 90% down to 10 micron size particles will be provided. A differential pressure sensor shall be provided across the filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.
- 3.02.04 AHU will have Double skin G.I casing (Sand witched panel with internal insulation of min. 25mm thick TF quality Expanded polystyrene/ PUF) with inspection facilities, supports made in a 16-G M.S. structure of sectionalized construction with one coat of rust proof anti-corrosive paints followed by two coats of final paint and complete with insulated SS drain pan, insulated drain piping etc. The AHUs shall be cabinet type with Fan section, Coil section and filter section. Adequate space between Filter section and Coil section shall be

kept for maintenance purpose and proper air flow. Fan section also shall have adequate maintenance space all around the fan and motor.

- 3.02.05 One set of operating controls consisting of motorized modulating 3-way mixing valve with cooling coils of AHUs and FCUs with temperature sensor, transmitter and actuator for controlling the flow of chilled water, will be provided. Small FCUs shall have multi-speed motor.

3.03.00 Fresh Air System

Fresh air unit for Control room areas and areas served by Precision air conditioners shall consist of a tube axial flow/centrifugal fan with drive motor, inlet louver with bird screen, dry panel HDPE filters, volume control damper, supports, supporting structures etc. 1 x100% capacity Fresh air unit shall be provided in each AHU room / PAC room. A differential pressure sensor shall be provided across each set of filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

For Fan coil unit, there shall be provision for suitable arrangement of fresh air intake from the nearest evaporative cooling units.

For Service Building and other non-critical areas, fresh air opening with air inlet louver and a volume control damper shall be provided in the AHU room.

3.04.00 High Efficiency Filter

High efficiency filter having an efficiency of 99 % down to 5 microns mounted in supply air duct is to be provided for air conditioning of all control rooms and allied area. A differential pressure sensor shall be provided across the filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

3.05.00 Electrode Type Humidifier

Electrode humidifier consists of high temperature Polypropylene water tank, electrodes, auto flash cycle activated on demand from the microprocessor based control system with humidity sensor, located in the AHU room for control room areas of Power House building. This Humidifier shall also be complete with make up connection with float valve, overflow connection and drain connection with valve.

3.06.00 Electric Strip Heaters

Electric strip heaters will be of adequate capacity mounted in supply air duct with thermostat, humidistat, air stat/safety thermostat and controlling temperature sensor etc. (For winter heating purpose and for monsoon reheat purpose.) for control room areas of Power House building.

Electric strip heaters will be of adequate capacity mounted in supply air duct with thermostat, air stat/safety thermostat and controlling temperature sensor etc. (For winter heating purpose) for various floors of Service Building.

3.07.00 Smoke Exhaust System

Smoke Evacuation system consisting of smoke exhaust fan with ducting and motorized isolating dampers with cowl & bird screen shall be located in AHU rooms servicing Control room areas of Power House building. The fan and motor shall be designed to withstand a temperature of 400 Degree C for 2 hours.

3.08.00 Duct Work

Duct work includes:

- a) G. I. Duct having zinc deposition of at least 180 gm/m².
- b) Damper with control arrangement at each branch off and wherever necessary.
- c) All supply & return air grilles and diffusers made of extruded aluminum powder coated and complete with volume control dampers (for SA grilles/diffusers only) and supporting frames.
- d) Flexible connections of rubberized canvas.
- e) Hangers and supports.
- f) Sealing compound and jointing gasket for ducts.
- g) 13 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal or equivalent thermal insulation for the entire air conditioning ducting.
- h) Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner outlet.
- i) Motorized fire damper with sensors, control etc. at strategic locations, as required. Provision of manual overriding operation through latch shall also be kept with the Motorized Fire Damper.

3.09.00 Water Cooled Precision Air Conditioners

(Applicable for ESP Control room, VFD Control Room (if applicable), AHP Control Room, Chemical Laboratory Building and DM Plant Control Room and its associated Office and Laboratory)

Water Cooled Precision Air Conditioners shall be complete with scroll compressors (suitable for R-410/407c refrigerant) and water cooled shell and tube condensers, interconnecting refrigerant piping (duly insulated) between condensers and PAC units, evaporator fans with highly efficient EC motors and their controls, high efficiency filters, cooling coils with electronic expansion valve, electrode type humidifiers with controls, electric strip heaters, thermally and acoustically lined powder coated MS casing, insulated SS drain pan, insulated

drain piping, and built-in microprocessor based control panel.

Such Air Conditioners will be associated with air distribution system consisting of a GI duct - work as elaborated above, Non Chemical Water Treatment Equipment at the inlet to the condensers of PAC .Condenser cooling water will be fed to the condenser from the Plant ACW system.

3x 50% capacity Precision AC Units are to be provided each for each PAC room.

Provision of introducing fresh air into the PAC unit room shall be kept through Fresh Air Unit as described earlier.

3.10.00 Air Cooled Precision Air Conditioners

(Applicable for Switch Yard Control room and CHP Control room)

Air Cooled Precision Air Conditioners shall be complete with scroll compressors (suitable for R-407C / 410A refrigerant) and remote air cooled condensers, interconnecting refrigerant piping (duly insulated) between outdoor condensers and indoor PAC units, evaporator fans with highly efficient EC motors and their controls, high efficiency filters, cooling coils with electronic expansion valve, insulated SS drain pan electrode type humidifiers with controls, electric strip heaters and built-in microprocessor based control panel thermally and acoustically lined powder coated MS casing and insulated drain piping. Such Air Conditioners will be associated with air distribution system consisting of a GI duct - work as elaborated above.

3x 50% capacity Precision AC Units are to be provided each for each PAC room.

Provision of introducing fresh air into the PAC Unit Room shall be kept through Fresh air unit as described earlier.

3.11.00 Air Cooled Non Duct-able Split Air Conditioners

(Applicable for rooms/cubicles housing PLC and other I/O units, computer room and any other area requiring air conditioning)

Air Cooled Non Duct-able Split Air Conditioners shall be complete with hermetically sealed rotary compressors and air cooled condensers in the outdoor units with powder coated GI casing, built-in electrical items & supports and Indoor units housing dry panel type HDPE filters, cooling coils, evaporator fans with two speed drive motors, all encased in powder coated GI casings with swiveling type supply air grilles and decorative RA grilles and interconnecting refrigerant piping (duly insulated) between outdoor and indoor units and insulated drain piping, microprocessor based cordless remote control panel and 240V, single phase MCB with connecting cable for each split unit.

Required no. of suitable capacity should be selected with 100% units as stand-by for all rooms/ cubicles housing PLC and other I/O units/ computer room running for 24 hours.

For AC areas with less than 12 hours operation, stand-by units may be avoided if multiple units are installed.

3.12.00 Electrical Work

3.12.01 One (1) 415 V Motor Control Centre (MCC) for operation and control of the complete Central AC system required for the Power House Building and the associated Service Building. The MCC be shall be located in the central Air-Conditioning Plant room.

Each MCC shall be fed by 2 x 100% incoming feeders, which shall be located at either end of the panel.

3.12.02 One (1) no. Local Starter Panel (LSP) for each AHU room of Power House Building and attached Service Building. This LSP will house In-coming MCB, outgoing starter for all drives located in AHU room and MCB for heaters, humidifiers and FCUs.

3.12.03 One (1) 415V Power Distribution Board (PDB) each for supplying power to the PAC units of each Auxiliary Building.

Each PDB shall be fed by 2 x 100% incoming feeders, which shall be located at either end of the panel.

3.12.04 Non Duct-able Split units shall be fed from local distribution board / nearest power source available in the respective building.

3.12.05 All the Electrical items as described above shall be as per relevant volume of the technical specification on electrical work.

3.12.06 DDC Based Control Panel

- I. Control, monitoring, operating and safety controls & interlocks, indication and audio-visual annunciation for all AC equipment of the Central Chilled Water Plant and AHU rooms shall be activated from central DDC based Control Panel located in the AC plant control room.
- II. Power shall be fed to this DDC Panel from the MCC located in the Central AC plant room. This DDC panel shall be interfaced with the MCC, Individual Microprocessor based Control panels of Chillers and LSPs located in AHU rooms.
- III. This DDC panel shall be associated with two nos. Workstations (Engineering & Operating).
- IV. The DDC System shall consist of:
 - a) One (1) no. DDC panel housing Direct Digital Controllers for Central Air Conditioning System. The DDC panel shall be suitable for HMI interfacing directly with sensors, actuators and environmental delivery systems (i.e., all component equipment and accessories of AC system), controls and monitoring for the central AC System. This Control system along with one work station shall be complete with necessary software & Licenses (OS cum ES) for control

and monitoring of the Central AC System and generation of alarm list, report etc.

- b) One (1) no work station complete with suitable Central Processing Unit (CPU) Key Board, Mouse and Video Display Unit (VDU) with 21 inches monitor.
- c) Necessary battery back up for RAM for 24 hours continuous operation during power failure and necessary UPS and battery charger with minimum 30 minutes back up.
- d) Necessary UPS Battery & Charger for DDC System back up shall be provided in the AC Plant Control Room.
- e) Necessary interface hardware and software for interconnection with other system for two-way data transfer for information exchange. The data format, the exact number of points etc. shall be finalized during detailed engineering stage.
- f) All other necessary hard wares to make the system complete and functional.
- g) One Common Hooter for audio annunciation of any malfunction of AC equipment and systems.
- h) System earthing and panel earthing of the DDC Panel.
- i) The DDC shall have inbuilt PID function's for precise control of the process parameters.
- j) The user friendly programming shall be done via Windows software.
- k) Interlock list for equipment should be incorporated in the operator station.
- l) Alarm List (Process & System), Event List , Different level of security.
- m) The DDC Control system and its HMI shall have necessary Graphic user interface for display of the processes with indication of devices and instruments. In case of alarms the alarm indication window will be displayed on the screen to attract the attention of the operator and generate output for audio-visual annunciation.
- n) Various controls and annunciations to be provided in DDC panel shall be as per clause no. 4.00.00: Control Philosophy.

3.12.07 Local Push Button Stations

Local Push Button Stations shall be provided for each drive motor and equipment (Cooling Tower Fan Motors, FCUs and Make-up Water Booster Pump Motors etc.), suitably located near drives and equipment of each AC system. LPBS shall consist of one no. emergency Red Stop P.B (pressed to latch and turn to release type) for each drive.

Local Push Button Stations shall be as per the relevant Volume of the electrical specification.

For Other detail VOLUME : II-F shall be referred to.

3.12.08 Local Distribution Board (240V)

Local Distribution Boards containing Switch / MCB for Non Duct-able Split Air Conditioners detail specification VOLUME : II-F shall be referred to.

3.12.09 Drive Motors

- i) Motors shall be supplied with mounting and coupling hard wares such as base plate, coupling, coupling guard, anchor bolts and nuts, all hardware etc.
- ii) Design ambient temperature of all motors for air conditioning system shall be 50 °C.
- iii) Motors shall have class F insulation but the temperature rise shall be limited to that of class B over an ambient temperature of 50 °C.
- iv) The motor nameplate kilowatt rating multiplied by the motor nameplate service factor shall be at least 15% greater than the driven equipment operating range maximum brake kilowatt.
- v) Motors rated 30 KW and above shall be provided with space heater suitable for 240 V, 50 Hz, 1 Ph. AC.
- vi) Motors rated below 250 watts shall be suitable for 240 V, 50 Hz, 1 Ph. AC. Motors rated 250 watts and up to 160 KW shall be suitable for 415V±10%, 3-Phase, 50Hz±5% AC.
- vii) Motors rated above 110 KW shall be fed by Air Circuit Breaker and others of lower rating shall be fed by MCB/MCCB.
- viii) All motor enclosures shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather proof construction.
- ix) All drive motors shall be as per relevant Volume of the Electrical Specification.

3.12.10 All Power, Control and Instrumentation cabling as required and conforming to the requirement of relevant Volume of Electrical Specification.

3.12.11 Grounding of all electrical items as per relevant Volume of Electrical Specification.

3.13.00 Suspended Ceiling work with supporting grids, hangers etc. for all the air conditioned areas. The Suspended Ceiling shall be complete with 12mm thick GYPSUM board at various elevations including supplying, fixing snap grid

systems of approved manufacturer with 40 mm X 50 mm cross tees and 40 mm X 50 mm end channels including MS hangers, cleats, supports, turn-

buckles, ties placed around 1200 mm (Max.) centre to centre for forming frame work to support snap grid systems and lighting fixtures including all ancillary work at site like providing of various cut outs, holes, recess, trap door (removable panels), wherever shown, welding to reinforcement to hangers, if required, grouting of hangers and complete with all finish in super decorating manner, providing openings for lighting and air conditioning fixtures including painting of all structural with two coats of approved primer and final paint and also complete with all materials as per working drawings, and direction of engineers.

3.14.00 Under-deck Insulation work for all the air conditioned areas. Roofs of AC spaces are insulated with 25 mm thick EPS (Under-deck) for roofs not exposed to Sun and 50mm thick EPS (Under-deck) for roofs exposed to Sun.

3.15.00 **Supply, Erection, Testing and Commissioning**

3.15.01 Erection, testing and commissioning of all the equipment and accessories mentioned herein above including supply of all grouting pieces, all matching flanges, connecting flanges, valves and other fittings bolts, nuts, gaskets and supporting arrangement as required, are included in the scope of work.

3.15.02 Base plate and foundation plates including anchor bolts, nuts, loose fittings etc. for equipment and as would be necessary for erection and complete anchoring of steel materials for the pipes, hangers and supports for water chilling unit and other equipment, are to be supplied.

3.15.03 At least 39 mm thick Aluminium foil faced Nitrile rubber / XLPE insulation on refrigerant piping as required for the Precision type PAC units and 26 mm thick similar insulation for Non Duct-able Split units.

3.15.04 Supply, erection, testing and commissioning of all electrical drives and equipment mentioned herein above including supply erection, testing and commissioning of cables, cable trays, grounding of all drives and equipment for each AC plant and system as required for efficient and trouble-free operation and successful commercial operation, are included in the scope of work.

Erection, testing and commissioning of electrical drive motors and equipment shall be as per relevant volume of the specification.

3.16.00 **Consumables**

All consumables such as grease and lubricating oil for one year's trouble free operation after handing over, are to be included.

3.17.00 **Spare parts**

Supply of recommended spare parts for three years trouble free operation and maintenance is to be included.

3.18.00 Special tools and tackles

Supply of special tools and tackles including tool box required for operation, maintenance and overhauling of the system is to be done.

3.19.00 Documents

Drawing, data, characteristic curves and instruction manuals for the equipment and system as detailed herein after and as described in the relevant volume of the specification are required.

3.20.00 Training of Purchaser's Personnel

Contractor is to arrange for training of purchaser's personnel for operation and maintenance of the plant and equipment supplied.

3.21.00 General

Above clauses specify the equipment for general guidance only. Any other equipment and/or materials necessary to ensure safe and satisfactory erection, commissioning and operation of the plant shall be supplied.

4.00.00 CONTROL PHILOSOPHY

4.01.00 Chilled Water Air Conditioning System

The chilled water plant shall operate with 2 x 100% capacity Packaged Screw Chiller unit (1R+1S), 2x100% capacity (One no. working and one no. Standby), condenser water (CW) pumps, 1x100% capacity (One no. working and one no. Standby), chilled water (CHW) pumps, 2x100% capacity (One no. working and one no. Standby) induced draft-cooling towers.

All the equipment of this system shall be operated from the DDC system work stations located in the AC plant room. Furthermore cooling tower fans, make up Water Booster Pumps and FCUs shall also be operated from their individual local Push-button stations.

One no. Local starter Panel shall be installed in each AHU room which will feed power to all the AHU fans, motors of 3-way mixing valves of AHUs, Fresh air fans (wherever applicable), Smoke Exhaust fans (wherever applicable) and their motorized isolating dampers, Fire damper motors, Electric heaters and Humidifiers and FCUs of SWAS rooms, UPS Room. This equipment located in each AHU room and SWAS/ UPS Room shall be operated and controlled from the workstations through DDC system located in the AC Plant Room as well as from these Local Starter Panels.

FCU/s for AC Plant Control room shall be operated from the workstations through DDC system and from their local Push-Button stations.

The Packaged Screw Chilling units shall incorporate microprocessor based control panel, which will also be interfaced with the DDC system.

The Packaged Screw Chilling units can be started only when its associated cooling tower fans, condenser & chilled water pumps are in operation.

All the drives of the AC system shall be manually started / restarted through DDC from the work stations after any trip.

The chilled water system shall be provided with the following safety & operating controls:

(i) Operating Control:

Room temperature control with the help of modulating 3-way chilled water flow regulating valve with the cooling coil of AHUs / FCUs through the central DDC system, getting sense from the temperature sensor and associated transmitter placed in the return air path.

Chilled water temperature control based on the room load with the help of operating temperature sensor and controlling through compressor's automatic unloading mechanism for screw chillers through the built-in Microprocessor based control panel of Packaged Screw Chiller. This control shall also be possible through the central DDC system.

Room RH control with the help of humidifiers (if required) & duct mounted re-heaters through the central DDC system getting sense from the RH & Temperature sensors and their associated transmitters placed in the return air path inside AHU rooms.

(ii) Safety Control:

The chilled water system shall be incorporated with the following safety controls and interlocks:

High discharge pressure cutout (HP).

Low suction pressure cutout (LP).

Low oil level cutout

High winding temperature cutout
through PTC sensors

Low chilled water temperature cutout by anti-freeze thermostat /temperature sensor for Screw chiller.

Cutout due to low flow of chilled water & condenser water by flow switches.

Cutout due to overload of all drive motors.

High air temperature cutout by safety thermostat / temperature sensor for duct mounted electric heaters.

Low cooling tower sump water level cutout for CW pumps. (Alarm for low water level in expansion tank & humidifier as applicable shall be provided).

Stopping of AHU fans in case of fire in the respective zone through the central DDC system.

Short circuit protection.

Closing of fire dampers at the air supply duct from AHUs in case of fire with the sense from room mounted fire/smoke detector through zonal fire panel and the DDC system.

Heater for compressors, which will be energized during compressor idling time. This safety control shall be actuated through the built-in Microprocessor based control panel of each Screw chiller.

Safety controls of Screw chillers will also include Over/Under voltage and voltage unbalance protection, Single phase & Phase reversal preventor, over/under current and current unbalance protection and others as per manufacturer's standard.

(iii) Interlocks:

The system components shall be interlocked with one another in the following way:

The Screw Compressor shall not start unless:

At least one cooling tower fan is running.

At least one condenser water pump is running.

At least one chilled water pump is running.

The duct mounted electric strip heater shall not be energized unless the respective AHU fans are running.

All the above Interlocking shall be actuated through the DDC Panel.

On-Off-trip status for all the drives, electric heaters & humidifiers (if required) shall be available at the work stations of the DDC Panel located in the respective AC plant rooms.

Motors of fire dampers provided in supply air duct of AHU shall remain energized in normal condition to effect opening of dampers. In the event of fire, the motors of fire dampers will be de-energized and the damper will close due to spring action, the relevant AHU fan motors will be tripped at the same time. These dampers shall be operated through the DDC Panel getting signal from relevant duct mounted smoke detectors / fire alarm panel.

Provision for one common audio annunciation for any kind of malfunctioning in AC plant shall be kept through a hooter located in the AC Plant Control Room and suitably interfaced with the DDC Panel.

The control system shall comprise central DDC Panels with two workstations located in the AC Plant control room.

The basic function of the system is as follows: -

To closely control and monitor inside temperature and humidity condition inside the air-conditioned spaces.

To optimize / minimize energy consumption by automated operation.

To provide centralized monitoring and control for various mechanical facilities including sequential start / stop of the whole AC system.

To generate maintenance data and alarms.

To maintain records of plant operation.

Programmed start / 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, humidifier and duct heater.

Programmed start / stop of individual FCU as per operating requirements and for maintaining the room temperature by controlling the 3 way mixing valves at chilled water line.

Safe and reliable operation, supervision & control, alarm & event management and optimization, maintenance management of the entire AC system shall be accomplished with the DDC system.

The DDC system shall be interfaced with:

The Air Conditioning MCC.

The Microprocessor based control panels of Screw Chiller.

The LSPs located in each AHU rooms.

The Temperature and RH sensors and their associated transmitters located in the AHU rooms.

The Temperature sensors located in the rooms served by FCUs.

The zonal fire panels/ duct mounted smoke detectors.

The two work stations and the Hooter.

4.02.00 Air Conditioning System with Water-Cooled Precision Air Conditioner

This system will operate round the clock for ESP Control Rooms, VFD Control Room (if applicable), Ash Handling Plant Control room, DM Plant Control room with associated office and Laboratory.

Water Cooled Precision Air Conditioners of 3x50% (Two nos. working and one no. Standby) capacity shall be provided for ESP Control Rooms, VFD Control Room (if applicable), Ash Handling Plant Control room, DM Plant Control room with associated office and Laboratory.

Condenser cooling water for the Precision Air Conditioners shall be supplied directly from the ACW system.

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

(i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Superheat control by means of electronic expansion valve, wherever applicable.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

(ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.

- Low condenser water flow cutout.

(iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

- a) Condenser water flow is low.
- b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

4.03.00 Air Conditioning System With Air-Cooled Precision Air Conditioner

This system will operate round the clock for Switch Yard Control room and Coal Handling Plant Control Room.

Air Cooled Precision Air Conditioners of 3x50% (Two nos. working and one no. Standby) capacity shall be provided for Switch Yard Control room and Coal Handling Plant Control Room.

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

(i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Superheat control by means of electronic expansion valve, wherever applicable.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

(ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.

(iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

- a) The condenser fans are running.
- b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

4.04.00 **Non Duct Able Split Air Conditioners**

Non-duct able Split air-conditioners will be controlled from the unit mounted Control panel or from the cordless hand operated remote.

5.00.00 **DESIGN CRITERIA**

5.01.00 The design outside conditions are taken from Meteorological Station at Khammam nearest to Kothagudem Thermal Power Station area. For designing of the equipment, outdoor conditions shall be considered as follows:

Outdoor design condition	:	Summer	: 42.6 Deg. C (DB), 26.6 Deg. C (WB)
		Monsoon	: 30.9 Deg. C (DB), 25.8 Deg. C (WB)
		Winter	: 20.8 Deg. C (DB),

Inside design condition : 22.0 Deg. C $\pm$ 1 Deg. C DB & RH 55 % $\pm$ 5% for critical areas like control room, control equipment rooms, computer room, UPS rooms, AVR rooms etc.

24.0 Deg. C $\pm$ 1 Deg. C DB & RH not exceeding 60% for the non-critical areas like offices, conference room, SWAS room, etc. and the areas served by split air conditioners.

For service building the inside conditions shall be 24.0 Deg. C $\pm$ 1 Deg. C DB & RH not exceeding 60% in all seasons except winter. In winter a DB temperature of 22.0 Deg. C shall be maintained.

Any equipment/process demanding any other (less) temperature shall be provided with.

Floor area : As per actual layout

Roof area : As per actual layout

Glass area : As per actual layout. All windows in the Air Conditioned shall be provided with light coloured Venetian blind

Lighting load : 21.4 Watt/sq.m (or actual) for all areas except shift charge engineer's room & service building where 16 watt per sq.m (or actual) shall be considered.

Occupancy : One (1) person in 12 sq.m (or actual)

Equipment/Panel load : As actual.

Solar load : Solar and transmission load through walls, roofs, doors, windows, glazing, floors etc. should be considered.

Ventilation Air : Fresh air at the rate of 1.5 air changes per hour for the control rooms and 1 air change per hour for office areas or at least 34 Cu. M/Hr. per person, whichever is higher, should be considered to achieve pressurization of air conditioned space and to meet the ventilation requirement of occupants.

Other loads : Heat load due to AHU fan motor, duct friction etc. shall be considered while finding total heat load.

Plant sizing : Plant sizing is to be done by allowing 5% margin on total sensible and latent heat calculated on the basis of above design considerations. An overall margin of 10% on calculated cooling load shall be considered in selecting Plant capacity.

All Condenser cooling water pumps and chilled water pumps, AHUS and FCUS shall have further, 10% margin on their flow capacities.

Insulation : Roof over AC space exposed to sun will be provided with 50 mm thick expanded polystyrene or equivalent. Roof over AC spaces not exposed to sun will be provided with similar insulation of 25mm thickness.

5.02.00 Individual air handling equipment shall be provided for individual facilities. Chilled water flow control valve (3-way), strip heater and electrode humidifier are provided for maintaining inside conditions.

5.03.00 All water piping for the make-up at cooling tower sump, Electrode humidifiers, Expansion tank and Make-up water tank etc. shall be provided by the bidder. Such make-up water piping shall be taken from the nearest clarified water header.

5.04.00 Electric power supply will be 415V $\pm$ 10%, 3 phase, 50 Hz. $\pm$ 5% A C.

5.05.00 The basic proposal by the bidder shall be for equipment strictly according to the technical specification. The location of air conditioning equipment, layout of ducting, piping etc. shall be designed by the bidder and approved by the Consultants/Owner.

5.06.00 The bidder shall satisfy himself regarding the refrigerating capacity required for maintaining the end conditions inside AC spaces before submitting the offer. For this purpose, the basis of computing air-conditioning load mentioned earlier is to be referred. The bidder shall have to guarantee the end conditions mentioned earlier.

5.07.00 Codes and Standards

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

IS-659 : Safety code for air-conditioning

IS-660 : Safety code for mechanical refrigeration

ASHRAE-23	:	Standard method of testing and rating [67 Standards] air conditioner.
AR1-450-6	:	Standards for water cooled refrigerant Condenser.
ASME Sec. VII	:	Unfired pressure vessels
IS-4503	:	Shell and tube type heat exchanger.
ASHRAE 22-72	:	Method of testing for rating water cooled refrigerant condenser.
ANSI-8-31.5	:	Refrigeration piping.
ANSI-8-9.1	:	Safety code for mechanical refrigeration.
AR1-410	:	Standard for air cooling and air heating coils.
AR1-210	:	Standard for unitary air conditioning equipment.
IS-3588	:	Specification for electrical axial flow fans.
AMCA-210	:	Methods of performance test for fans.
BS-2831	:	Methods of test for air filters used in AC and general ventilation.
IS-4671	:	Expanded polystyrene for thermal insulation purpose.
IS-702	:	Industrial bitumen.
IS-1239	:	Heavy class Pipes for sizes upto 150 mm dia.
IS-8188	:	For Water conditioning.
IS-325	:	3 phase induction motors.
IS-4029	:	Guide line for testing 3 phase induction motor.
IS-210	:	Specification grey iron casting.
IS-2062	:	Structural steel
AMCA -Bulletin No. 210	:	Standard code of testing centrifugal and axial flow fans
IS-2825	:	Code of practice for welding mild steel
IS-2676	:	Dimensions for wrought aluminum and aluminum alloy sheets and strips.

ASHRAE Code : for various filter

IS-655 : Specification for metal air ducts

BS-4735 : Horizontal Burning for XLPE insulation

BS- 4370 Part-1 : Dimensional Stability for XLPE Insulation

ASTM D 1056 : Water Absorption for XLPE Insulation

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

5.08.00 The refrigerant for Split units shall be R-22 as per ARI designation.

5.09.00 For requirements of materials of construction, 5.00.00 of this section shall be referred to.

5.10.00 Special Note

In case any discrepancy is found between requirements of this section and those mentioned in other sections, stipulations of this section shall prevail.

6.00.00 DESIGN, CONSTRUCTIONAL AND OTHER REQUIREMENT

6.01.00 General Instruction to the Tenderer

6.01.01 The Tenderer shall refer only to those of the following clauses which are applicable for this particular project as detailed in clause 1.00.00 and 2.00.00 of this specification. The clauses which are not applicable for this project shall be ignored.

6.02.00 General Design, Constructional and other Requirement

6.02.01 All the equipment shall be capable of withstanding the stresses which may be experienced during normal operation and test.

6.02.02 All the equipment shall be designed to permit inter-changeability of parts and ease of access during inspection, maintenance, installation and repair of various parts.

6.02.03 All parts subject to substantial temperature changes shall be designed and supported such as to permit free expansion or contraction without resulting in leakages, harmful distortion, misalignment or play.

6.02.04 Proposals for repair or any similar operations involving the plugging, welding, boring or addition of metal to the original castings shall be submitted to the Purchaser/Consulting Engineer and approval shall be received before any such

- work is carried out. Drawing showing details and locations of such modifications shall be submitted to the Purchaser/Consulting Engineer for his records.
- 6.02.05 All equipment shall be heavy duty type suitable for installation in heavy industries and for long period of uninterrupted service.
- 6.02.06 All materials used shall conform to the specification and shall be new and first class in all respects.
- 5.02.07 Anchor bolts, nuts and seating steel work shall be supplied with the equipment. Only hexagonal nuts shall be used for holding down the equipment, with proper lock nuts. All bolt holes shall be spot faced for nuts. In specific cases where not necessary, spot facing may be omitted.
- 6.02.08 Casting and welding shall conform to their respective specifications and shall be free from flaws and objectionable imperfections, machined true and in a workmanlike manner.
- 6.02.09 The separate pieces of equipment shall be marked with unit number. The assembly drawings shall indicate part number of each equipment and unit number for easy correlation.
- 6.02.10 Coupling guards and belt guards shall be furnished as applicable.
- 6.02.11 All equipment, ducts, pipes, controls etc. shall be fully treated against corrosion and sealed against moisture, sand and dust ingress.
- 6.02.12 All plant including ducts and pipes as well as machines shall be vibration isolated, or otherwise treated so that :
- No excessive vibration is felt in the floors or walls of the rooms served by any machine.
 - The mechanically induced vibration levels in floors, walls and ceilings of rooms are sufficiently small as to limit the radiation of the sound level to the rooms within acceptable levels.
- 6.03.00 **Packaged Screw Chillers**
- A. Refrigerant Compressors (Twin Screw Type)
- I. The compressor may be designed either for direct or for indirect drive.
 - II. The compressor assembly shall be adequately designed for minimum vibration and noise disturbances.
 - III. The shaft seal shall be of proven design.
 - IV. All safety devices against high-pressure refrigerant, low-pressure refrigerant and low oil pressure shall be provided, High winding temperature through PTC sensor. The compressor units must be provided with oil pressure regulator.

- V. The horsepower of the compressor motor shall be sized for 115% of maximum rated power required for the unit including the drive loss.
- VI. The compressors shall be provided with built-in-unloaded starting device. The compressor shall have automatic capacity control device preferably built-in-type to match reduced refrigeration load.
- VII. Capacity control must be achieved by use of slide valve, which provides fully modulating capacity control from 100% to 10% (20%, at least) of full load. The slide valve shall be actuated by oil pressure controlled by external solenoid valves.
- VIII. The oil separator should be effective enough to incur gravity drop out of oil from the refrigerant gas before it enters the condenser.

B. Heat Exchangers (Condensers and Chillers)

- I. All condensers shall be of shell and tube type with water in the tubes and refrigerant in the shell.
- II. All chillers for chilled water plant shall also be shell and tube type with water either in tubes or outside the tubes.
- III. The heat exchanger shall be designed for a minimum working pressure of 10.5 kg/cm² gauge on the water side and 11.3 kg/cm² on the refrigerant side and shall generally conform to the latest ASME CODE for unfired pressure vessels Section- VIII. The design pressure shall have a reasonable margin over the maximum working pressure.
- IV. The average velocity of water in tubes shall not be more than 2.5 m/sec.
- V. Water heads or refrigerant heads of the heat exchangers shall be as not to allow leakage of fluid from one pass to the other.
- VI. Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating.
- VII. The overall fouling factor for the condensers and chillers shall be 0.0002 and 0.00013 Hr.M² °C /K Cal respectively.
- VIII. The condensers shall be designed to provide at least 2 °C sub cooling of refrigerant under rated design condition. The water chillers also shall be designed to superheat the refrigerant by at least 3 °C under rated design condition.
- IX. Testing and other design feature of the heat exchanger shall meet the requirements of TEMA Class-C heat exchangers or approved equal.

- X. The heat exchangers shall have open able water boxes for ease in maintenance.
- XI. The tube for water chillers shall be of deoxidised copper with or without integral fins. The tubes for the condensers shall also be copper with integral fins. The tube wall thickness at any point shall not be less than 18 SWG.
- XII. The baffle plates and the tube sheets shall be made of steel. The shell shall be made up of seamless tube or shall be fabricated from flange quality steel plate (ASTM-A285 Grade-C). The tube support plates shall be made of flange quality carbon steel plates and shall be as per TEMA Standard.
- XIII. The heat exchangers shall be provided with vent valve, relief valve, and/or safety fusible plug on refrigerant side and vent valve and drain valve on water side (at every section of the baffled shell of heat exchanger).
- XIV. The tenderer shall quote packaged units having compressor, condenser and chiller assembly together in a single framework and mounted on a common base plate. Provision for refrigerant charging and chemical cleaning of water tubes shall be provided.
- XV. Each heat exchanger shall be provided with water flow switch. This shall be interlocked with the control of the individual refrigeration system/corresponding compressor drive.
- XVI. All the heat exchangers shall be provided, with standard connections like thermo wells, inspection valve and antifreeze thermostat / temperature sensor and external equaliser connection for expansion valves for chiller. Insulation shall be terminated in such a manner that it will not be damaged during removal of bolts, covers etc. Separate covers similar to flange covers shall be constructed to facilitate easy removal.

6.04.00 Water Pumps

- 6.04.01 Each pump shall be of horizontal split casing / end suction centrifugal type, directly coupled to electric drive motor and mounted on a common base plate. Pumps having motor of 5 HP capacity or below can be of mono-block construction, provided its materials of construction are as mentioned below and motor is as per desired motor specification.

The pump shall be complete with casing, impeller, renewable type wearing rings, shaft, shaft sleeve, bearings, stuffing box, Mechanical Seal (if applicable), cowlings, base plate etc. as applicable. The design pressure for the casing shall not be less than 16 bar for chilled water pumps.

- 6.04.02 Pump head-capacity characteristics shall be gradually rising from operating to shut off point without any zone of instability. The pump BHP-flow characteristics shall be preferably be non-over loading type beyond rated capacity point.
- 6.04.03 Operating speed of the pump shall not preferably be more than 1500 rpm. Vibration isolations of efficiency 90% (approx.) shall be provided.
- 6.04.04 Material of the pump shall preferably as follows (all material shall be of tested quality).
- a) Casing : Cast Iron, as per IS 210, Gr FG 260 for both CHW & CW pumps. (As per manufacturer's Standard)
 - b) Impeller : Bronze to IS: 318 Grade 2
 - c) Shaft : Carbon Steel C-45.
 - d) Shaft sleeve : Bronze
 - e) Wearing ring : Bronze
 - f) Base Plate : Cast Iron
- 6.04.05 Pumps shall be provided with suitable bearings sized adequately to take the maximum possible unbalance load occurring due to all mechanical and hydraulic reasons.
- 6.04.06 Pump and drives shall be directly coupled through a flexible coupling. Suitable coupling guard shall be provided for each pump.
- 6.04.07 Each pump shall be completed with pressure gauge at the suction and discharge, isolating valves, all integral piping required for sealing and cooling, casing drain and vent connections etc. The pressure gauge of pump will be connected with a siphon and a two-position brass cock.
- 6.04.08 The rated BHP of the motor shall provide for 15% margin over the rated BHP of the pump. For other electrical particulars of the motor refer detailed specification of the motors.
- 6.04.09 The design of the pumps shall conform to the relevant IS Code.
- 6.04.10 Major rotating components of the pumps like impellers, balancing drums etc. shall be individually balanced statically and finally each pump shall be dynamically balanced.
- 6.04.11 The critical speed of the pump shall be at least 20% above the operating speed.

- 6.04.12 All pumps and motors shall be aligned properly, and bolted and doweled to a common base frame.
- 6.05.00 **Induced Draft Cooling Towers**
- 6.05.01 The cooling towers shall be cross flow induced draft type with FRP casing & sump with air entry on all four sides and air discharge on top. The fan motor shall be easily accessible from outside and out of moist air stream.
- The internals shall be of stainless steel SS or MS epoxy painted to withstand corrosive atmosphere. The tower shall be of low height, suitable for round the clock operation at location in the space shown in the applicable drawings. The tenderer shall confirm that the tower supplied by them can be accommodated in the space shown in the drawing.
- 6.05.02 Cooling tower shall be of sufficient capacity to cool the rated amount of water through the specified range at the design W.B. temperature.
- 6.05.03 The structural frame work of the tower including all members and connections shall be designed for operating loads and prevailing wind pressure. Steel members shall be MS epoxy painted and be of sufficient size to safely withstand all imposed loads.
- 6.05.04 FRP casing sheets shall be clamped on close centre to the structural steel members. Rubber neoprene gaskets must be used on all bolted joints as a seal against water leakage.
- 6.05.05 Louvers shall be of fixed type.
- 6.05.06 The fan deck shall be of ample strength to support all loads normally encountered in operation and maintenance. Stiffeners shall be provided on the under side.
- 6.05.07 Galvanised steel ladder with safety cage and hand railing shall be provided in such a number and locations as necessary to give safe and complete access to all parts to tower requiring occasional inspection or adjustment. An access door shall be provided for fan deck and the cell for ready access to the interior parts of the tower.
- 6.05.08 Fills shall be of extended area of formed PVC suitable to withstand hot water temperature of 55 °C.
- 6.05.09 Louvers and drift eliminators shall be of PVC/FRP construction.
- 6.05.10 Eliminators shall be provided in removable sections & installed in the cell of the tower. The number of deflection in the eliminators shall be so arranged as to reduce drift loss to 0.2% of the water circulated.

- 6.05.11 The water distribution system shall be open basin with gravity feed nozzles. The system shall be self draining and non-clogging and designed for flexible operation and ready accessibility. All main piping connection shall be brought out and end in flanges, to flexible connection.
- 6.05.12 The cold water basin shall be of F.R.P. construction. The basin shall be complete with float valve for make up water control, a drain and overflow connection. The make-up water supply pipe shall be positioned at least double the pipe diameter above the maximum water level in the basin. The water basin shall be constructed such as to provide a coarse strainer of Brass wire mesh easily accessible from outside.
- 6.05.13 Fan shall be of the propeller type, cast aluminium and multi bladed aerofoil construction with adjustable pitch. The entire fan assembly shall be statically balanced. Outlet velocity of air shall be not less than 610 meters per minutes and the fan tip speed shall not exceed 4570 meters per minute.
- 6.05.14 Each fan shall be gear driven. Where reduction gears are used, housing shall be of heavy cast iron construction with large oil reservoir and complete with supply of oil.
- 6.05.15 Fan motors shall be of the totally enclosed fan cooled type and of the required capacities. Motor shall preferably be located outside the moist air stream.
- 6.05.16 Fan drive shaft using reduction gearing shall be dynamically balanced and connected through flexible couplings.
- 6.05.17 The mechanical equipment assembly shall be adequately supported on the fan deck.
- 6.05.18 Fan discharge hatch shall be covered with galvanised wire mesh to prevent birds nesting during idle periods.
- 6.05.19 All nuts, bolts and fasteners used in the cooling tower shall be stainless steel / Nickel or chrome plated.
- 6.06.00 **Piping**
- A. Refrigerant Piping
- I. Refrigerant piping shall be of M.S. seamless (as per IS-1239, Part-I heavy grade) or copper tube (IS-5493). Welding rings shall be used for smaller pipes. Weld preparation of joints, cleaning of pipes shall be carried out as per relevant code.
- II. Pressure drop in hot gas, liquid and suction lines should not exceed the value corresponding to 2 °F (1.1 Deg C) change in saturation temperature of the fluid.

- III. Velocity in the discharge and suction pipe of the refrigerant shall not be too high as to create undue vibration and noise, velocity in the vertical length of discharge and suction pipe of the refrigerant shall be high enough to carry the entrained oil in the refrigerant, even in case of unit running at lowest partial capacity. An angle type drain valve with male flare outlet connection will be installed at the bottom end of each vertical riser pipe to drain any accumulated oil.
 - IV. Instrument piping for gauges, switches etc. shall be copper only. Capillary tubes will be used wherever possible. For field-mounted instruments, this is not applicable.
 - V. Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Bidder.
 - VI. Liquid-moisture indicator with leak proof glass on opposite sides shall be provided in the liquid line for facilitating visual inspection of liquid refrigerant charge.
 - VII. The liquid line shall be provided with Drier-Strainer.
- B. Water Piping
- I. Condenser cooling water piping and chilled water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I, for higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade. Drain water piping shall be of M.S. heavy grade.
 - II. The piping shall be so designed that the water velocity through the piping shall not exceed 2.5 m/sec and also the piping friction drop shall be limited to 4 m per hundred meters of pipe length. Pipe sizes indicated in tender drawings shall be followed.
 - III. The pipes shall be of plain end in case of M.S. Pipes (i.e., suitable for welded connections) as far as possible.
 - IV. Counter-flanges for connecting to flanges on valves or equipment shall be made of IS-2062 or superior and shall preferably be slip on type, suitable for welding on the piping in case of M.S. Piping.
 - V. All bolts and nuts for flange connection shall be hexagonal carbon steel type as per IS-1363 and with the material and other requirements as per IS-1367. All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flanged connections for ease of removal / replacement of valves.
 - VI. Bends, fittings fabricated at site are not acceptable. The Contractor shall use the standard fittings / bends, as per IS-1239, Part-II.

- VII. Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the

Bidder. The supports within the plant room shall be of structural/pipe supports from the floor, provided by the A.C. Contractor.

- VIII. The flanged joints for water line will use canvas, impregnated rubber gasket. Compressed fiber gaskets shall be used with flat face flanges and raised face slip-on flanges. Spiral wound gaskets shall be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

Gaskets shall be suitable for the design pressures and temperatures: -

- i) Compressed Fiber Gaskets: Compressed fiber gaskets shall be in accordance with ANSI B16.21, and materials shall be suitable for a maximum working pressure of 40 bar and a maximum working temperature of 400° C. Gaskets shall be dimensioned to suit the contact facing. They shall be full faced for flat face flanges and shall extend to the inside edge of the boltholes on raised face flanges. Gaskets for plain finished surfaces shall be not less than 1.6 mm thick and for serrated surfaces shall be not less than 2.4 mm thick.
- ii) Spiral Wound Gaskets: Spiral wound gaskets shall be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. The gasket shall be inserted into a steel gauge ring whose outside diameter shall fit inside the flange bolts properly positioning the gasket. The gauge ring shall serve to limit the compression of the gasket to the proper value. Compressed gasket thickness shall be 3.3 mm $\pm$ 0.1 mm.
- iii) Ring Joint Gaskets: Ring joint gaskets shall be octagonal in cross section and shall have dimensions conforming to ANSI B16.20. Material shall be suitable for the service conditions encountered and shall be softer than the flange material.
- iv) Rubber Gaskets: Rubber gasket materials shall be cloth inserted sheet rubber and shall conform to ANSI B16.21. They shall be full face and 1.6mm thick.

The material should be able to withstand adequate strength in compression without damage. Pipe lines should be such installed that any equipment or valves can be removed by disconnecting flange bolts and nuts union joints. If necessary, a short piece joint to be installed for easy removal. All threads for screwed joints should be properly made. The threads will be covered to make a leak proof joint. Pipes passing through any building structure will pass through a pipe sleeve. The thickness of pipe sleeve will be not less than the

thickness of the passing pipe itself. A rubber grommet or such other material will protect pipes entering any equipment.

- IX. All drainpipes will use 'tee' fitting instead of elbows or bends. 'Tee' fitting should be such installed that the plug can be removed and any section of pipe can be cleaned. Drain valves will be located at lowest point of pipelines. If necessary more than one drain valve will be

installed to facilitate complete drainage from pipe. Condensate drain piping shall be insulated as per the specification.

- X. Water filling valve and air vent shall be installed on the highest point of pipeline. If necessary more than one valve is to be installed for satisfactory operation or maintenance of the plant. In case of insulated pipes the connections for pressure gauge, thermometer, drain valve, purge valve, filling valve and any such other accessories, the connection should be long enough such that the requisite pipe insulation can be carried out on the main pipe. The connecting pipes or fittings will be insulated separately if necessary. Location of instruments, fittings, fixtures shall be as in single line flow diagram. Location / sizes of air vents are also indicated.

- XI. The insulation will be fixed as per manufacturer's recommendation. Where valves, pipe fittings etc. occur, access to both shall be provided. Flange insulation shall be in two halves for easy removal without affecting insulation covering adjacent parts. Insulation of valves shall be with provision of aluminium valve boxes with hinged cover / halves.

- XII. Piping arrangement and alignment shall be as per layout.

6.07.00 Valves & Accessories

A. General

Valve pressure classes, sizes, types, body materials, and end preparations shall generally be as described herein. Special features and special application valves shall be utilized where required.

Valves specified to have flanged, socket-welded, or screwed connections shall have ends prepared in accordance with the applicable ANSI standards. Steel flanges shall be raised face type unless otherwise required. Cast iron and bronze flanges shall be flat-faced type. Butt-welding ends shall be prepared in accordance with 2.11.5 Butt Weld End Preparation and Piping Fit-Up.

Steel body gate, globe, angle, and check valves shall be designed and constructed in accordance with ANSI B16.34 as applicable. Valve bodies and bonnets shall be designed to support the valve operators (hand wheel, gear, or motor) with the valve in any position, without external support.

B. Steel Body Valves 50 mm and Smaller

Steel body valves 50 mm and smaller shall have forged steel bodies. Forged steel valves complying with the standards and specifications listed in Table 126.1 of ANSI B31.1 shall be used within the manufacturer's specified pressure temperature ratings with the following limitations. The use of Class 1500, 2500, and 4500 forged steel valves shall be limited in accordance with the pressure temperature ratings specified in ANSI B16.34, and the criteria established in MSS SP-84.

Class 800, 1500, 2500 and 4500 forged steel valves shall be constructed as follows: -

- a) Class 800 valves shall have bolted bonnet joints. Class 1500, 2500 and 4500 valves shall have pressure seal, integral, or breech lock bonnet joints. Gate, globe, and angle valves shall have outside screw and yoke construction.
- b) All valves, except gate valves, shall have seats of the integral type. Gate valves shall have renewable seats.
- c) Class 1500, 2500, and 4500 valves shall be of loose back seat design.
- d) Class 1500, 2500, and 4500 globe valves shall be of the Y-pattern type.
- e) Valve ends shall be socket-weld type unless otherwise required.
- f) Except as otherwise required, check valves shall be of the guided piston or swing disk type. All check valves shall be designed for installation in either horizontal piping or vertical piping with upward flow.

C. Steel Body Valves 65 mm and Larger

Steel body valves 65 mm and larger shall have cast steel bodies. The face-to-face and end-to-end dimensions shall conform to ANSI B16.10. The use of these valves shall be in accordance with the pressure temperature ratings specified in ANSI B16.34 as applicable.

Gate, globe, and angle valves shall be provided with back seating construction; and shall be of outside screw and yoke construction. Gate valves 100 mm and larger shall have flexible wedge disks. Split disks shall not be permitted. Valves shall have full size ports, except where venturi ports are specifically permitted to Engineer's approval. The use of valves with venturi ports shall be limited to selected large diameter, high-pressure valve applications.

Class 150, 300, and 400 valves 65 mm and larger shall be constructed as follows: -

- i) Bonnet joints shall be of the bolted flanged type having flat face flange facings for Class 150 valves; and male and female facings for Class 300 and 400 valves.
- ii) Body ends shall be butt weld type unless otherwise required.

Class 800, 900, 1500, 2500, and 4500 valves 65 mm and larger shall be constructed as follows: -

- i) Bonnet joints shall be of the pressure seal or breech-lock type.
- ii) All Class 800, 900, 1500, 2500, and 4500 valves shall have grease-lubricated antifriction bearing yoke sleeves.
- iii) Body ends shall be butt weld type unless otherwise required.

Check valves used on pump discharge installations, and on other applications in which the valves may be subjected to significant reverse flow water hammer or fluid surges, shall be of the non slam tilting disk type. All other check valves shall be of the guided piston, swing disk, or double disk spring check type. The use of double disk spring check valves shall be limited to 350 mm and larger cold-water services. All check valves shall be designed for installation in either horizontal or vertical piping with upward flow. Stop check valves, where specified, shall be Y-pattern globe type.

D. Iron Body Valves

Iron body gate, globe, and check valves shall have iron bodies with bronze trim. The face-to-face dimensions shall be in accordance with ANSI B16.10. These valves shall have flanged bonnet joints. Gate and globe valves shall be of the outside screw and yoke construction. Body seats shall be of the renewable type. Gate valves shall be of the wedge disk type. Lined cast iron body diaphragm and check valves used with lined piping shall be flanged body with liner and diaphragm material suitable for the service.

E. Butterfly Valves

Rubber-seated butterfly valves shall be generally constructed in accordance with AWWA C504 Standard for Rubber-Seated Butterfly Valves. The valves shall also generally conform to the requirements of MSS Standard Practice SP-67, Butterfly Valves. Valves of the wafer or lug wafer type shall be designed for installation between two ANSI flanges. Valves with flanged ends shall be faced and drilled in accordance with ANSI B16.1. The selected use of butterfly valves shall be in accordance with the pressure temperature ratings specified in AWWA C504, the pressure temperature ratings specified by the manufacturer as per the following criteria: -

- a) Butterfly valves shall generally be used for 150 mm and larger cold-water services only.
- b) Butterfly valves for buried service shall be of cast iron body material and shall be equipped with flanged ends.
- c) Cast iron butterfly valves shall have pressure class selected based on the piping design pressure as follows:

	Piping Design Pressure	Valve Class
i)	1.8 bar and below	Class 25

- | | | |
|------|---------------------------|-----------|
| ii) | Above 1.8 bar to 5.2 bar | Class 75 |
| iii) | Above 5.2 bar to 10.3 bar | Class 150 |
- d) Cast iron butterfly valves shall be limited to use with piping systems having a design temperature of 50 C or less.
- e) Butterfly valves for other than buried service shall be of carbon steel or cast iron body material depending on the service application. Valves 600 mm and larger in size shall be equipped with flanged ends. Valves 500 mm and smaller in size shall be of the wafer type, or lug wafer type, if used with steel piping; and shall be flanged if used with other piping materials (cast iron, etc.).
- f) Carbon steel butterfly valves shall be limited to use with piping systems having a design temperature of 65 C or less. Carbon steel butterfly valves shall have pressure class selected in accordance with the pressure temperature ratings specified in ANSI B16.34 for 600 mm and smaller valves. Valves 750 mm and larger in size shall be selected and specified based on the piping design pressure and temperature, without reference to a specific pressure class.

Metal seated or Teflon seal ring seated butterfly valves for special service applications shall be of the wafer or lug wafer type; and shall be designed for installation between ANSI flanges. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

F. Bronze Body Valves

Bronze gate and globe valves 50 mm and smaller shall have union bonnet joints and screwed ends. Bronze gate and globe valves used in control air service shall have brazed joint ends. Gate valves shall be inside screw, rising stem type with solid wedge disks. Globe valves shall have renewable seats and disks.

Bronze check valves 50 mm and smaller shall be Y-pattern swing disk type or guided piston type designed for satisfactory operation in both horizontal piping and vertical piping with upward flow.

Bronze valves 65 mm and larger shall have bolted flange bonnet joints and flanged ends. Gate and globe valves shall be of the outside screw rising stem construction. Gate valves shall have either integral or renewable seats. Globe valves shall have renewable seats.

The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer and in accordance with the criteria established in MSS SP-80. Bronze valves shall generally be Class 200, and shall be limited to service with piping systems having design pressures of 14 bar or less, and design temperatures of 65°C or less.

Bronze valves shall generally be limited to a size of 80 mm or less.

G. Plug Valves

Plug valves shall be of the eccentric, lubricated, or Teflon sleeve plug type, as required by the service. Plug valve bodies shall conform to the requirements of ANSI for dimensions, material thickness, and material specifications. Bonnets shall be of the bolted flange type. Body ends shall be flanged, faced, and drilled

for installation between ANSI flanges. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

H. Ball Valves

All ball valves shall have full area ports, Teflon seats & seals, and chrome plated carbon steel or stainless steel balls. Ball valve bodies 50 mm and smaller shall have threaded end connections. Ball valves 65 mm and larger shall have flanged ends. The valves shall not require lubrication. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

I. Check Valves

These shall be swing check type with material of construction as given above. The body shall be of cast iron with flanged ends.

J. Flow Regulating-Cum-Measuring Valves

These are special valves to be installed at the outlet of each cooling coil/heating coil as shown in drawings. The Contractor shall also supply measurement it including manometer. The valves shall be of variable orifice design double regulating type. The valve shall have measurement ports for connecting the manometers. The Contractor shall supply all calibration charts etc. The valve shall have provision for locking at pre set flow condition and it shall be possible to close the valve and again open up to this pre set point. The valves shall be of gun-metal/bronze construction.

K. 3-Way Mixing Valves

These are special valves to be installed at the outlet of each AHU heating coil as shown in drawings. The motor shall be actuator based controlled. The valve shall operate from the sense of the room thermostat. The Contractor shall also supply measurement kit including manometer. The valves shall be of variable orifice design double regulating type. The valve shall have measurement ports for connecting the manometers. The Contractor shall supply all calibration charts etc. The valve shall have provision for locking at pre-set flow condition and it shall be possible to close the valve and again open up to this pre set point. The valves shall be of gunmetal / bronze construction.

L. Refrigerant Valves

All refrigerant valves as may be applicable shall have Brass body with flange connection or sweat connection for welding or brazing to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. The valve body and bonnet connection shall have bolted and welded connection.

It is preferable to have Teflon gland packing for the valves construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak proof-ness of the valves shall be tested at

minimum 1.5 times the design pressure for the system but not less than 35 Kg / Sq. Cm.

6.08.00 Air Handling Equipment

6.08.01 Air Handling Units

A. FAN

The fans shall be forward/backward curve bladed centrifugal type. The number of fans per unit shall be as per standard of the manufacturer. The impeller and the scroll casing of the fans shall be made of steel and protected with suitable painting as per Manufacturer's standard.

The fan shaft shall be of Carbon steel. Bearing shall be heavy-duty self-aligning type. The fans shall be dynamically balanced. The motor shall be adequately rated to prevent overload.

B. DRIVE

Centrifugal fans shall be equipped with V-belt drive and belt tensioning arrangement. All belts shall be sized with 1.1 service factor. All belt drive shall be equipped with removable guards to avoid accidental hazards. There shall be a minimum of two belts per drive.

C. DRY FILTER

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filters shall be of dry panel type. The filter shall have G.I. frames of adequate thickness but not less than 20 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

D. COOLING COIL

The cooling coil for chilled water shall consist of seamless copper tubes with aluminium fins. There shall be preferably only one cooling coil per AHU or as per manufacturer's standard.

The cooling coil for chilled water plant shall be equipped with manually - operated flow regulating valve with provision for flow balancing at site to control the chilled water flow. This cooling coil shall be designed for chilled water / air duty. Counter-flow process of heat transfer shall be considered in the design requirement. The flow factor of 0.001 Hr. Sq. Ft. - °F / BTU (0.0002 hr - Sq. M °C / Kcal) shall be taken in the design of the cooling coil. Number of rows shall be minimum 4 and shall follow even number for any

particular coils to facilitate connection of water/refrigerant only on one side of the unit.

Fin design shall be chosen for the duty to be performed with special attention to the possibility of lint accumulation. However, in any case, number of fins in the coils shall not exceed 13 / Inch. Velocity of air across the coils shall be limited to 2.5 m/sec.

In case of chilled water-cooling coil, arrangement for air purging and water draining from the coil is to be provided.

E. CASING

- a) The casing shall be of double skin type GI with at least 25mm thick PUF insulation (density approximately 35Kg/ M³) in between two skins (made of 24 G GI sheet) and complete with supply air outlets with volume control dampers and flexible connections, structural frame work with supports and serrated rubber pads as vibration isolators and shall be provided with thermal break at the joints of different sections. Outer skin of the AHU shall be powder coated.
- b) Base frames shall be supplied for floor mounted type units. Drain pans shall be in SS-304 construction having at least 65mm depth and shall be fabricated in such a way to form the slope towards drain point.
- c) The main structure of the Unit (i.e. framework) shall be in extruded aluminium construction. The structural members shall have industrial anodized finish to form scratch proof, corrosion resistant, smooth finish surface. The structural member shall have a thermal break between inner & outer surface to minimize heat loss. The sealing surface of the extrusions shall be provided with the groove to hold the gasket. The gasket shall be of synthetic construction having tubular shape for proper sealing. The inner face of the panels shall be flushed with inner face of the extrusions to minimize the corners.
- d) Panels of the casing shall be fitted reasonably airtight with suitable gaskets with cams or similar fastenings for easy opening.
- e) Necessary arrangement shall be provided on the casing for measuring temperature and pressure in a cooling coil.

- f) Easily open able inspection doors shall be provided at required locations for easy maintenance. The Doors shall have handles and hinges in glass filled nylon construction.
- g) The Lock shall be flushed type to minimize projections. Locks shall have proper arrangement to secure the doors tightly.

6.08.02 Fan Coil Units

- A. The fan coil units shall be of reputed make – horizontal type for ceiling suspension. The units shall be complete with chilled water coil, one or more centrifugal fans and motors, cleanable HDPE filters, double wall insulated condensate drain pan with 15 mm thick expanded polystyrene (self extinguishing quality) insulation sandwiched between top and bottom sheets of drain pan and 18 gauge sheet steel casing panels. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pans.
- B. Access panels shall have positive locking fasteners for easy removals. The filters shall be mounted at the rear section of the cabinet with filter box.
- C. All cooling coils shall be standard three row staggered seamless copper tube with aluminium plate fins mechanically bonded to copper tubes. Tubes shall be aluminium 10 mm O.D. and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within the insulated end sections of the base unit for protection against sweating. Each coil shall be provided with an air vent and drain plug. All coils shall be factory tested at 21 kg. Per Sq. cm. air pressure while submerged in water. Fin spacing shall not be less than 10 fins per inch. Tubes shall be mechanical / hydraulically expanded for thermal contact resistance with fans.
- D. Fans shall be centrifugal, forward-covered, and direct driven by shaded pole motor.
- E. All fans coil units shall be equipped with copper piping connection and manual air vent at the cooling coil. Other accessories shall be wall mounted thermostat for individual unit, containing two speed and ON / Off control for fan speed, motorized three-way diverting/mixing valve for individual unit, Y-strainer, ball valve and globe valve, adjustable discharge air grilles.
- F. The fan coil unit shall be selected for the lowest operating noise level. It should offer capacity at the lower speed.

6.09.00 Air Filters

6.09.01 Pre-Filters

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filters shall be of HDPE construction. The filter shall have G.I. frames of adequate thickness but not less than 20 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

6.09.02 High Efficiency Filters

The filters shall be having efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sandwiched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall not exceed 1.5 m/sec.

High efficiency filters shall be provided with differential pressure switch with alarm.

6.10.00 Duct Work

6.10.01 Velocity of air in any section of the supply duct shall not exceed 8 m/sec.

6.10.02 Sheet metal thickness for AC duct shall conform to IS-655.

6.10.03 The general layout of the ducting location and number of air grilles and diffusers etc. shall conform to the specific requirements of individual areas of application so as to ensure proper air distribution of all the zones. The same shall be subject to approval by the Engineer.

6.10.04 Where dimensional locations are not indicated on the drawings, the Contractor will be responsible for the final arrangement and routing of the ductwork. Variations in duct sizes may be made as acceptable to the Owner if the cross-sectional area remains the same and the revised aspect ratio is less than four. Ductwork will be arranged to minimize pressure drop using low-loss fittings and transitions. Where radius elbows are used for duct turns, the radius ratio will not be less than 1.5 wherever possible. Where space limitations require a bend with a radius ratio of 0.75 or less, not less than two turning vanes will be installed in the bend.

6.10.05 All ductwork for supply of air inclusive of accessories such as damper, vanes, access doors etc. shall be fabricated from G.I. sheet of at least grade 180 as per IS 277 or aluminium sheet. The ductwork shall be properly reinforced to prevent sagging, buckling or vibration. Interior of all ducts shall be smooth and free from obstruction. All duct sections shall be cross-broken.

6.10.06 The construction of ducts shall conform to IS : 655/ASHRAE/SMACNA as far as applicable, unless otherwise stated here.

6.10.07 JOINTS

- a) All longitudinal joints for the ducts will be Pittsburgh Lock seam type.
- b) Transverse joints for the low-pressure ducting shall be continuous around the four sides, the corner closure are required. The type of transverse joints shall be as follows:

<u>Large side mm</u>	<u>Type of transverse joints</u>
Up to 600	25 mm wide pocket, drive or S-slip
601 - 1000	85 mm wide, bar s-slip or pocket slip
1001 – 2250	40 mm x 40 mm x 6 mm M.S. angle connection

- c) The low-pressure ducting work shall be provided with intermediate transverse bracing continuous around the four sides between the joints according to the following sizes:

<u>Large side mm</u>	<u>Bracing</u>
0 - 450	None
451 - 1500	40 mm x 40 mm x 6 mm angle 1200 from joints.
1501 and above	40 mm x 40 mm 6 mm angle 600 mm from joints.

- d) Riveting and Sealing

All joints, slips and seams shall be made secure by reverting on centres not exceeding 150 mm. All transverse stiffeners and all reinforced bar slip joints shall cross at corners and be riveted. All bar slip joints and angle iron bracing shall be riveted on centres not exceeding 75 mm.

- e) All construction joints and duct seams shall be reasonably sealed with bitumastic cold emulsion or equivalent vapour seal.

6.10.08 Hangers and Supports

- a) All ductwork shall be provided with adequate hangers or supports to ensure rigid support and to prevent vibration. Spacing of duct supports shall not exceed 3 m centres.
- b) Hangers shall be suspended from the building steel with provision for necessary auxiliaries, or special steel members, or by hooks fixed to the embedded plates provided in the ceiling.
- c) Hangers for all ducts shall be trapeze type with the shelf construction from 35 mm x 35 mm x 5 mm angle iron and hung by two steel rods each of not less than 10 mm dia. for ducts, with larger side less than 2250 mm while for those greater than 2250 mm shall be with 50 x 50 x 5 angles and rods not less than 16 mm dia.
- d) All hangers and supports shall be as per drawings / specifications. When vertical ducts pass through floor slab, they shall be supported by means of collars, constructed of steel structural angles securely fastened about the girth of the duct and bitumastic compound between the horizontal leg of the supporting angle and the floor. The duct aspect ratio shall not be more than 4: 1. Turning vanes are required to be provided with bend more than 45 Deg.

6.10.09 Access Doors

All main ductwork shall be accessible throughout using tight fitted hinged access doors. Doors shall have to be cemented on sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.

Access doors/panels are to be provided at following places:

- Near each fire damper
- Near each heater coil
- Near each filter bank

In case access doors are to be installed in the insulated ducts, the access door panel should be suitably insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the duct when the plant is running.

6.10.10 Flexible Connection

Rubber impregnated canvas or equal flexible connections of at least 150 mm length shall be provided at each connection between ductwork and fan units.

6.10.11 Dampers

- i) **SPLITTER DAMPER**

Splitter dampers in branch take off shall be provided. Dampers blades shall be minimum 16 SWG thick. Alternatively catcher shall be provided in right angle tee of ducts.

ii) FIRE DAMPER

Fire dampers shall be provided as per the requirement mentioned elsewhere in the specification. The fire dampers shall be of motorised / solenoid/fusible link type operated by smoke detectors of the zone fire fighting system. The fire damper shall be smoke-tight type and shall have 120 min. fire rating. Provision shall be kept for manual operation of the damper.

Blade thickness : At least 16G CRCA
Frame : At least 40 x 40 x 3 mm Angle.

Motorised Fire Dampers shall be rated for 240 V, 50 Hz, 1 Ph., AC supply. Motor for Fire dampers shall be continuously rated. These Dampers shall close on de-energisation and open on energisation of Motor. Provision shall be kept for manual operation of the Damper.

Fire dampers will be provided at the supply/exhaust duct for fire-rated walls/floors as required by National Fire Protection Association (NFPA) and International Building Code (IBC).

iii) ACTUATORS

The actuators will be UL listed.

Dampers will be equipped with operators of sufficient power to control dampers, without flutter or hunting, through the entire operating range at air velocities at least 20 percent greater than maximum design velocity. Operators will have sufficient power on closure to provide tight sealing against maximum system pressures. Damper actuators will be designed to provide a minimum of 200 percent of the torque required to operate the damper and to meet the air leakage criteria. Damper actuators will not be less than 2.26 N-m (20 inch-pounds). Each damper section will contain one or more damper actuators. Jack-shafting of the section is not permitted.

Operators functioning in sequence with other operators will have adjustable operating ranges and set points.

Spring-return operators will be provided for two-position control or on reversible operators where required for fail-safe operation.

Electric motor operators for modulating control will be reversible type.

Locations where temperatures fall below minimum operating temperature of operator will be heated.

When dampers are installed on ducts to be externally thermally insulated, each damper operator will be equipped with stand-off mounting brackets, bases, or adapters to provide clearance between the duct and operator not less than the thickness of insulation. Standoff mounting items will be integral with the operator or standard accessory of damper manufacturer.

iv) OPPOSED MULTIPLE LOUVRE DAMPER

Opposed multiple louvers dampers shall be provided at the fan outlets and wherever mentioned in the drawings, specification and fan schedule. Each blade of the dampers shall be provided with bronze, gunmetal or nylon bearing at each end of its spindle. The spindle with bearing shall be mounted in a strong structural framework. Operating lever with fixing device for keeping the damper at the desired position shall be fitted for the manually operated dampers.

Operating level will be fixed on an indicator to show the percentage of opening of the damper in all cases except for the application with grilles and nozzles.

Velocity across the dampers shall not exceed 10 m/sec. Damper blades at fan outlet shall be made up of 16 gauge M.S.

6.10.12 Diffusers, Grilles, Registers - Conventional Design

Design of grilles & diffusers shall be such as to create desired throw and spread of air and shall be approved by the purchaser/engineer.

All diffusers and grilles shall be made up of powder coated sheet steel / extruded aluminium with finish painting. Design of all diffusers and grilles shall be made by the Contractor matching with the lighting and other fittings and to be approved by the Engineer. Each supply air diffusers shall be fitted with opposed blade damper, built-in vanes and louvers arranged as per manufacturer's standard design.

Side throw type supply registers shall have two sets of adjustable louvers with opposed blade dampers. The front of louvers shall be horizontal to provide horizontal deflection and the rear set of vertical louvers shall adjust vertical deflection. The dampers shall have horizontal opposed blades regulated by an operating lever in the frame. All wall type exhaust / return air grilles shall have one set of louvers in the front. The louvers shall be fitted such as to remain in position by friction grip. All supply air grilles shall have one set of opposed multiple louver dampers at the inlet. The dampers shall be gang operated and will have a device to keep the dampers fixed in one position.

The grille frame and louvers shall be manufactured of at least 20 SWG GI sheet and 22 SWG M.S. respectively. No grilles should by any chance make any rattling sound during continuous operation. All grilles shall match the decor of the space.

All grilles/diffusers shall be fitted with suitable gasket to prevent air leakage.

6.11.00 **Insulation**

6.11.01 Thermal Insulation

- A. The following items are to be insulated:
- I. Refrigerant suction piping from the evaporator coil outlet up to the compressor inlet shall be insulated with minimum 39 mm thick aluminium foil faced Nitrile rubber/ XLPE for Screw type Package Water Chilling Unit and 26 mm Nitrile Rubber/XLPE with 30G Aluminium sheet Cladding for Precision/ Split Air Conditioner. For better efficiency of operation the liquid line running side by side with the suction line may be insulated together with the suction line already mentioned.
 - II. Double skin Casing of the cabinet type air-handling unit with at least 25 mm thick Poly Urethane Foam (PUF)/ EPS sandwiched between them.
 - III. Supply air duct and part of the return air duct passing through non conditioned space, if any, with at least 13mm thick aluminium foil faced Nitrile Rubber / XLPE Insulation.
 - IV. Entire chilled water-piping, valves, chilled water circulating pumps, and chillers with 39 mm thick aluminium foil faced Nitrile rubber/XLPE.

The portion of Chilled water piping exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene and finished with chicken wire mesh, 12 mm thick sand-cement plaster and an overall cladding of 30G Al. sheet.
 - V. Drain Piping from AHU/Precision ACs /Split AC unit/ FCU and Chillers shall be insulated with 13 mm/ 6mm (for FCU and Split units) thick aluminium foil faced Nitrile Rubber/ XLPE.
 - VI. Screw type Packaged Chiller and Chilled Water Pump shall be insulated with 39 mm thick aluminium foil faced Nitrile Rubber/ XLPE.
 - VII. Chilled water Expansion tank drain piping with 6 mm thick aluminium foil faced Nitrile Rubber/XLPE.
 - VIII. Insulation of Precision AC Unit/ Split AC Unit shall be as per manufacture's standard.
 - IX. Roof of AC spaces shall be insulated with 25 mm thick EPS (under deck) for not exposed to sun and 50mm thick EPS (under deck) for exposed to sun.
- B. Insulation shall be fixed as per manufacturer's recommendation. Due care shall be taken to avoid damage to vapour arresters and insulation.
- C. Extra insulation thickness shall be provided at duct pipe hangers and special care shall be taken to seal the insulation and hanger member penetrations and instruments and accessories tapings.

- D. Special care shall be taken to provide satisfactory insulation for valves, flanges, vessel connections etc. with proper facility for maintenance and inspection.
- E. Insulated ducts crossing the floors shall have to be normally protected from damage and water splashing by providing suitable cladding up to 300 mm from the floor level.

6.11.02 Acoustic Insulation

All supply air ducts in the air conditioning system shall be insulated with Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner.

6.12.00 Precision / Split AC Units

6.12.01 Water Cooled Precision Air Conditioners

A. Compressor

The compressor shall be hermetically sealed scroll type medium speed, single acting type designed for R-407C/410A duty. The compressor shall be complete with crank case heater (to be energised when compressor is on off cycle).

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

B. Condenser

All condensers shall be of shell and tube type with water in the tubes and refrigerant in the shell.

The heat exchanger shall be designed for a minimum working pressure of 10.5 kg/cm² gauge on the water side and 19.0 / 27.0 kg/cm² for R-407C / 410A on the refrigerant side and shall generally conform to the latest ASME CODE for unfired pressure vessels Section- VIII. The design pressure shall have a reasonable margin over the maximum working pressure.

The average velocity of water in tubes shall not be more than 2.5 m/sec.

Water heads or refrigerant heads of the heat exchangers shall be as not to allow leakage of fluid from one pass to the other.

Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating.

The overall fouling factor for the condensers shall be $0.0002 \text{ Hr.M}^{20}\text{C/K.Cal.}$

The condensers shall be designed to provide at least 2°C sub cooling of refrigerant under rated design condition.

Testing and other design feature of the heat exchanger shall meet the requirements of TEMA Class-C heat exchangers or approved equal.

The heat exchangers shall have open able water boxes for ease in maintenance.

The tubes for the condensers shall also be copper with integral fins. The tube wall thickness at any point shall not be less than 18 SWG.

The baffle plates and the tube sheets shall be made of steel. The shell shall be made up of seamless tube or shall be fabricated from flange quality steel plate (ASTM-A285 Grade-C). The tube support plates shall be made of flange quality carbon steel plates and shall be as per TEMA Standard.

The heat exchangers shall be provided with vent valve, relief valve, and/or safety fusible plug on refrigerant side and vent valve and drain valve on water side (at every section of the baffled shell of heat exchanger).

The tenderer shall quote packaged units having compressor, condenser and evaporator assembly together in a single framework and mounted on a common base plate. Provision for refrigerant charging and chemical cleaning of water tubes shall be provided.

Each heat exchanger shall be provided with water flow switch. This shall be interlocked with the control of the individual refrigeration system/ corresponding compressor drive.

All the heat exchangers shall be provided, with standard connections like thermo wells, inspection valve and antifreeze thermostat and external equaliser connection for expansion valves. Insulation shall be terminated in such a manner that it will not be damaged during removal of bolts, covers etc. Separate covers similar to flange covers shall be constructed to facilitate easy removal.

The design pressure shall have a reasonable margin over the maximum working pressure.

C. Evaporator Cooling Coil

The cooling coil shall be direct expansion type with multi-row deoxidised copper tubes with aluminium fins. Air velocity across the coil shall be limited

to 2.5 m/sec. The coils shall be pressure tested and thoroughly dehydrated before assembling.

The coil shall be placed to make the system draw through type. Refrigerant feed control shall be by electronic expansion valve. Temperature control shall be through microprocessor based control panel. Insulated condensate drain pan of SS construction shall be provided within the unit.

The unit shall be factory assembled, wired, with inter connecting refrigerant piping and built-in microprocessor based control console and tested as per the relevant code.

The cooling coil shall be to produce the capacity required under specified coil condition and air quantity. Heat load calculation to check the system selection shall be carried out and submitted by the tenderer.

D. Evaporator Fan

The fan shall be heavy duty DIDW centrifugal type statically and dynamically balanced with forward/backward curve blade, directly driven by high efficiency EC motors. Fan wheels and casing shall be constructed of steel and mounted on steel shaft. The bearings shall be ball bearing type mounted on vibration absorbing rubber mounts. The fan motor shall be mounted within the cabinet. Motor horsepower shall be sized for 120% of the rated power required.

The supply fan shall be sized to deliver the required air quantity against the total external static pressure required for the system application, after taking care of all internal static pressure requirements of the units.

E. High Efficiency Filter

A set of High efficiency filters will be located inside the PAC unit cabinet. The filters shall be high efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sandwiched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling them.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall preferably not exceed 1.5 m/sec.

F. Humidifier

The humidifier shall be of Electrode type and shall be placed inside the PAC unit cabinet. The humidifier shall be electronically controlled through the built-in microprocessor based control panel of the unit. A provision of make-up water connection with the humidifier shall be kept with the Unit cabinet.

G. Electric Strip Heater

The PAC unit will be provided with built-in electric strip heater electronically controlled through the built-in microprocessor based control panel of the unit.

Such control includes both operating and safety controls with the sense of air temperature at the RA path and at the downstream side of the heater respectively.

H. Casing and Cabinet

All components shall be housed in a welded sheet metal cabinet of double skin of not less than 22 G thick MS powder coated sheets. The gap between two skins is filled up with at least 25mm thick PUF/ EPS insulation. Different sections will be constructed with framework and connected with each other in an airtight manner through gaskets, thermal barriers and sealant.

Removable panels shall be constructed of framed 1.6 mm sheet steel with angle iron framing. Units shall be provided with 316 L.S.S. fasteners for easy removal and access for servicing. Air handling section of evaporator shall be provided with an acoustic lining of 25 mm thick fiberglass covered with fiber glass cloth and perforated aluminium sheet on the inside surface of the unit casing.

The return air opening shall be on the front face with a matching grille of same colour finish.

6.12.02 Air Cooled Precision Air Conditioners

A Compressor

The compressor shall be hermetically sealed scroll type medium speed, single acting type designed for R-407C/410A duty. The compressor shall be complete with crank case heater (to be energised when compressor is on off cycle).

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

B Condenser (Outdoor Unit)

The Condenser shall be of Air Cooled type and shall be constructed of copper tube with aluminum fins. Tubes shall be designed for a minimum working pressure of 30 kg/ sq. cm. The condenser shall be complete with

fans with drive motors and shall be provided with charging connection, safety relief valve and standard accessories, all encased in a powder coated GI casing with built-in electrical items and supporting frame. The condenser shall have the matching capacity with the compressor. There shall be a provision of isolating switch for the fans.

C Evaporator Cooling Coil

The cooling coil shall be direct expansion type with multi-row deoxidised copper tubes with aluminium fins. Air velocity across the coil shall be limited

to 2.5 m/sec. The coils shall be pressure tested and thoroughly dehydrated before assembling.

The coil shall be placed to make the system draw through type. Refrigerant feed control shall be by electronic expansion valve. Temperature control shall be through microprocessor based control panel. Insulated condensate drain pan of SS construction shall be provided within the unit.

The unit shall be factory assembled, wired, with inter connecting refrigerant piping and built-in microprocessor based control console and tested as per the relevant code.

The cooling coil shall be to produce the capacity required under specified coil condition and air quantity. Heat load calculation to check the system selection shall be carried out and submitted by the tenderer.

D. Evaporator Fan

The fan shall be heavy duty DIDW centrifugal type statically and dynamically balanced with forward/backward curve blade, directly driven by high efficiency EC motors. Fan wheels and casing shall be constructed of steel and mounted on steel shaft. The bearings shall be ball bearing type mounted on vibration absorbing rubber mounts. The fan motor shall be mounted within the cabinet. Motor horsepower shall be sized for 120% of the rated power required.

The supply fan shall be sized to deliver the required air quantity against the total external static pressure required for the system application, after taking care of all internal static pressure requirements of the units.

E. High Efficiency Filter

A set of High efficiency filters will be located inside the PAC unit cabinet. The filters shall be high efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sandwiched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling them.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall preferably not exceed 1.5 m/sec.

F. Humidifier

The humidifier shall be of Electrode type and shall be placed inside the PAC unit cabinet. The humidifier shall be electronically controlled through the built-in

microprocessor based control panel of the unit. A provision of make-up water connection with the humidifier shall be kept with the Unit cabinet.

G. Electric Strip Heater

The PAC unit will be provided with built-in electric strip heater electronically controlled through the built-in microprocessor based control panel of the unit.

Such control includes both operating and safety controls with the sense of air temperature at the RA path and at the downstream side of the heater respectively.

H. Casing and Cabinet

All components shall be housed in a welded sheet metal cabinet of double skin of not less than 22 G thick MS powder coated sheets. The gap between two skins is filled up with at least 25mm thick PUF/ EPS insulation. Different sections will be constructed with framework and connected with each other in an airtight manner through gaskets, thermal barriers and sealant.

Removable panels shall be constructed of framed 1.6 mm sheet steel with angle iron framing. Units shall be provided with 316 L.S.S. fasteners for easy removal and access for servicing. Air handling section of evaporator shall be provided with an acoustic lining of 25 mm thick fiberglass covered with fiber glass cloth and perforated aluminium sheet on the inside surface of the unit casing.

The return air opening shall be on the front face with a matching grille of same colour finish.

6.12.03 Non-Duct able Split Type Air Conditioning Units

A. General

I. The split type room air conditioner consists of two units one Indoor unit (Evaporator) & an Outdoor unit (Condenser). It will be complete with all components to perform filtering and cooling of air in all seasons except winter. The refrigerant condenser will be air-cooled. The unit will be suitable for wall mounting.

- II. The unit shall have normal rating capacity as per the schedule mentioned elsewhere in the specification measured at a room temperature 24 °C DB and RH not exceeding 65% under design outside conditions specified elsewhere. The capacity variation should not be more than 5%.

B. Indoor Unit

- I. The indoor unit consists of panel type dry filter, cooling coil, evaporator fan etc.
- II. The filter is panel type dry having an efficiency of 90% down to 10-micron size Particles. The filter media shall be designed to hold dust, sand and prevent it from being dislodged by vibration or other cause and passing through filter. The face velocity of air across the filters shall not exceed 2.5 m / sec.
- III. Cooling coil will be direct expansion type made of seamless copper tubes with aluminum fins, number of fins as per manufacturer's standard but not more than 13 per inch & R22. The coils should be located at the suction side of the Evaporator Fans. Velocity of air across the coils shall be limited to 2.5 m/sec.
- IV. Piping accessories like Hot gas piping, cold gas piping and liquid refrigerant pipeline all made of copper complete with at least 26 mm thick Aluminium foil faced Nitrile rubber / XLPE or equivalent insulation interconnecting indoor and outdoor units, liquid line valves, liquid refrigerant piping, gauges and instruments, filter-drier, moisture indicator, isolating valves etc., shall be provided as may be required for safe and trouble free operation.
- V. The evaporator fan shall be Centrifugal, DIDW with forward Curved blades directly driven by TEFC squirrel cage induction motor operating in AC 240 V $\pm$ 10%, 1 Ph, 50 Hz $\pm$ 5% supply, with 3- step speed control. The evaporator fan shall be both statically and dynamically balanced.
- VI. Sheet metal casing with inspection facilities, made of Powder coated M.S. sheet and complete with suitable refrigerant pipe connections, insulated drain pan, insulated drain piping, supply and return air opening with decorative grilles with automatically swiveling louvers (for supply air grilles). The casing should be insulated inside to prevent condensation. This shall be provided from inside surface to limit the noise.

C. Outdoor Unit

- I. The outdoor unit shall consist of a compressor, air cooled condenser with liberally sized aluminium finned copper tube coil and low noise directly driven fan and totally enclosed weather proof motor housed in power coated MS casing.

- II. The Compressor shall be rotary type with R-22 refrigerant of specified capacity & motor. The compressor assembly shall be adequately designed for minimum vibration and noise disturbances. The compressor rotor assembly shall be dynamically balanced. The shaft seal shall be of proven design. The horsepower for the compressor motor shall be sized for 115% of rated power required for the unit including the drive loss.
- III. Accessories like Suction and discharge valves, safety valve, HP and LP cut out switches, powder coated sheet metal casing, vibration-isolating device, foundation bolts, built in Electricals like starters, switch fuse units, relays, contactors. The speed of the compressor should not exceed 1500 rpm.
- IV. Air-cooled condenser with directly driven axial flow fan & adequately sized drive motors (TEFC squirrel cage Induction type) with relief valve, hot gas connection, charging connection with valve, louver at the intake & exhaust of air, and other standard accessories. The condenser fan shall be both statically and dynamically balanced.
- V. The heat exchangers shall be designed for a minimum design test pressure of 20.33 Kg/m² on the refrigerant pipe. The design pressure shall have a reasonable margin over the maximum working pressure. Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating. The condensers shall be designed to provide at least 4°C sub cooling of refrigerant under rated design condition. The unit should be operating free from any vibration and noise.
- VI. The piping will be thermally insulated wherever required such that there is no condensation on the outside of the piping. The insulation will be of Aluminium foil faced XLPE or Nitrile rubber or equivalent.
- VII. Refrigerant piping shall be either of M.S. seamless (as per IS-1239, Part-I heavy grade) or copper tube (IS-5493) or ASA-9-31.5). Pressure drop in hot gas, liquid and suction lines should not exceed the value corresponding to 2 °F change in saturation temperature of the refrigerant. Velocity in the discharge and suction pipe of the refrigerant shall not be so high as to create undue vibration and noise, velocity in the vertical length of discharge and suction pipe of the refrigerant shall be high enough to carry the entrained oil in the refrigerant, even in case of unit running at lowest partial capacity. Instrument piping for gauges, switches etc. shall be of copper only.
- VIII. All the above equipment along with the electrical items like starter, contactor and other controls shall be encased in a powder coated MS casing. The casing shall be complete with supports fabricated out of MS angles, & sheets (duly painted), anchor bolts, nuts etc. The entire unit shall be installed with rubber pad type vibration isolators.

IX. All refrigerant valves as may be applicable shall have steel or brass body with flange connection or socket connection for welding or brazing to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. It is preferable to have the stems of rising stems inside screw type. The valve body and bonnet connection shall have bolted or welded connection.

X. It is preferable to have Teflon gland packing for the valves. The construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak tightness of the valves shall be tested at minimum 1.5 times the design pressure for the system.

6.13.00 Fresh Air System

6.13.01 For critical areas like control room, control equipment room etc., outside fresh air will be inducted into the AHU room/ PAC room through a Fresh Air system consisting of an inlet louver, dry panel type filter, a fan with a short duct (if necessary), SA register and mixed with the return air in AHU room/ PAC room.

For other non-critical areas like service building fresh air will be inducted in the AHU room through the wall mounted rain protection cowl with bird screen and a volume control damper.

6.14.00 Miscellaneous Items

6.14.01 Heater

A. Strip heater

I. Heating equipment wherever required shall be electrical type. All frame members, control box cover and associated sheet metal parts are to be heavy gauge steel with corrosion resistance treatment. Heating equipment may be required for winter heating as well as for reheating. Reheating heaters may be used for winter heating also.

II. Electric heaters will be fin-tube type of specified KW rating, with fins permanently brazed to metal sheath. The metal sheath and fins will be of G.I. sheet material.

III. Wherever electric heaters are installed in the ductwork, size of ducts should be suitably increased to offset the additional resistance created by the heaters. All heaters shall be mounted on such insulators that there shall be no leakage current under all weather condition including high humidity operation. The mounting frame shall be suitably grounded by earth wires / earth leads of two points.

IV. An air stat is to be installed such that in case there is no circulation of air over the heater coils the heaters will be de-energised. Wherever the heaters are installed in the ductwork the terminal block will be such positioned in a junction box that it will be outside the ductwork in an accessible position. The junction box will be vermin proof, rat proof and provided with a hinged cover. A caution plate as per I.E. rules will also be provided. Access door will be provided in the duct near the heating coil for easy inspection and removal / replacement / fixing of individual strip heaters. The capacity of heaters will be distributed over three phases.

V. In case of reheating the heater will be controlled by humidity sensor & humidity transmitter and in case of winter heaters it will be controlled by temperature sensor & temperature transmitter.

B. Electric Room Heater

Electric Room Heaters shall be with High / Low control.

Electric Room Heaters shall be suitable for AC 240 V $\pm$ 10%, 1 Ph, 50 Hz $\pm$ 5% supply.

6.14.02 Electrode Humidifier

A. Electrode humidifier consists of high temperature Polypropylene water tank, electrodes, auto flash cycle activated on demand from the microprocessor based control system with humidity sensor, located in the AHU / PAC room. Such Humidifier shall be controlled by its own stand-alone microprocessor based control panel. Alarm indication will be provided for low water level in the water tank.

B. Whenever the relative humidity of the conditioned space reaches the minimum allowable percentage of humidity, the humidifier shall be energized to restore the relative humidity. The humidifier shall be such controlled that it shall not exceed the maximum allowable limit of relative humidity in the conditioned space. The humidifier shall be sized and designed accordingly.

6.14.03 Non Chemical Water Treatment Equipment

A. The water treatment equipment is a 1 M long pipeline, which once installed, stops the formation of scale in the heat exchange zones completely.

B. The water treatment equipment consists of Metal Cell and Core and is installed on line after the pumps and before the heat exchange zone. The distance of the heat exchange zone should not be more than 30 M and there should not be any static area between the water treatment equipment and heat exchange area.

6.15.00 False Ceiling

6.15.01 Scope

The work under this Section shall include the supply and installation of suspended ceiling using GYPSUM boards together with the suspension system as shown on drawing or specified in Schedule with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or instructed by the Engineer.

6.15.02. Installation

A. Suspension System

General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

Metal Grid Suspension System

Aluminium grid ceiling system shall be "Beadlock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be jolly snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by MS flats, angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces & end tees shall rest on the moulding, unless otherwise shown on drawings.

B. CEILING PANELS

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V-joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and

schedule of items, 6 mm thick cement: lime: sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

6.15.03 Acceptance Criteria

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.15.04 Rates

Shall be lump sum rates for complete items called for in the "Schedule of Items". No extra payment will be made for arrangement for lighting fixtures, air conditioning diffusers, access panels, etc. The rate shall include all cutting and wastage from standard size sheets, boards, runners, etc.

6.16.00 Electrical Items

6.16.01 General Electrical Specification

For detailed General Electrical Specification, relevant Electrical section, as applicable, shall be followed.

6.16.02 Drive Motor

For detailed technical specification of motors, relevant Electrical section, as applicable, shall be followed.

6.16.03 Local Push Button Station (LPBS)

For detailed technical specification of Local Push Button Station (LPBS) system relevant Electrical section, as applicable, shall be followed.

6.16.04 Power Distribution Board

For detailed technical specification of Power Distribution Board relevant Electrical section, as applicable, shall be followed.

- 6.16.05 Cables
- For detailed technical specification of Cables relevant Electrical section, as applicable, shall be followed.
- 6.16.06 Cable Trays and Racks
- For detailed technical specification of Cable Trays relevant Electrical section, as applicable, shall be followed.
- 6.16.07 Grounding
- For detailed technical specification of Grounding relevant Electrical section, as applicable, shall be followed.
- 6.16.08 DDC System
- For detailed technical specification of DDC System relevant part of the specification shall be referred to.
- 6.17.00 **Controls & Instrumentation**
- 6.17.01 Control System
- A. All control shall be electrical / electronic type depending upon the requirement & as specified under the specification.
- B. Chilled Water System Controls
- All safety controls against high refrigerant pressure, low refrigerant pressure, low oil pressure, high and low voltage, compressor over-load and protection against freezing of the water chiller, low flow condenser cooling water & chilled water shall be provided.
- All safety controls against antifreeze protection, pump cavitations, motor protection etc. shall be provided.
- Operating thermostat/ temperature sensor sensing outlet water temperature of chiller shall be provided for each compressor. This thermostat/ temperature sensor shall control the liquid line solenoid valve in conjunction with the capacity controller for Screw type. Automatically operated heaters with safety thermostats & automatic unloaded starting device shall be provided for the compressor. Antifreeze thermostat to trip off respective compressor shall be provided for each compressor.
- C. Direct Expansion System Controls
- All devices for automatic refrigerant flow control by thermostatic expansion valve sensed by the superheat in suction line, solenoid valves in the liquid line to operate in conjunction with automatic capacity control of compressor by room thermostat (as applicable) sensing from the inside temperature of the

conditioned space is to be provided. High pressure and low-pressure cut out, low oil pressure cut out (if applicable), high and low voltage protection, compressor motor overload protection shall be provided. Automatically operated crank case heater with safety thermostats shall be provided for reciprocating compressors.

D. Air Handling Unit Controls

The temperature of all conditioned spaces shall be maintained / controlled by a modulating type 3 way mixing valve. The modulating motor will be operated by getting sense from the temperature sensor and associated transmitter placed in the return air path. There shall also be control valves in the chilled water line (for chilled water units) for manual control of chilled water flow into the cooling coil. These control valves shall be flow regulating cum measuring type with precision adjustment arrangement.

E. Annunciations

Audio-visual alarm facility is envisaged of the system. Details of the annunciation system shall be as per mentioned elsewhere and as per requirement.

6.17.02 Miscellaneous Instruments

- A. The pressure indicators and temperature indicators shall have minimum 150 mm size dial. The pressure gauges shall be Bourdon type and complete with isolating/valves. The pressure gauge shall conform to IS: 3624 and temperature gauge as per BS: 1041.
- B. Water flow switch shall be vane actuator type or differential pressure type, with adjustable actuation set point. The level switch shall be ball float operated magnetic type complete with cage. The switch case shall be weather proof conforming to NEMA-4.
- C. Apart from the thermostat, pressure switches, level switches and level indicators specified in this tender document, the local instruments shall also be furnished as a part of the system as shown in drawings enclosed and as per functional requirement.
- D. The range of controls and instruments should be such that the operating ranges are preferably in the mid scale. The accuracy should not be less than + 1% of full scale deflection. The repeatability of readings shall be + 1%. The differential in controls should be such that the equipment is able to operate at desired settings or maintain desired condition.
- E. The scale of pressure indicators for refrigerants units will be in kg/cm². Saturation temperature of the refrigerant in use, at the corresponding

pressure should also be indicated in the scale. The suction and oil gauge shall be compound gauge. The scale of pressure indicator for pumps will be in meter. The temperature indicator's scale will be in °C. The range should be such that even when the equipment is idle and the temperature of the medium is at such variance, the indicator will not be damaged.

- F. All instruments should be such selected and installed that they are easily readable from the floor.

7.00.00 SPECIAL TOOLS

The supplier shall furnish a complete set of all special tools, wrenches etc. with necessary toolboxes as required for erection, operation & maintenance, overhaul or complete replacement of any equipment supplied under this specification. The supplier shall enclose a list of such tools recommended by them.

8.00.00 SPARE PARTS

- 8.01.00 The supplier shall furnish and quote the Mandatory spare parts for the complete Air Conditioning System Equipment as per the list attached in the other part of the specification.

9.00.00 TESTING AND INSPECITON AT MANUFACTURER'S WORKS

- 9.01.00 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of the applicable codes.
- 9.02.00 Following tests shall be carried out during and after completion of different component parts as applicable and in accordance with the requirements of the applicable codes.
- 9.03.00 Material analysis and testing shall be carried out.
- 9.04.00 Hydraulic test for pressure parts including piping of VAM & its components, pumps, compressors & its components, vessels etc.
- 9.05.00 Dynamic balancing of all the rotating parts is to be done.
- 9.06.00 Performance test of Vapor Absorption Chiller, pump, compressors, condenser, cooling towers and air handling units shall be done as per code procedure.
- 9.07.00 Tests on motors as per Indian Standard IS-325 and IS-4029.
- 9.08.00 Other tests, as necessary and recommended by the manufacturer.

Test certificates and reports shall be made available to the Purchaser / Engineer on the above tests, for approval and before despatch of equipment.

The representatives of Purchaser / Engineer shall be given full access to all tests. The Tenderer shall inform the Purchaser within 21 days prior to important shop tests so that if the Purchaser / Engineer so desires, their representatives can witness the tests.

Cost of conducting all shop tests shall be borne by the supplier.

10.00.00 FIELD TEST

10.01.00 Overall performance of the air conditioning system with peak summer and monsoon outside conditions as well as individual equipment shall be tested after complete installation at site. Duration of such test shall be 72 hours. This test shall be carried out to determine whether the plant meets the performance requirements specified here in and shall include measurements of all parameters under various outside conditions and establishment of correct supply of equipment. All testing and calibrating instruments required for this purpose shall be supplied by the contractor.

10.02.00 Inspection and testing of duct work

All component and duct work supplied shall be subjected to inspection and testing as per relevant codes and standard.

10.03.00 All ductwork shall be carefully examined to determine their performance with the specification with respect of dimensions, materials, marking, leakage, workmanship and other requirement.

10.04.00 The contractor shall give assistance for all site tests of the equipment according to prescribed procedure laid down by the Manufacturer / Engineer.

11.00.00 PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND RECORDS

11.01.00 The Tenderer shall have to guarantee the performance of individual equipment. The Tenderer shall also guarantee maintenance of the inside conditions as indicated under “design criteria”.

11.02.00 Rectification of Deficient Performance

If the shop / site performance tests indicate the failure of the guaranteed performance of the equipment concerned, the tenderer will be given sometime to make good the deficiency at his own cost by incorporating the necessary modification, alteration and replacement.

11.03.00 Test Records

The certificates and records of the above mentioned tests should be submitted to the Purchaser for approval. The manufacturer shall maintain records of all tests required in the specification for at least 5 years. A list of records shall be submitted to the Purchaser on completion of the job. The Purchaser shall be able to obtain certified copies of such records at any time.

12.00.00 SPECIAL CLEANING, PROTECTION & PAINTING

12.01.00 Internal surface of all parts shall be cleaned to remove loose scale and dirt. The external surface of the motor and end shield shall be sand blasted to remove all rust, scale etc. All sharp edge shall also be removed. Welded rods, studs and other foreign objects shall be removed prior to final assembly. Excess oil and grease shall be removed by wiping.

12.02.00 All parts shall be painted with two (2) coats of rust preventing paint. One (1) coat of final paint shall be applied over and above the rust proof paint before despatch of material.

12.03.00 All equipment shall be boxed / crated or otherwise protected for shipment. Dry nitrogen desiccant and other protection shall be provided as may be necessary.

13.00.00 DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL

13.01.00 Beside submitting the enclosed Proposal Exhibit Sheets duly filled in, the proposal shall also include the following drawings, curves and information wherever applicable.

Preliminary cooling and heating load calculation is to be furnished.

13.02.00 Preliminary equipment layout drawings of the air conditioning plant room, AHU room and preliminary ducting layout drawing are to be furnished.

13.03.00 Manufacturer's catalogue and literatures incorporating outline and sectional drawings and ducting data for the following equipment:

Screw Compressor
Water-cooled Condensers
Chiller
Air Handling Unit (Fan, cooling coil & filter)
Drive motors for various equipment as applicable
Condenser cooling & chilled water pumps
Cooling tower
Non chemical water treatment

Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct able Split Air-conditioner
Fan Coil Unit
Motor
Direct Digital Controller

- 13.04.00 Manufacturer's selection chart for the following equipment:
- Water-cooled Screw Chiller
AHU
Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Unit
Pump
Cooling Tower
Fan
Fan Coil Unit
- 13.05.00 Manufacturer's catalogues and literatures on air conditioning system, instruments and controls.
- 13.06.00 Sectional drawings for air diffusers and grilles, as applicable.
- 13.07.00 Manufacturer's data sheets for filters and refrigerant.
- 13.08.00 Drive list
- 13.09.00 A detailed experience list about supply for system of similar type for similar application mentioning in each case the salient technical parameters, date of commissioning and name of customers.
- 13.10.00 A comprehensive write-up and / or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.
- 13.11.00 Any other relevant data and particulars.
- 14.00.00 **POST AWARD DOCUMENTS, DATA TO BE FURNISHED**
- 14.01.00 Description of the system offered.
- 14.02.00 Sizing calculations for all equipment and accessories which include cooling and heating load calculations, system pressure drop calculations, duct sizing calculations, pump capacity calculation, calculations for AHUs/FCUs and fresh air fans.

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|----------|---|
| 14.03.00 | Particulars of drawings, data, instruction manual and Drive List. |
| 14.03.01 | Equipment layout drawing for

Packaged Screw Chiller
Air conditioning plant room
Air handling unit room
Cooling Tower
Pump
Expansion Tank
Make-up Water Tank
Water-cooled precision air conditioner

Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Unit
Fan Coil Unit |
| 14.03.02 | Schematic flow and instrumentation diagram of the complete system indicating the limits of supply and erection. |
| 14.03.03 | Ducting layout drawing showing the details of duct sizes, duct joints, duct insulation, duct supports, diffusers, grilles, dampers etc. |
| 14.03.04 | Layout drawings showing the route of Steam piping, refrigerant piping and cooling water piping with details of insulation hangers, supports etc. |
| 14.03.05 | Outline drawings incorporating all principal dimensions, civil foundation drawings and weight etc. and also sectional drawings incorporating data of material of construction wherever applicable for following equipments:

Water-cooled Screw Chilling Unit
Air handling unit
Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Air conditioner
Drive motor for above equipment as applicable
Cooling tower
Expansion tank
Make-up Water Tank
Fan coil unit |
| 14.03.06 | Drawings and data sheets of each of Equipment and Instruments. |
| 14.03.07 | Drawings and data sheets for air filters, refrigerant / filter drier. |
| 14.03.08 | Write up on system interlock and / or interlock block diagram. |
| 14.03.09 | Electrical schematic and wiring diagram for control panel and the system as applicable with back-up write-up. |
| 14.03.10 | Control panel / Switchgear outline drawings, bill of instruments and drawings showing construction of control panel / switchgear. |

- 14.03.11 Reflected False Ceiling Plan indicating detail of supports/ hangers, grids, fixing detail of Grilles and diffusers and lighting fixtures etc.
- 14.03.12 Fixing/ application detail of under deck insulation indicating type and thickness and weight of insulation.
- 14.03.13 Other drawings and data.
- 14.03.14 Material test certificates.
- 14.03.15 Shop test reports and certificates.
- 14.03.16 Operation, maintenance and overhauling manuals shall be provided as per following specification.

OPERATION AND MAINTENANCE MANUAL

The successful tenderer, shall prepare, during the project execution stage a manual giving details of operation and maintenance instructions. The manual will be comprehensive manual and will be provided by the Engineer. The manual shall cover but not limited to the following aspects:

- i) Equipment description with design particulars.
- ii) Installation and Maintenance Instruction including preventive maintenance requirements.
- iii) Instruction for pre-commissioning check-up, operation.
- iv) Trouble shooting.
- v) Spare Parts list.
- vi) Lubricant and lubrication schedule
- vii) Control logic and inter connection and calibration of controls.
- viii) System description
- ix) Necessary drawings, illustration
- x) List of manufacturer's name and catalogues
- xi) Safety instructions.

The manual shall be securely bound in hard back durable folder with proper indexing and separators.

15.00.00 List of Drawings

Sl. No.	Drawing No.	Description
01.	13A06-003-DWG-VA-001	Schematic Diagram of Package Screw Chiller Unit
02.	13A06-003-DWG-VA-002	Schematic Diagram of Water Cooled Precision Air Conditioner
03.	13A06-003-DWG-VA-003	Schematic Diagram for Common Chilled Water Type Air

		Conditioning System of Power House and Service Building
04.	13A06-003-DWG-VA-004	Schematic Diagram of Air Cooled Precision Air Conditioner
05.	13A06-003-DWG-VA-003	Schematic Diagram of Air Cooled Split AC Unit

ANNEXURE-II TO SECTION - 2

**TECHNICAL SPECIFICATION
FOR
VENTILATION SYSTEM**

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	INTRODUCTION
2.00.00	SYSTEM DESCRIPTION
3.00.00	SCOPE OF SUPPLY
4.00.00	CONTROL PHILOSOPHY
5.00.00	DESIGN CRITERIA
6.00.00	DESIGN AND CONSTRUCTIONAL REQUIREMENT
7.00.00	SPECIAL TOOLS
8.00.00	TESTING AND INSPECITON AT MANUFACTURER'S WORKS
9.00.00	FIELD TEST
10.00.00	PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND RECORDS
11.00.00	SPECIAL CLEANING, PROTECTION & PAINTING
12.00.00	DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL
13.00.00	POST AWARD DOCUMENTS, DATA TO BE FURNISHED
14.00.00	LIST OF DRAWINGS

VOLUME: IIID

SECTION - II

VENTILATION SYSTEM

1.00.00 INTRODUCTION

1.01.00 The purpose of the system is to provide ventilation for different areas of 1X800 MW Supercritical Thermal Power Plant (Stage –VII, Unit #12 at Kothagudem Thermal Power Station, Telangana) to achieve the following :-

- i) Acceptable working environment.
- ii) Scavenging out structural heat gain and heat load from various equipment, hot pipes, lighting etc.
- iii) Dilution of air polluted due to generation of obnoxious & hazardous gaseous/aerosol contaminants like acid/chemical fumes, dusts etc.

1.02.00 Evaporative Cooling System with Air Washer Units (AWU) shall be adopted for the ventilation of the following areas of Power House Building:

- i) TG Hall
- ii) MCC, Switchgear rooms and cable spreader rooms
- iii) Battery Charger Rooms

1.03.00 Mechanical Dry Ventilation System with either Supply or Exhaust Fans shall be provided for the following areas of the Power House Building:

- i) Battery Rooms
- ii) Elevator Machine Rooms
- iii) Toilets

1.04.00 Mechanical Dry Ventilation System with Exhaust Fans shall be provided for the following areas of Mill Bay:

- i) Coal Conveyor Tripper floor

1.05.00 Similarly evaporative cooling system with Unitary Air Filtration Units (UAF) shall be provided for the ventilation system for the MCC / Switchgear Rooms and other non-AC areas of the following areas:

- i) Non-AC areas of ESP Control Building
- ii) Ash handling electrical / control building.
- iii) CHP control building

1.05.00 Dry Ventilation System with either Supply or Exhaust Fans shall also be provided for the following Auxiliary Buildings:

- a) DG and Compressor House
- b) Ash slurry pump house
- c) HFO & LDO forwarding pump house
- d) CW treatment building
- e) DM Plant building
- f) DM, service and potable water pump house
- g) Non-AC areas of Chemical House
- h) CPU Regeneration Building
- i) Switch yard control building
- j) CW Pump House
- k) AHP Compressor Building
- l) Non-AC areas of Service Building
- m) Silo Utility-cum-HCSD Pump House
- n) Vacuum pump house
- o) Ash water pump house
- p) Clarified water pump house
- q) Centrifuge building
- r) Store Building

2.00.00 **SYSTEM DESCRIPTION**

2.01.00 Evaporative cooling system by adopting Air Washer Unit (AWU) is to be provided for the ventilation of Power House Building. Cooled and filtered air from Air Washer Units should be distributed by means of ducting to the TG building near various heat sources like turbo-generator, condenser, boiler feed pump, HP & LP heaters, oil coolers etc. The quantity of air exhausted should be kept lower than the quantity of air supplied (usually 60-65% of the supply air is exhausted) in such a way that a little over pressure is maintained inside the hall. This will reduce infiltration of outside hot and dusty air.

On the basis of net heat gain and assumed temperature rise, the supply air quantity for TG hall is to be worked out. This air quantity will be supplied from four (4) AWU - two (2) being placed on B-C bay at De-aerator floor and two (2) being located outside A row of Power House building. Such division and location area is decided to achieve effective air distribution with fewer amounts of duct work and less pressure drop in fans with no cross-over of ducting across A-B bay.

The Air Washer Units will primarily serve TG hall and the electrical areas like MCC Room, Switchgear Room and Cable Spreader Room. The washed air supplied to MCC / Switchgear / Cable Spreader Rooms will be exhausted outside through gravity dampers / exhaust fans (usually 60-65% of the supply air is exhausted to maintain a little overpressure inside the room). Fire dampers (Motorized) shall be provided in the supply air ducting / fans leading to all electrical rooms (MCC, Switchgear etc.).

The supplied air in the lower level of TG hall after taking the heat load of TG bay rises through different openings to the upper floors and is then finally exhausted by means of Roof extractors placed over the roof of TG Hall. Some quantity of air leaks out through various leakage areas due to the overpressure maintained inside the TG Hall.

All these Air Washer Units shall be of package type construction enclosed in sheet metal casing to avoid the problem of water seepage and also to reduce load on building structure. Sump of AWU to be made out of sheet metal / masonry construction with anti-corrosive paintings. All accessories (except water circulation pumps with drive motors, strainers and some portion of piping) shall be placed inside the AWU casing.

Roof extractors are to be provided with rain water protection cover.

While developing the layout, all fresh air ventilation louvers shall be considered 1000 mm from floor level and directed downwards at an angle. Ventilation fans on AB bay roof shall be kept staggered and shall not be near the centerline of turbo generator set.

- 2.02.00 Exhaust (pull type) ventilation system is adopted for the Battery Rooms by providing Bifurcated type axial flow exhaust fans (1R+1S) of spark proof construction and with flame proof motors and fusible link type fire dampers. In the event of failure of any of the battery room exhaust fans, the second fan will be put into operation to take care of the ventilation need of this Battery Room. All the parts of this system coming in contact with acid fumes shall be epoxy painted. The air discharge from the Battery Room shall be taken to a high level (around 1M above TG Building Roof Level) through an exhaust duct (MS Epoxy painted). In case routing of such exhaust duct is not feasible, the steel parts in a radius of around 5M from the discharge end of the Battery Room Exhaust Fans shall have to be painted with acid resistant epoxy resin based paint. Intake Air for the battery room shall be drawn from the adjacent TG hall through manually operated louver shutter provided in the Battery Room.

A negative pressure shall be maintained inside the Battery Room to prevent leakage of acid fumes and other hazardous gases outside the Battery Room.

- 2.03.00 Coal conveyor tripper floor of the Mill Bay shall be ventilated by means of Roof Extractors. Air intake louvers should be provided at lower level for air entry to the coal tripper floor.

- 2.04.00 Pressurized Ventilation system shall be provided for the Elevator Machine rooms with the help of wall mounted Fan-Filter Units. Air will be exhausted through Back Draft Dampers.
- 2.05.00 Exhaust Ventilation system shall be provided for the Toilets by installing wall mounted type exhaust fans. Air will enter the toilets through door grilles.
- 2.06.00 In the MCC/ switchgear room of ESP, AHP & CHP Control Building, washed and filtered air supply will be provided by the Unitary Air Filtration Unit due to the reasons that the this building is located in a very dusty zone and heat load of this Building is high.
- 2.07.00 Ventilation provision for Auxiliary Buildings in various locations shall be done as follows:

Sl. No.	Building	Ventilation System
1.	Electrical MCC/Switchgear areas of ESP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
2.	Electrical MCC/Switchgear areas of AHP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
3.	Electrical MCC/Switchgear areas of CHP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
4.	DG and Compressor Building	For DG area air entry through intake louvers for radiator cooling (in case of air cooled DG) will serve the purpose of ventilation. For water cooled DG, exhaust ventilation will be provided by wall mounted exhaust fans and air entry through inlet louvers. For Compressor area wall mounted Supply air Fan Filter Units and air exhaust through Back Draft Dampers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
5.	DM Plant building	Wall mounted Exhaust Fans for Plant area and Chemical Storage area and fresh air entry through Inlet Louvers.

6.	Ash Slurry Pump house	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
7.	HFO & LDO Forwarding Pump house	For pump area, wall mounted Exhaust fans of spark proof construction with flame-proof motors and fusible link type fire dampers and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
8.	CW Treatment Building	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.
9.	DM, Service & Potable Water Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
10.	Chemical House	Wall mounted Exhaust Fans for Plant area and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
11.	CPU Regeneration Building	Wall mounted Exhaust Fans for Plant area and fresh air entry through Inlet Louvers.
12.	Switch Yard Control Building	For battery room, wall mounted Exhaust fans of spark proof construction with flame-proof motors and fusible link type fire dampers and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.

13.	Store Building	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.
14.	CW Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. Alternatively, evaporative cooling system may be considered for pump area. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
15.	AHP Compressor Building	For Compressor area wall mounted Supply air Fan Filter Units and air exhaust through back draft dampers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
16.	Service Building	For Electrical rooms, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers. Exhaust Ventilation system shall be provided for the pantries by installing wall mounted type exhaust fans. Air will enter through door grilles / inlet louvers. Exhaust Ventilation system shall be provided for the stores by installing wall mounted type exhaust fans. Air will enter through door grilles / inlet louvers.
17.	Silo Utility cum HCSD Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For Electrical rooms, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
18.	Vacuum Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers.
19.	Centrifuge Building	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.

20.	Ash Water Pump house	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
21.	Clarified Water Pump house	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For battery room, wall mounted Exhaust fans of spark proof construction with flame-proof motors and fusible link type fire dampers and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
22.	Toilets (For all areas)	Exhaust Ventilation system shall be provided for the Toilets by installing wall mounted type exhaust fans. Air will enter the toilets through door grilles.

N.B. Above requirement is tentative only based on the current Plot Plan. Final requirement of ventilation will be decided during detail engineering when the list of buildings will be finalized and layout drawing of each building will be frozen.

2.08.00 In general, for a particular area / room ventilation equipment / systems shall be selected in multiple modules and therefore no idle stand-by equipment has been envisaged. However, for the Battery Rooms one idle stand-by fan unit shall be provided in consideration of their locations and hazardous spreading of acid fumes in case of failure of running fan.

3.00.00 **SCOPE OF SUPPLY**

3.01.00 **Equipment**

Equipment sizing is to be done on the basis of heat load and number of air changes. The higher of the sizes arising out of these requirements should be considered. Selection of fan duty conditions is to be supported by back-up calculations, to be enclosed with bid.

- 3.01.01 Centrifugal Fan unit each complete with:
- a) Fan impeller (backward curved) with casing and supports and required steel frame / supporting structure, if any.
 - b) Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption.
 - c) Drive Pulleys, V-belt, belt guards, slide rails etc.
 - d) Dampers at fan outlet and flexible connection (Rubberized Canvas) with matching flanges.
 - e) Vibration isolators (rubber in shear type / neoprene rubber pad), foundation bolts and nuts.
 - f) Removable drain plug with the fan casing.
- NB: These Centrifugal fans also cover those required for Air Washer and Unitary Air Filtration Units.
- 3.01.02 Wall mounted axial flow fans each complete with:
- a) Fan impeller of cast alloy aluminium construction (LM-6 Grade) with blades of aerofoil design.
 - b) Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption including motor brackets.
 - c) Vibration Isolators.
 - d) Short duct (wherever required).
 - e) Coned inlet and grouting framework, if any.
 - f) Rain protection cowl with bird-screen made of GI, Foundation Bolts etc.
 - g) Dry filters including fixing framework for fan filter unit (wherever required).
 - h) Back draft dampers, wherever specified.
 - i) Protective wire netting inside the room, wherever required.
- N.B. For Toilets, Pantries, Stores requiring small capacity fans, Propeller type fans are acceptable.
- 3.01.03 Roof mounted axial flow fan (Roof Extractor) each complete with:
- a) Fan impeller of cast alloy aluminium construction (LM-6 Grade) with blades of aerofoil design.

- b) Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption including motor brackets.
- c) Vibration Isolators.
- d) Short duct mounting (if required) having inspection door and base with proper water sealing arrangement.
- e) Grouting Frame.
- f) Fan casing of heavy gauge sheet steel construction.
- g) Rain protection hood / cowl with bird screen and disconnection switch, foundation bolts etc.

3.01.04 Sheet metal type Air washer Units (AWU), each complete with:

- a) Air Intake Louver with bird screen of GI construction.
- b) Automatically cleanable water flooded stainless steel mesh filters cleaned by one bank of spray header with stainless steel water spray nozzles spraying water over the filter in the direction of air flow and one more bank of spray header with stainless steel water spray nozzles spraying water opposing the air flow.
- c) Two numbers Horizontally Split casing / back pull-out type Centrifugal pump sets (one running and one standby) complete with drive motor for circulation of water through the above spray header banks and provided with pot type suction strainer with bypass valves, inlet and outlet pressure gauges and filter back wash arrangement.
- d) Moisture eliminator sets of die-extruded PVC construction.
- e) Inspection doors with ladder and marine lights for different sections and cat walks as required.
- f) All valves, pipes with fittings, nuts and bolts, internal fittings and supports, including ball float valves for make-up water connection, quick-fill connection with valve, drain piping with valves up to the nearest drain point, and overflow connection with siphon.
- g) Double inlet Double width Centrifugal fan with electric drive motor, drive pulleys, v-belt, belt guards, cushy foot mountings, removable drain plug and other accessories as required. Both inside and outside surfaces of all parts of the fan shall be spray galvanized. The fan with drive motor shall be placed inside casing of AWU.

- h) Air washer casing shall be sheet steel fabricated construction with adequate stiffeners, bracings etc. (duly spray galvanized / painted with epoxy resin based paint from inside and outside) covering all components of the Air Washer Unit including Centrifugal Blowers, but excluding the water circulating pump sets.

Top Surface of the AWU shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

Air Washer Sump made of sheet metal construction / masonry construction and duly painted with epoxy resin based paint both from inside and outside. The sump shall be complete with make-up water connection with float valve, quick fill connection with isolating valve, drain connection with valve, overflow connection with siphon and coarse strainer chamber and low level switch.

NOTE: Bidder will indicate make up water requirement for the equipment offered by them.

3.01.05 Unitary Air Filtration (UAF) units each consisting of:

- a) Air Intake Louver with bird screen of GI construction.
- b) Automatically cleanable type Stainless Steel mesh Filters complete with SS / Al. frame continuously flooded with water by one bank of spray header with stainless steel water spray nozzles spraying water over the filter in the direction of air flow.
- c) Two (2) nos. (one no. working and one no. stand-by) Centrifugal mono-bloc pumps for circulation of water. Pump system shall be provided with pot strainer with by-pass valves, inlet and outlet pressure gauges and filter back wash arrangement.
- d) Moisture eliminator sets of die-extruded PVC construction.
- e) UAF chamber & sump shall be of sheet metal construction. Both the casing and water sump shall be duly spray galvanized / painted with epoxy resin based paint from inside and outside and shall be complete with all valves, pipes, nuts and bolts, pipe hangers, supports, internal fittings and supports, suction pipe connection with coarse strainer, make-up water connection with ball float valve, quick fill connection with isolating valve, drain connection with valve, overflow connection with siphon and low level switch.

Top Surface of the UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

- f) Interconnecting G.I. piping between pump and UAF Spray Header / Sump complete with necessary supports and supporting structures etc.
- g) Inspection door with ladder, marine lights and cat walk in the spray chamber.
- h) Single inlet single width Centrifugal fan complete with electric drive motor, drive pulleys, V-belt, belt guards, slide rails and other accessories etc. Both inside and outside surfaces of all parts of the fan shall be spray galvanized.
- i) GI connection piece between the centrifugal fan and UAF casing.

3.01.06 GI sheet steel fabricated ducting including the following:

- a) GI sheet metal (180 Grade) duct as per IS 655. Minimum duct thickness shall be 1 mm (20 G).
- b) Damper with control arrangement at each branch off and whatever necessary.
- c) All supply air grilles and diffusers made of powder coated MS sheet (20 SWG) / extruded aluminium with volume control dampers and supporting frames as required at site.
- d) Supports and hangers including anchor bolts as required.
- e) Sealing compound and jointing gasket for ducts.
- f) Flexible connections of rubberized canvas.
- g) The exposed portion of the ducting shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.
- h) Motorized Fire Dampers with supply and Fusible Link type Fire Dampers with exhaust air duct / path (wherever applicable).

Motorized fire dampers will be provided in the supply air ducts and supply air openings leading to all the electrical areas (MCC and Switchgear Rooms, cable spreader rooms of Power House as well as ESP, AHP & CHP control buildings).

The signal from smoke detectors / thermal sensors including potential free contact at the fire panel shall be sent to operate the supply air fire damper. In case of fire / power failure, the damper actuator shall be de-energized to close the damper and respective fan motor shall be tripped in case of fire.

Power supply for the motorized dampers shall be arranged from Bidder's respective Local Starter cum Control Panels (LSCP) for AWU / UAF unit. The fire dampers shall be electrically operated motorized type (rated $240V \pm 10\%$ volt, $50 \pm 5\%$ HZ AC). The damper shall be suitable for electrical opening and closing for their automatic operation and manual testing purpose with the help of bypass Push Buttons. The damper actuators shall be spring return type. The damper shall be interlocked with respective motors of ventilation system.

Fusible Link type Fire Dampers are to be provided with Exhaust duct / path wherever applicable.

- h) Back draft dampers will be provided at the air outlet areas where pressurized ventilation has been envisaged.

- 3.01.07 All drive motors.
- 3.01.08 Local Starter Cum Control Panels (LSCP) for AWU and UAF units.
- 3.01.09 Local Starter Panels (LSP) for Ventilation fans except AWU and UAF units.
- 3.01.10 Power and Control Cabling and Grounding details.
- 3.01.11 Installation of all equipment supplied by bidder.
- 3.01.12 Anchor bolts, nuts and bolts and loose fitting as would be necessary for erection and commissioning.
- 3.01.13 One complete set of tools and tackles.
- 3.01.14 One set of recommended spare parts for trouble free operation of the system together with mandatory spare parts as specified.
- 3.01.15 Cleaning protection and painting as specified herein.
- 3.01.16 The above clauses specify the equipment for general guidance only. Any other equipment and/or material necessary to ensure safe and satisfactory erection, commissioning, operation and maintenance shall also be included in the scope of the specification.
- 3.01.17 Grounding of all drives and equipment required for Power House Ventilation system as per Main Plant Package, Technical Specifications, and relevant volume for Electrical Works.

4.00.00 CONTROL PHILOSOPHY

4.01.00 Ventilation fan motors

All ventilation fan motors except Air Washer / UAF Units shall be controlled from Local Starter Panel / Switch to be provided near each fan.

4.02.00 Air Washer / UAF Units

Each Air Washer / UAF Unit will have one Local Starter cum Control Panel (LSCP) located near each Air Washer / UAF Unit for its control.

a) Humidity Control (applicable for Air Washer)

To protect the equipment located in the ventilation space (mainly for the MCC/ Switchgear Room) from effects of high humidity, the control device using humidistat is interlocked with a two-way actuator operated control valve to be mounted on the header of that spray bank which is not connected with the filter washing. Humidity beyond 60% RH in these ventilated spaces shall automatically close the two-way valve. The valve may be opened automatically at about 50% RH. However, manual over-riding facility shall be provided for this humidistat controlled valve. Minimum two (2) nos. Humidistat shall be provided for each Air Washer Unit.

Relative humidity inside the ventilated areas shall also be displayed digitally on the LSCP.

b) AWU / UAF Unit Sump Water Level Control

The water sump of each Air Washer / UAF Unit shall be provided with a low level switch which will initiate an alarm & will trip the pump, in case water level falls below a pre-determined mark. At the delivery pipe of each pump a pressure switch will be provided along with pressure indicator.

c) Following indications are to be provided in Local Starter-cum-Control Panel for Air Washer / UAF Units.

- I. FAN RUNNING.
- II. FAN STOP.
- III. PUMP – 1 RUNNING (FOR SPRAY SET ARRANGEMENT).
- IV. PUMP – 1 STOP (FOR SPRAY SET ARRANGEMENT).
- V. PUMP – 2 RUNNING (FOR SPRAY SET ARRANGEMENT).
- VI. PUMP – 2 STOP (FOR SPRAY SET ARRANGEMENT).

- VII. FAN MOTOR OVER LOAD TRIP.
- VIII. PUMP - 1 MOTOR OVER LOAD TRIP.
- IX. PUMP - 2 MOTORS OVER LOAD TRIP.
- X. RH HIGH.
- XI. RH LOW.
- XII. SUMP WATER LEVEL LOW.
- XIII. Relative Humidity

Provision of alarm (audio-visual) for Trip of any motor & low water level in the sump shall also be kept in the Local Starter cum Control Panel.

d) Motorized Fire Dampers

Motorized Fire Dampers are to be installed in the ventilation supply air ducting / with the supply air fans leading to electrical rooms like various MCC Rooms, Switchgear Rooms and Cable Spreader Rooms. These dampers shall be operated with the help of signal from smoke detectors / thermal sensors through zone fire panel. Motors shall remain energized in normal condition to effect opening of dampers. In the event of fire, the motors will be de-energized and the damper will close due to spring action.

In case of fire, all the motorized fire dampers provided in the supply air duct will close and the relevant fan motors will be tripped at the same time. The signals for this operation will come from zone fire panel.

In case of fire in the TG Hall or in the electrical rooms, all the supply fans of AWUs shall be stopped automatically with the sense from smoke detectors / thermal sensors through zone fire panels.

5.00.00 **DESIGN CRITERIA**

5.01.00 The design outside condition are taken from the Meteorological Station at Khammam nearest to the Kothagudem Thermal Power Station shall be considered as follows:

Summer: 42.6 Deg. C (DB), 26.6 Deg. C (WB)

Monsoon: 30.9 Deg. C (DB), 25.8 Deg. C (WB)

Winter: 20.8 Deg. C (DB), 18.4 Deg. C (WB)

5.02.00 **Inside Design Condition**

The desired condition inside the ventilated space has to be maintained by selecting proper type of Ventilation System.

- 5.02.01 In dry type forced (mechanical) Ventilation System where the ambient air is drawn and distributed inside the building/room and then exhausted, the average design condition inside the space to be ventilated is to be restricted about 3°C higher than the ambient (outside) dry-bulb temperature. Relative humidity will depend upon moisture content of ambient air.
- 5.02.02 In the areas ventilated by evaporative cooling units, the inside dry bulb temperature will be restricted to 5°C less than the summer ambient temperature (DB). This temperature will occur only for a few hours of some days in peak ambient condition and will prevail near the roof level where the hot air along with some solar heat load through roof will be exhausted out by roof extractors /wall mounted exhaust fans/louvers/back draft dampers.
- 5.02.03 Inside condition of TG hall and other electrical areas like switchgear room, MCC room of Power House building will be made reasonably dust free by adopting flooded type filter in the Air Washer Units. Moreover some amount of over pressure will be maintained inside the TG hall and electrical areas, and dust infiltration will be prevented thereby. For this system to work effectively, the rolling shutters should be kept closed. In some dry type mechanical ventilation, dry type washable metallic filter shall be adopted where cleanliness requirement is of importance. Here also some amount of over pressure will be maintained by using back draft damper to prevent the ingress of dust.
- 5.02.04 Auxiliary buildings should be ventilated generally as mentioned earlier. Areas not covered in these places but require ventilation should also be ventilated.
- 5.02.05 The following minimum air change rates are to be maintained for the areas indicated below.

Building / Area	Air Change / Hour
TG Hall	6
Cable Spreader Room	5
Electrical Room like MCC Room, Switchgear Room in the TG Building	15
Oil Room	20
Battery room	20
Elevator Machine Room	15
Mill building – coal bunker area	30
Non AC areas of ESP, AHP & CHP control building	15
Chemical House	20
DM plant	10
HFO & LDO forwarding pump house	20
Stores	5
DG area	10

Building / Area	Air Change / Hour
Compressor house	15
Switchyard Control Building (Non AC area)	15
Pump Houses –pump area	10
Electrical Rooms associated with the pump Houses	15
Electrical Rooms for all Auxiliary Buildings	15
Toilets	20
Pantries	20

Note:

The fan capacities shall be decided on the basis of the actual Heat Load and specified temperature rise or specified minimum air change rate, whichever is higher.

6.00.00 **DESIGN AND CONSTRUCTIONAL REQUIREMENT**

6.01.00 **General**

- 6.01.01 All equipment shall be heavy-duty type suitable for installation in heavy industries and long period of uninterrupted service.
- 6.01.02 The equipment shall be designed to permit interchangeability of parts and ease of access during inspection, maintenance and repair.
- 6.01.03 All parts subject to substantial temperature changes shall be designed and supported to permit free expansion or contraction without resulting in leakage, harmful distortion or misalignment.
- 6.01.04 All electrical and mechanical equipment shall be designed and manufactured so that no damage will result from transportation, storage, installation and operation of the equipment with the climatic conditions to which it will be subjected.
- 6.01.05 All materials used shall conform to the specification and shall be new and first class in all respects.
- 6.01.06 Anchor bolts, nuts and seating steel work shall be supplied with the equipment. Only hexagonal nuts shall be used for holding down the equipment, with proper lock nuts. All bolt holes shall be spot faced for nuts. In specific cases where not necessary, spot facing may be omitted.
- 6.01.07 Casting and welding shall conform to their respective specifications and shall be free from flaws and objectionable imperfections, machined true and in a work-man like manner.

- 6.01.08 Proposal for repair or any similar operations involving the plugging, welding, boring or addition of metal to the original castings, shall be submitted to the Purchaser/Consulting Engineer and approval shall be received before any such work is carried out. Drawings showing details and locations of such modifications shall be submitted to the Purchaser/Consulting Engineer for his records.
- 6.01.09 The separate pieces of equipment shall be marked with unit number. The assembly drawing shall indicate part number of each equipment and unit number for easy correlation.
- 6.02.00 **Centrifugal and Axial Flow Fans**
- 6.02.01 Centrifugal fans shall be SISW/DIDW as mentioned in the Specification. The design shall be in general end suction and upward/downward/inclined/horizontal discharge type as demanded by the system/installation need. All centrifugal fans are coupled to the drive motors with V-belts. Puller holes should be provided on fan impellers and pulleys for ease of extraction from fan/motor shaft. Fan/motor shafts should have threaded centre holes for fixing pushers and locking the impeller/pulley axially on fan/motor shaft.
- 6.02.02 All Roof extractors / supply fans and wall mounted exhaust/supply fans are of direct drive axial flow type. Roof extractors/supply fans shall have multi-bladed impeller with a short duct casing while wall mounted exhaust/supply fans shall have coned inlet suitable for free discharge of air.
- 6.02.03 The centrifugal fans and axial flow fans shall be capable of withstanding the stresses which may be experienced during normal operation under the condition which it is required for and during over speed test.
- 6.02.04 It is desirable that all centrifugal fans shall be designed to operate within 9% and 25% of system throttling line.
- 6.02.05 All the fan units shall be reasonably noise and vibration free in operation and therefore of reasonably low speed. RPM of axial flow fans shall be restricted within 1000 to reduce their noise level excepting roof extractors for which RPM shall be restricted to 1500. Outlet air velocity of all fans shall be restricted within 12 m/s.
- 6.02.06 Casing for centrifugal and axial flow fans shall be reasonably leak proof.
- 6.02.07 The first critical speed of the rotating assembly shall be at least 25% above the operating speed.
- 6.02.08 Fan wheels shall be statically and dynamically balanced according to AMCA standard. Fans of 5 HP and above sizes must be dynamically balanced.

6.02.09 Impeller

- a) The blades of the centrifugal fan impeller for all units shall be backward curved unless otherwise specifically mentioned. The blades of the impeller shall be die formed aerofoil or laminar type. They shall have self-cleaning and non-overloading characteristics, and shall be welded to the back plate and shroud, if any. The fan wheel shall be statically and dynamically balanced.
- b) The axial flow fan impeller shall be cast in one piece, finished all over and are fully balanced both statically and dynamically. Finally the assembled rotor shall be dynamically balanced. All axial flow fan impeller shall consist of high efficiency aerofoil section blades. Puller holes should be provided on fan impellers and pulleys for ease of extraction from fan/motor shaft. Fan/motor shafts should have threaded centre hole for fixing pushers and locking the impeller/pulley axially on fan/motor shaft.

6.02.10 Casing

- a) Centrifugal fan casing shall be of welded construction and provided with flanges on inlet and outlet sides for duct connection. Mounting legs welded to the casing shall be provided. Plummer blocks should preferably be not supported on the bracings/stiffeners of casing sidewalls.
- b) Axial flow fan casing for roof extractors/supply fans and their components shall be suitable for outdoor installation. The casings will be provided with flanges at inlet and outlet. All nuts & bolts associated with it shall be of zinc or cadmium plated with proper baking to remove hydrogen.

Easily removable inspection cover having galvanized fly nut shall be provided. The inspection covers shall be located such that the grease nipple for all bearings and also motor terminals are easily accessible through the cover. It is however, preferred that provisions will be there for greasing the fan bearings from outside the fan casing.

Suitable motor brackets as per manufacturer's standard for both roof and wall exhausters/supply fans shall be fitted. The brackets shall be designed to provide rigid mounting for motors.

6.02.11 Bearing

Centrifugal fan shaft shall be mounted on self-aligning, heavy-duty spherical roller bearing of adequate capacity and life. In no case the life of the bearings shall be less than 40,000 hours. Centrifugal fans for air washers installed in the T.G. Building, should have minimum bearing life of 100,000 hours. Bearings shall be grease lubricated and provided with fittings for lubrication from outside. The bearings shall be located in an easily accessible location to facilitate maintenance.

- 6.02.12 Roof extractors/wall mounted fans (if located on the exposed wall) shall be provided with hood for protection against rain and other contingencies. It must ensure no dripping of rainwater under any circumstances and will have low-pressure drop of air. The hoods shall be provided with a heavy gauge expanded metal bird screen. Axial flow fans should be fitted with protective screens from inside of room.
- Rain protection cowls will be designed to suit wall mounted exhaust/supply fans for protecting fans from rain. The cowls will be provided with bird screen of heavy gauge expanded metal netting.
- A typical sketch enclosed herewith shows arrangements for both roof extractors and rain protection cowl. Any other approved design for the hoods and cowls can be considered. Grouting frames for the cowls if required shall be included in the supply along with nuts and bolts.
- 6.02.13 Coned Inlet
- Wall mounted exhaust fans shall be provided with coned inlet made of M.S.
- 6.02.14 Inlet Screen
- Inlet screen shall be manufactured of min. 14 SWG galvanized wire knitted in 1" square mesh. Suitable flanges to protect the edges of the screen shall be provided.
- 6.02.15 Vibration Isolator
- Double deflection rubber in shear or rubber in compression type vibration isolators shall be provided with each centrifugal fan and each axial flow fan. Rubber bushes, washers, wherever needed for the vibration isolators shall be included in the supply. Sufficient number of such isolators shall be provided to ensure isolation of foundation from vibration of the equipment.
- 6.02.16 Fans For Special Application
- Fans for battery room, oil rooms and fuel stores shall be of spark proof construction. These axial flow type fans shall be bifurcated type construction with motor away from air stream. Motors for these fans shall be of flameproof construction.
- All fans for special application shall have all accessories as mentioned in the Specification.
- 6.02.17 Fan Drive
- a) Centrifugal fans shall be provided with V-belts and sheaves. All belts shall be sized with minimum 1.5 service factor. All V-belt drives shall be equipped with removable guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. All pulleys should have threaded puller holes for the ease of their extraction.

- b) All direct drive axial flow fan impellers shall be directly mounted on extended motor shaft.

6.02.18 Materials of Construction

The following materials shall be used for the construction of various parts:

a)	Centrifugal fan impeller	:	MS sheet (IS-2062) duly spray galvanized
b)	Axial flow fan impeller	:	Cast Aluminium Alloy (LM-6 Grade)
c)	Fan shaft	:	EN-8 as per BS-900 or equivalent
d)	Fan Scrawl	:	Heavy gauge M.S. (IS-2062)
e)	Fan supports, frames and	:	M.S. of adequate thickness (IS-Structure.- 2062)
f)	Coned inlet for wall mounted exhaust fans / Supply fans	:	M.S. (IS-2062)
g)	Dampers	:	M.S. of heavy gauge (IS-2062)
h)	Flexible connections for fan inlet and outlet	:	Plastic impregnated canvas with M.S. flange & cleats.
i)	“V” pulleys	:	G.I. multi-grooves (IS-210, Gr.20)
j)	“V” belts (Matched sets)	:	Reinforced rubber of appropriate section.
k)	Slide rails	:	C.I. or M.S.
l)	Connection pieces	:	Galvanized iron according to supplier's design.
m)	Bolts and Nuts	:	GI or cadmium plated unless otherwise specified.
n)	Rain protection cowls, hoods And casing for roof Exhausters/wall exhausters/ Supply fans	:	Aluminium or hot dipped galvanized after fabrication from M.S.
o)	Vibration isolating pad washers & bushes, if any.	:	Hard synthetic rubber of Hardness 40° shore.

6.03.00 Air Washer Units

6.03.01 General

- I. Air washer shall be of sheet metal type construction. The air washer unit is a complete system comprising air washer internals, casing, Masonry Sump (tank), associated pumps and fans.
- II. The air washer unit shall be designed as Two Banks water spray system type units. Ambient air is sucked by the centrifugal fan unit / units successively through the Air Intake Louver with Bird Screen of GI construction, automatically cleanable type Stainless Steel mesh Filters complete with SS / Aluminium frame continuously flooded with water through Stainless Steel water spraying Nozzles from one spray bank header and another bank of spray header with Stainless Steel water spraying Nozzles spraying water in the opposite direction of air, Die-extruded PVC moisture eliminators and finally delivered to the duct system with Supply air Grilles for distribution. Properly hinged air tight epoxy painted inspection doors of suitable sizes shall have to be provided in each sheet metal Air Washer.
- III. The Air Washer Units shall be suitable for running with clarified water.
- IV. The air washer units shall be designed for a saturation efficiency of 90%.
- V. All the equipment for the air washer units shall have to be accommodated as per space availability. But within the space allotted the equipment design and location may be modified to suit the supplier's standard equipment.
- VI. The various sections of the unit shall be bolted with suitable gasket to avoid leakage of water. All the sections of the units shall be Epoxy painted from inside and outside to prevent corrosion/ weathering damage. The nuts and bolts used for jointing the sections shall also be galvanized. All in side and out site parts of the fan shall be spray galvanized except the fan shaft that shall be of epoxy painted.

6.03.02 Filter Section

The Filter section consists of a set of Stainless Steel (SS-316) mesh filter modules mounted on a ladder type SS / Aluminium framework of not less than 16 G thick and quick release mechanism for easy dislodgement of the filter modules. The filter material shall be weaved with SS wire of 0.16 mm dia. providing an aperture of max. 0.025 mm. Such filters are continuously flooded with water spray from double bank spray header system in the direction of airflow. The water will be collected in a masonry tank and will be re-circulated by means of the said pump.

The filter module size shall not be more than 610 mm x 610 mm.

The pressure drop across the filter shall be restricted to 8 mm of WG in clean condition and 12 mm of WG in dirty condition. The face velocity across the filter shall not exceed 2.5 m / sec.

6.03.03 Spray Arrangement

- I. There will be two bank water spray system each bank is having a number of branches with spray nozzles. The Spray nozzles shall be made of Stainless Steel and shall be of hollow-cone type with an orifice dia. of 6 mm. Supplier shall confirm the layout of the nozzles on the vertical face. The nozzle arrangement shall ensure good spray distribution and fine break-up of water across the air stream.
- II. The water header and piping shall be of G.I. One pot strainer with very fine mesh brass screen shall be fitted preferably in the suction line of all the pump sets. The strainer should have a by-pass line.
- III. Water from the washer chamber tank shall be taken through a primary screen type water filter fitted in an accessible position in the tank. The filter screen shall be manufactured of S.S netting in a S.S. Frame.
- IV. All accessories like valves, drain valves, fittings, pipe support, hangers, etc. shall be included in the supply. These will be manufactured according to the supplier's standard.
- V. The Contractor shall use the regular type fittings / bends for piping as per IS-1239. Spacing and location of hangers shall conform to the preferred engineering practice. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Tenderer.
- VI. All drain pipes will use "Tee" fitting instead of elbows or bends. "Tee" fittings should be installed such that the plugs can be removed and any section of the pipe can be cleaned. Drain valve will be located at the lowest point of the pipelines. If necessary, more than one drain valve will be installed to facilitate complete drainage from pipe. The make-up piping including all valves, bends, fittings, supports etc. shall be supplied by the Tenderer.

6.03.04 Pumps

The water spray will be generated with the help of a Horizontal Split Casing / back pull out type Centrifugal Pump-Motor set and associated Medium Class GI piping with all fittings and supports.

Details on pumps are furnished under separate clauses.

6.03.05 Moisture Eliminator Sets

- I. Moisture eliminator sets used for the air washer units shall be vertical and die-extruded PVC construction.

- II. Face velocity of air for the PVC Eliminator sets shall not exceed 2.5 m / sec.
- III. Eliminators shall be manufactured in suitable sizes for easy handling, erection and replacement whenever necessary.
- IV. Moisture Eliminator shall have bends at 30° with the direction of airflow and shall have 2 effectively hooked edges for trapping the carry over of water. The catcher should face the direction of airflow.
- V. The Moisture Eliminators shall be fixed rigidly in their proper position and spacer shall be provided to maintain the proper gap.
- VI. Holding frame for the PVC Eliminators shall be of G.I. angles of adequate strength for support.
- VII. Eliminator plates shall be of die-extruded PVC having at least three (3) bends and shall be provided with suitable drip tray and draining facility.

6.03.06 CENTRIFUGAL FANS

Details of fans are furnished under separate clauses.

6.03.07 CASING & TANK

The equipment shall be located within the sheet metal fabricated casing as specified in the other part of the specification with adequate stiffeners, bracings etc duly epoxy painted / spray galvanized from inside and outside. The overflow pipe connected with masonry water tank must be terminated with a siphon, to avoid leakage of air into the air washer chamber. All air washer internals coming in contact with moist air shall be epoxy painted. All inside and outside parts of the fans shall be spray galvanized whereas the shaft shall be epoxy painted. Provision of Marine lights shall be kept in both the Filter and Fill section.

Top Surface of the AWU shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

This air washer contain the sheet metal / masonry sump (tank) shall be connected with the Filter section and shall be complete with make-up connection with float valve, quick fill connection, drain connection with valve and overflow connection with siphon. The tank shall be of epoxy painted / spray galvanized from inside and outside.

6.04.00 UNITARY AIR FILTRATION UNIT

6.04.01 Unitary Air Filtration Unit is a complete system comprising UAF internals, casing, tank, associated pumps and fan.

6.04.02 The UAF units shall be designed for a saturation efficiency of 60%.

6.04.03 Unitary Air Filtration Unit shall have in general one set of air intake louver, one set of automatically cleanable type Stainless Steel mesh Filters with continuous water spraying arrangement over the surface of it to clean the filters and PVC die-extruded Moisture Eliminator sets after the above water flooded filters to eliminate the carry over of moisture. Suitable stainless steel grid shall be used inside both the filters and eliminators for reinforcement.

6.04.04 Water will be re-circulated by means of mono-bloc pumps.

Details on pumps are furnished under separate clauses.

6.04.05 The unit shall be self-enclosed by MS casing duly painted with epoxy resin based paint / spray galvanized. The casing front shall be provided with the air intake louvers with bird screen of GI construction. Water with the dirt will be collected in the MS sump duly painted with epoxy resin based paint and bled off to the drain in small quantity.

Top Surface of the UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

6.04.06 The drain pan shall be provided with overflow pipe terminating to the nearest drain point. The unit may be installed indoor or outdoor as shown in drawings. Suitable rain protection sheds of sheet metal construction shall be provided for the motors installed outdoors.

6.04.07 One backward curved Centrifugal Fan Motor unit shall be used for conveying the air. All parts of the fan for this system coming in contact with moist air shall be spray galvanized except the fan shaft, which shall be epoxy painted.

Details of fans are furnished under separate clauses.

6.04.08 Velocity through any section of UAF unit shall not exceed 2.5 M/Sec. except for Inlet louver for which the face velocity shall not exceed 2 M/Sec.

6.05.00 WATER PUMP

6.05.01 Each water circulating pump set shall be of horizontal split casing / back pull out type centrifugal type, directly coupled to electric drive motor and mounted on a common base plate. However, pumps having motor of 5 HP or below can be of mono-block construction.

The pump shall be complete with casing, impeller, renewable type wearing rings, shaft, shaft sleeve, bearings, stuffing box, cowlings, base plate etc. as applicable. The design pressure for the casing shall not be less than 16 bar for Air Washer pump sets.

6.05.02 The pumps will operate under flooded suction and shall have radial suction and vertical discharge.

6.05.03 Pump head-capacity characteristics shall be gradually rising from operating to shut-off point without any zone of instability. The pump BHP flow characteristics shall preferably be non-over loading type beyond rated capacity point.

Pump shall be rated for continuous operation.

6.05.04 Operating speed of the pump shall preferably be not more than 1500 RPM. Vibration isolators of efficiency 90% (approx.) shall have to be provided for each pump set.

6.05.05 Material of the pump sets shall preferably be as follows (all material shall be of tested quality):

- | | | | |
|----|----------------------------|---|--------------------------------------|
| a) | Casing | - | Cast iron, Grade-FG200 as per IS-210 |
| b) | Impeller and wearing rings | - | Bronze |
| c) | Shaft | - | EN-8 as per ES-900 |
| d) | Shaft sleeve | - | Bronze as per IS-318 |

6.05.06 The pump bearings and the shaft shall be sized adequately to take the maximum possible unbalance loads occurring due to all mechanical and hydraulic reasons. Bearings should have a minimum life of 40000 hours of operation.

6.05.07 Pump and drives shall be directly coupled though a flexible coupling. Suitable coupling guard shall be provided for each pump.

6.05.08 Each pump shall be complete with the following accessories:

- Pot type strainer at inlet complete with screen, drain arrangement etc. All pot type strainers shall have easily removable top cover for access to the filter cartridge. The filters shall be fitted with fine mesh copper or brass wire strip.
- 150mm dia dial type Pressure Gauges, one each at the suction and discharge side of the pump set. The pressure gauge of the pump sets will be connected with a siphon and a two position brass cock.
- Butterfly type isolating valves, one each at suction and discharge side of the pump.

- Non-return (check) valve at the discharge side of the pump set.
 - Base plate, coupling, coupling guard, anti-vibration mountings and foundation bolts.
 - All integral piping required for sealing, cooling, casing, drains and vent connections.
- 6.05.09 The design of the pumps shall conform to the relevant IS Code, Standards of Hydraulic Institute of U.S.A. or approved equivalent.
- 6.05.10 Pump motor will be selected on the basis of 15% margin over the shaft power consumption or more than the limit load of the pump which ever is higher. For other electrical particulars of the motor refer detailed specification of the motors.
- 6.05.11 Major rotating components of the pumps like impellers, balancing drums etc. shall be individually balanced statically and finally each pump shall be dynamically balanced.
- 6.05.12 The critical speed of the pump shall be at least 20% above the operating speed.
- 6.05.13 All pumps and motors shall be aligned properly, and bolted and doweled to a common base frame.
- 6.06.00 **WATER PIPING**
- 6.06.01 Water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I. For higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade shall be supplied. Drain water piping shall be of M.S. heavy grade.
- 6.06.02 The piping shall be so designed that the water velocity through the piping shall not exceed 2.5 m/sec and also the piping friction drop shall be limited to 4 m per hundred meter of pipe length. Pipe sizes, if indicated in tender drawings shall be followed.
- 6.06.03 The pipes shall be of plain end in case of M.S. Pipes (i.e., suitable for welded connections) as far as possible.
- 6.06.04 Counter-flanges for connecting to flanges on valves or equipment shall be made of IS-2062 or superior and shall preferably be slip on type, suitable for welding on the piping in case of M.S. Piping.
- 6.06.05 All bolts and nuts for flange connection shall be hexagonal carbon steel type as per IS-1363 and with the material and other requirements as per IS-1367. All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flanged connections for ease of removal / replacement of valves.
- 6.06.06 Bends, fittings fabricated at site is not acceptable. The Contractor shall use the standard fittings / bends, as per IS-1239, Part-II.

6.06.07 Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Bidder. The supports within the plant room shall be of structural / pipe supports from the floor and is to be provided by the Contractor.

6.06.08 The flanged joints for water line will use canvas, impregnated rubber gasket. Compressed fiber gaskets shall be used with flat face flanges and raised face slip-on flanges. Spiral wound gaskets shall be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

Gaskets shall be suitable for the design pressures and temperatures: -

- i) Compressed Fiber Gaskets: Compressed fiber gaskets shall be in accordance with ANSI B16.21, and materials shall be suitable for a maximum working pressure of 40 bar and a maximum working temperature of 400° C. Gaskets shall be dimensioned to suit the contact facing. They shall be full faced for flat face flanges and shall extend to the inside edge of the bolt holes on raised face flanges. Gaskets for plain finished surfaces shall be not less than 1.6 mm thick and for serrated surfaces shall be not less than 2.4 mm thick.
- ii) Spiral Wound Gaskets: Spiral wound gaskets shall be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. The gasket shall be inserted into a steel gauge ring whose outside diameter shall fit inside the flange bolts properly positioning the gasket. The gauge ring shall serve to limit the compression of the gasket to the proper value. Compressed gasket thickness shall be 3.3 mm $\pm$ 0.1 mm.
- iii) Ring Joint Gaskets: Ring joint gaskets shall be octagonal in cross section and shall have dimensions conforming to ANSI B16.20. Material shall be suitable for the service conditions encountered and shall be softer than the flange material.
- iv) Rubber Gaskets: Rubber gasket materials shall be cloth inserted sheet rubber and shall conform to ANSI B16.21. They shall be full face and 1.6mm thick.

The material should be able to withstand adequate strength in compression without damage. Pipe lines should be such installed that any equipment or valves can be removed by disconnecting flange bolts and nuts union joints. If necessary, a short piece joint to be installed for easy removal. All threads for screwed joints should be properly made. The threads will be covered to make a leak proof joint. Pipes passing through any building structure will pass through a pipe sleeve. The thickness of pipe sleeve will be not less than the thickness of the passing pipe itself. A rubber grommet or such other material will protect pipes entering any equipment.

- 6.06.09 All drain pipes will use 'tee' fitting instead of elbows or bends. 'Tee' fitting should be such installed that the plug can be removed and any section of pipe can be cleaned. Drain valves will be located at lowest point of pipelines. If necessary, more than one drain valve will be installed to facilitate complete drainage from pipe.
- 6.06.10 Water filling valve and air vent shall be installed on the highest point of pipeline. If necessary, more than one valve is to be installed for satisfactory operation or maintenance of the plant. Location of instruments, fittings, fixtures shall be as in single line flow diagram. Location / sizes of air vents are also indicated.
- 6.06.11 Piping arrangement and alignment shall be as per layout.
- 6.07.00 **VALVES & ACCESSORIES**
- 6.07.01 General
- Water line gate valves shall conform to IS: 778-1984 for smaller sizes and IS: 780-1984 for larger sizes. Those shall be designed for working pressure of 16 Kg/Sq.Cm. The valves shall be I.S.I. marked and of reputed make. Alternatively water type, butterfly valve can be offered. Those valves shall be manufactured and tested conforming to BS: 5155 and AWWA C504.
- Note: Butterfly type valve can be offered in the range 80 mm N.B. up to and including 150 mm N.B.
- 6.07.02 Gate Valves
- Those shall be non-rising stem of following material of construction.
- | | | |
|---------------------|---|--|
| Up to 65 mm dia | : | Brass body and Brass internals, Screwed Ends |
| Valve rating | : | Class - 2 |
| 75 mm dia and above | : | CI Body and high tensile brass internals, Flanged Ends |
| Valve ratings | : | PN 1.6 |
- 6.07.03 Wafer Type Butterfly Valves
- These valves shall be of single piece ribbed steel construction and of flange less wafer type. Discs shall be of high duty iron with epoxy coating or electrolytic nickel plating.
- Material specification : Body IS-210 FG 260 CI or cast steel to suit working pressure of 16 Kg/sq. cm.

Disc	:	Epoxy coated / EN plated FG 260 CI or AISI 316 SS.
Seat	:	Nitrile rubber bonded on bakelite hard back.
Top Shaft	:	EN 8 Carbon steel or AISI 304 SS.
Bottom shaft	:	AISI 410
Body seal	:	SS AISI 304 L
Disc seal	:	Nitrile rubber / EPDM / Vitron
Bearings	:	Phosphor Bronze
Gear unit	:	Worm type
Bottom cover	:	CI IS 210 GR FG 260/CS IS 2062 GR B
Bolting (Internal)	:	SS AISI 304
Bolting (External)	:	CS IS 1367 GR 8.8

6.07.04 Globe Valves

Those shall be Straight type and with following material of construction.

Up to 65 mm dia	:	Brass body and Brass internals Screwed Ends
Valve rating	:	Class - 2
75 mm dia and above	:	CI Body and Flanged Ends high tensile brass internals
Valve ratings	:	PN 1.6

6.07.05 Check Valves

These shall be swing check type with following material of construction.

Up to 65 mm dia	:	Brass body and Brass internals, Screwed Ends
Valve rating	:	Class - 2
75 mm dia & above	:	CI Body and Flanged Ends high tensile brass internals
Valve ratings	:	PN 1.6

6.08.00 DUCT WORK

6.08.01 Duct Fabrication

I. General

- a) Velocity of air in any section of the supply duct shall not exceed 12 M / Sec.
- b) The construction of ducts and sheet metal thickness for ventilation duct shall conform to IS: 655 / ASHRAE / SMACNA as far as applicable, unless otherwise stated here. However, minimum duct thickness shall be 1 mm (20 G).
- c) The general layout of the ducting location and number of air grilles and diffusers etc. shall conform to the specific requirements of individual areas of application so as to ensure proper air distribution of all the zones. The same shall be subject to approval by the Purchaser / Consultant.
- d) All duct work for supply of air inclusive of accessories such as damper, vanes, access doors etc. shall be fabricated from G.I. sheet of 180 grade as per IS-277. The ductwork shall be properly reinforced to prevent sagging, buckling or vibration. Interior of all ducts shall be smooth and free from obstruction. All duct sections shall be cross broken.
- e) Suitable drain point with water trap shall be provided for all washed air duct routing at suitable places, preferably just after Air Washer Units.

II. Joints

- a) All longitudinal joints for the ducts will be Pittsburgh Lock seam type.
- b) Transverse joints for the low-pressure ducting shall be continuous around the four sides, the corner closure are required. The type of transverse joints shall be as follows:

Large side mm	Type of transverse joints
Up to 600	25 mm wide pocket, drive or S-slip
601 - 1000	85 mm wide, bar s-slip or pocket slip
1001 - 2250	40 mm x 40 mm x 6 mm M.S. Angle connection.

- c) The low-pressure ducting work shall be provided with intermediate transverse bracing continuous around the four sides between the joints according to the following sizes:

Large side mm	Bracing
0 - 450	None
451 - 1500	40 mm x 40 mm x 6 mm angle 1200 from joints.
1501 and above	40 mm x 40 mm 6 mm angle 600 mm from joints.

- d) RIVETING AND SEALING

All joints, slips and seams shall be made secure by reverting on centers not exceeding 150 mm. All transverse stiffeners and all reinforced bar slip joints shall cross at corners and be riveted. All bar slip joints and angle iron bracing shall be riveted on centers not exceeding 75 mm.

- e) All construction joints and duct seams shall be reasonably sealed with bitumastic cold emulsion or equivalent vapour seal.

III. HANGERS AND SUPPORTS

- a) All ductwork shall be provided with adequate hangers or supports to ensure rigid support and to prevent vibration. Spacing of duct supports shall not exceed 3 m centers.
- b) Hangers shall be suspended from the building steel with provision for necessary auxiliaries, or by special steel members, or by an inch anchor / expansion bolts, or by hooks fixed to the embedded plates provided in the ceiling.
- c) Hangers for all ducts shall be trapeze type with the shelf construction from 35 mm x 35 mm x 5 mm angle iron and hung by two steel rods each of not less than 10 mm dia. for ducts, with larger side less than 2250 mm while for those greater than 2250 mm shall be with 50 x 50 x 5 angles and rods not less than 16 mm dia.
- d) All hangers and supports shall be as per drawings / specifications. When vertical ducts pass through floor slab, they shall be supported by means of collars, constructed of steel structural angles securely fastened about the girth of the duct and bitumastic compound between the horizontal leg of the supporting angle and the floor.

IV. ACCESS DOORS

- a) All main ductwork shall be accessible throughout using tight fitted hinged access doors. Doors shall have to be cemented on sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.
- b) Access doors / panels are to be provided near each fire damper.
- c) In case access doors are to be installed in the insulated ducts, the access door panel should be suitably insulated, such that it can be operated without damaging the duct insulation.

6.08.02 FLEXIBLE CONNECTION

Rubber impregnated canvas or equal flexible connections of at least 150 mm length shall be provided at each connection between ductwork and fan units to isolate vibration.

6.08.03 VOLUME CONTROL DAMPER

I. SPLITTER DAMPER

Splitter dampers in branch take off shall be provided. Damper blades shall be minimum 16 SWG thick. Alternatively catcher shall be provided in right angle tee of ducts.

II. OPPOSED MULTIPLE LOUVER DAMPER

Opposed multiple louvers dampers shall be provided at the fan outlets and wherever mentioned in the drawings, specification and fan schedule. Each blade of the dampers shall be provided with bronze, gunmetal or nylon bearing at each end of its spindle. The spindle with bearing shall be mounted in a strong structural framework. Operating lever with fixing device for keeping the damper at the desired position shall be fitted for the manually operated dampers.

Operating level will be fixed on an indicator to show the percentage of opening of the damper in all cases except for the application with grilles and nozzles.

Velocity across the dampers shall not exceed 10 m/sec. Damper blades at fan outlet shall be made up of 16 gauge M.S.

III. GRAVITY OPERATED DAMPER

Gravity operated back draft dampers are needed to protect the back flow of air wherever specified. These dampers shall be designed such as not to allow infiltration of air from outside while forced ex-filtration by the fan will be achieved through the above dampers. The louvers of the dampers shall be freely mounted on the spindles to allow the damper to open with the pressure developed by the fan. The dampers shall be provided with flanges at inlet. The damper blades shall be made of aluminium and the frame shall be of CRCA sheet duly galvanized / Aluminium.

6.08.04 GRILLES & DIFFUSERS

- I. Design of grilles and diffusers shall be such as to create desired throw and spread of air and shall be approved by the Purchaser / Consultant.
- II. All diffusers and grilles shall be made up of powder coated sheet steel / extruded aluminium with finish painting. Design of all diffusers and grilles shall be made by the Contractor matching with the lighting and other fittings and to be approved by the Purchaser / Consultant. Each supply air diffusers shall be fitted with opposed blade damper, built-in vanes and louvers arranged as per manufacturer's std. design.
- III. Side throw type supply registers shall have two sets of adjustable louvers with opposed blade dampers. The front of louvers shall be horizontal to provide horizontal deflection and the rear set of vertical louvers shall adjust vertical deflection. The dampers shall have horizontal opposed blades regulated by an operating lever in the frame. All wall type exhaust / return air grilles shall have one set of louvers in the front. The louvers shall be fitted such as to remain in position by friction grip. All supply air grilles shall have one set of opposed multiple louver damper at the inlet. The dampers shall be gang operated and will have a device to keep the dampers fixed in one position.
- IV. The grille frame and louvers shall be manufactured of at least 20 SWG GI sheet and 22 SWG MS. respectively. No grilles should, by any chance, make any rattling sound during continuous operation.
- V. All grilles/diffusers shall be fitted with suitable gasket to prevent air leakage and shall match the decor of the space.

6.09.00 DRY FILTER

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filter media shall be of High Density Poly Ethylene. The filter shall have G.I. frames of adequate thickness but not less than 18 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 610 mm x 610 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5 m/sec. The efficiency shall be about 90% down to 10

micron size particles. Allowable pressure drop during clean and dirty conditions shall be 6 mm WG and 10 mm WG respectively.

6.10.00 THERMAL INSULATION

6.10.01 The exposed portion of the ducting shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

6.10.02 Top Surface of the AWU & UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

6.11.00 Electrical items shall consist of:

I. DRIVE MOTORS

- All exhaust fan motors shall be designed for a minimum of 55 Deg C ambient temperatures. Supply air fan motors shall be designed for a minimum of 50 Deg C ambient temperatures.
- Motor rating for centrifugal fans with backward curved blades and axial flow fans shall be minimum 115% of the fan power at duty condition. Motor rating for Pump motor shall be minimum 115% of pump power at duty condition.
- Insulation of motor windings shall be class 'B'. In case of substitution by class F insulation, the temperature rise shall be limited to class B temperature rise as per IS: 325.
- Motors rated 30 KW and above shall be provided with 240V space heater.
- Motor T.B. shall be suitable to receive the cables as detailed elsewhere in the specification.
- Motors rated 250 watts and up to 160 KW shall be suitable for 415V $\pm$ 10%, 3-Phase, 50Hz $\pm$ 5% AC.
- Motors rated below 250 watts shall be fed with 240 V, single phase, 50 Hz. AC supply.
- Motors rated above 125 KW shall be fed by Air Circuit Breaker.
- All motors shall be suitable for D.O.L starting.

- All motor enclosures located indoors shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be weather-proof construction.
- II. Local Starter cum Control Panels (LSCP) for AWUs and UAF Units
- Local Starter Cum Control Panel shall be provided for each Air-washer Units in and for each UAF unit.
 - Each Air Washer / UAF system will have one LSCP located near each Air Washer / UAF Unit. These LSCPs shall house all electrical devices for power and control purposes of Air Washer/ UAF Unit loads, (Fan Motors, Pump Motors, Fire dampers etc. and other controls.)
 - This LSCP shall house incoming MCCB for incoming power supply, outgoing MCCB/MCB with power contactors, auxiliary contactors, thermal overload relays, Start-Stop push buttons, and indication lamps for incoming power supply, ON/OFF/TRIP indication lamps, terminal block, wiring for fan and pump motors, motorized fire dampers and controls
 - Stop P.B. shall be pressed to latch and turn to release type.
 - Control Voltage at LSCP shall be 240V, 1Ph, 50HZ. Necessary control transformer shall be provided in LSCP.
 - For Motors rated 30KW and above, Ammeters shall be provided in LSCP.
 - For all motors having long starting time, the thermal overload relays shall be provided with saturable core current transformer to avoid spurious tripping during starting of the motor, the current transformer will have linear characteristics up to approximately twice the setting current.
 - The panel shall be wall/floor mounted.
 - By-pass P.B. for manual testing of fire-dampers for Air washer system from remote shall be provided in this panel.
 - Power supply to 240V motorized Fire Dampers shall be fed from respective LSCP through MCB and Contactors.
 - Audio-visual Annunciations with common hooter, Accept, Reset PB for Trip of any motor & low water level in the sump shall be provided in LSCP.
 - Potential free contact for 'Air Washer/UAF Trouble' Group Annunciation in each LSCP for AW / UAF system. Remote Group Annunciation in each LSCP shall be provided by the contractor for Purchaser's use.

- 10% spare annunciation facia shall be provided over and above the annunciations as listed and / or recommended by the bidder, spare facia shall be equipped with all devices as provided for the active facia.
- Lamps shall be LED type.
- 1 module of each type and rating as spare shall be provided in each LSCP.

III. Local starter Panels for ventilation fans except AWUs and UAF Units

- 415V, 3 phase, 4 wire, 50Hz Local Starter Panel shall be provided at each auxiliary building for feeding ventilation fan motors. For Power House Building and Auxiliary buildings grouping of fan motor starter in each Local Starter Panel will depend on the number of ventilation fans, their motor ratings and locations.
- Local Starter Panel shall also house incoming MCB for incoming power supply, outgoing MCB with power contactors, auxiliary contactors, thermal overload relays, Start-Stop push buttons, and indication lamps for incoming power supply, ON/OFF/TRIP indication lamps, terminal block, wiring for fan motors, etc.
- Emergency Stop P.B. shall be pressed to latch and turn to release type and provided for each fan.
- The LSPs shall be suitable for cable entry from top and suitable mounting arrangement. The LSPs shall be front wired and front connected and their enclosure shall be dust and splash proof, conforming to degree of protection of IP-54.

IV. All 240V, 1ph fans (below 0.25KW motor rating) will be operated by switches located near the individual fans. Power supply to the fans through their switches shall be arranged from their nearest Distribution board.

V. Cabling and Grounding.

All power and Control Cabling and Grounding will be provided for the ventilation system.

7.00.00 SPECIAL TOOLS

The Bidder shall furnish a complete set of all special tools, wrenches, etc. with necessary tool boxes as required for erection, maintenance, overhaul or complete replacement of any equipment supplied under this specification. The Bidder shall enclose a list of such tools.

8.00.00 TESTING & INSPECTION AT MANUFACTURER'S WORKS

8.01.00 The minimum quality assurance plan / test of various components of Ventilation System are listed below. However, Bidder shall conduct any other tests/ inspection required at the manufacturer's works to ensure that the equipment being supplied shall conform to the requirement of this specification and other applicable standards and codes. The detail of checks to be carried out in various stages of manufacturing and erection of various items of the system shall be submitted for Purchaser's approval in the form of quality assurance plans, field quality plans and procedures.

The items covered under the scope of supply and erection shall be of Purchaser's approved makes. Bidder has to ensure that the proposed bought out makes have proven track record and meet the qualification criteria mentioned elsewhere in the spec. Bidder is to submit the proposal of sub vendors of bought outs for Customer's approval along with their offer and no deviation with regard to approved sub vendors shall be acceptable to the Purchaser.

Material tests like physical, chemical test on various components being used shall be done as per relevant standards. Manufacturer's test certificates shall be submitted for all those tests for the review and approval of Purchaser.

All raw materials including the bought out shall be subjected to bidders inspection/ TC review as per their procedure / approved QAP for total compliance. The same shall not be limited to mechanical, physical, electrical, operational, aesthetic and functional checks, but shall confirm to the best engineering practice and strict adherence to the specifications and standards. Bidders QAP shall indicate all such tests and procedures.

The in process checks for various components shall confirm to the bidder's internal procedures which shall confirm to best manufacturing practices, national and international standards. QAP shall reflect all such tests/ standards and procedures in detail.

Internal test records / test reports shall be produced to Purchaser as required.

All panel mounted components/items like circuit breakers, switches, contactors, relays, push buttons, isolators, fuses, terminal blocks etc. shall be type and routine tested as per relevant IS/ international standards including special tests as applicable.

Type test certificates for Degree of Protection (of various items as applicable) as per the required degree specified elsewhere in the specification shall be submitted for Purchaser's review and approval.

Further to verify compliance to degree of protection on routine basis, following shall be carried out:

1. For IP-5X - It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.

2. For IP-4X - It shall not be possible to insert a one mm dia steel wire in to the enclosure from any direction without force.

8.02.00 Routine Tests

8.02.01 Centrifugal Fan

- a. 20% DPT of welding on fan hub, blades, casing and impeller as applicable.
- b. UT of fan shaft (if dia. ≥ 50 mm) shall be carried out.
- c. 100% DPT of the fan shaft after machining shall be carried out.
- d. All rotating parts shall be statically & dynamically balanced as per IS 1940 Gr. 6.3 or better as applicable.
- e. All centrifugal fans shall be subjected to free run test to check the temperature rise, noise, vibration, current drawn during testing.
- f. Fans shall be performance tested with job motor (if required) as per relevant IS for airflow, static pressure, speed, efficiency, power consumption, noise and vibration.

8.02.02 Axial Flow Fan

- a. Acceptance tests and routine test shall be carried out as per IS: 3588.
- b. Dynamic balancing of the rotating part shall be carried out as per relevant standards.
- c. NDT of the fans blade/impeller shall be carried out as per relevant standard as required.
- d. Complete fan shall be performance tested with job motor (if required) as per relevant IS for airflow, static pressure, speed, efficiency, power consumption, noise and vibration.

8.02.03 Centrifugal Pump

- a. Non-destructive examination as follows:
 - i. Impeller/wearing ring/shaft sleeve/Casing/diffuser: MPI/DPT.
 - ii. Shaft, Couplings and other active components: UT (If shaft dia. ≥ 50 mm) and DPT.
 - iii. Fabricated Pump components: DPT on welds.
- b. Hydrostatic test at two times the bowl discharge pressures at rated capacity or 1.5 times the shut off head whichever is greater.
- c. Dynamic balancing of assembled rotor to grade 6.3 or better as per ISO-1940.

- d. Performance test with job motor as per Hydraulic Institute Standards over entire operating range at rated speed, including vibration and noise measurement.
- e. Strip test after performance test (if required).

8.02.04 Air Distribution System & Air Filter

- a. Functional test of fire damper along with actuator shall be done.
- b. Filters shall be tested for pressure drop, efficiency and dust holding capacity and test certificates shall be submitted for review.
- c. All ductwork shall be carefully examined to determine their performance with the specification with respect of dimensions, materials, marking, workmanship and other requirement.
- d. After completion, all main ducting shall be checked for air leakage/tightness by smoke test method for leakages (at site). Leakages if any shall be made good by bidder.

8.02.05 Pipe and Fitting

- a. All pipes shall be hydrostatic pressure tested (UT/ECT are allowed as alternative) at tube mill as per relevant Std.
- b. All mother pipes used for fittings shall be subjected to hydraulic or ultrasonic test at tube mill.
- c. Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes.
- d. All welds shall be subjected to a visual examination and DPT.

8.02.06 Valve

- a. Hydraulic pressure tests shall be carried out on each valve to check body and bonnet strength. Seat leakage shall also be carried out as per approved drg. /data sheet. Check valve shall also be tested for leak tightness test at 25% of specified seat test pressure.
- b. Functional and dimensional testing and wear travel, seat contacts, smooth opening & closing shall be carried out on each valve.

8.02.07 Insulation

- a. Insulation material shall be tested for all mandatory tests as per relevant standards/ specification.
- b. Thermal conductivity test (only for thermal insulation) shall be done once in six months for the insulation material manufactured during six

months period for the same density, outer dia. and thickness of material as per IS: 3346 or equivalent standard. However if such tests have been carried out by the bidder on similar item which is not older than six months in a third party laboratory, test reports shall be submitted for review.

8.02.08 Air Washer Unit

- a. Dimensional check shall be carried out after a complete assembly as per the approved drawing/data sheet.
- b. Each component of the AWU & UAF shall be tested separately as per the inspection requirement mentioned herein above and relevant standard.
- c. Performance and functional test after a complete assembly shall be carried out with job motor at site if supplied in knock down condition.

8.02.09 Electric Motor

Every motor shall be routine tested as per IS: 325 to the extent necessary to establish that it is identical to the type tested motor.

8.02.10 Local Starter cum Control Panel / Local Starter Panel

- a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of equipment.
- b. All wiring and current carrying parts shall be subjected to HV/IR test as applicable.
- c. Primary current and voltage shall be applied to all instrument transformers.
- d. Routine tests shall be carried out on all equipment such as instrument transformers, meters, contactors, switch fuse unit etc.
- e. The tests shall include wiring continuity tests, insulation tests, and functional tests to ensure operation of the control / protection / metering of individual equipment.
- f. All switches, meters, and other devices shall be tested and calibrated in accordance with relevant IS standards.
- g. Dimensional checks, bill of material check for quantity & make, painting checks shall also be carried out.

8.02.11 Cable Tray and Galvanizing Structure (if applicable)

Material check, Dimensional Check, Zinc coating thickness as per IS: 3203, IS: 4759 and Mass of zinc coating as per IS: 4759 & IS: 6749 including Adhesion

test and Uniformity of Zinc coating as per relevant IS shall be conducted on cable tray and accessories.

8.02.12 Gauges, Switches, Instruments, etc.

Accuracy, calibration, repeatability, material, dimension, functional tests and other checks as applicable shall be checked.

8.02.13 Painting

Painting of all surfaces shall be checked for shade, surface finish, uniformity, coating thickness (DFT) and adhesion test/peel off test.

9.00.00 **FIELD TEST**

9.01.00 **Type Tests**

Bidder should have performed the applicable type tests as per the IS / applicable standards on various components of each type and rating. Reports not older than five years shall be submitted to this effect. All such type test reports shall be subjected to the approval of Purchaser. In case the bidder has to carry out these type tests, all such tests shall be done at bidder's risk and cost within the schedule specified herein. No deviation in this regard is acceptable.

9.02.00 **Field Test**

Overall performance of the ventilation system shall be tested after complete installation at site. This test shall be carried out to determine whether the plant meets the performance requirements specified here in and shall include measurements of all parameters under various outside conditions and establishment of correct supply of equipment. All testing and calibrating instruments required for this purpose shall be supplied by the contractor.

10.00.00 **PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND TEST RECORD**

10.01.00 The Tenderer shall have to guarantee the performance of individual equipment. The Tenderer shall also guarantee maintenance of the inside conditions and the minimum air changes as indicated under "design criteria".

10.02.00 The test shall be conducted at the manufacturer's works / site in accordance with the specification and if the shop / site performance tests indicate the failure of the guaranteed performance for the equipment concerned, it would be necessary for the manufacturer to make good the deficiency at its own cost by incorporating the necessary modification, alteration and replacement.

10.03.00 The additional test required to show the effect of such alteration shall be performed by the manufacturer at no expense to the purchaser.

10.04.00 **TEST RECORDS**

The certificates and records of all tests shall be submitted to the purchaser / Consultant for approval. The manufacturer shall maintain records of all tests required in the specification during manufacturing, erection and commissioning. A list of records shall be submitted to the purchaser on completion of the job. The purchaser shall be able to obtain certified copies of such records at any time.

11.00.00 SPECIAL CLEANING, PROTECTION & PAINTING

11.01.00 Internal surface of all parts shall be cleaned to remove loose scales and dirt. The external surface of the motor and end-shield shall be sand blasted to remove all rusts, scale etc. All sharp edges shall also be removed. Welding rods, studs & other foreign objects shall be removed prior to final assembly. Excess oil and grease shall be removed by wiping.

11.02.00 All shop finished parts shall be painted with two (2) coats of rust preventing paint. One (1) coat of synthetic enamel final paint shall be applied over and above the rust proof paint before despatch of material.

11.03.00 All surfaces coming in contact with corrosive fumes / gases during exhaust ventilation system, e.g., that in the battery room shall be painted with chlorinated rubber paint or suitable epoxy paint.

11.04.00 All equipment shall be boxed / crated or otherwise protected for shipment. Dry nitrogen desiccant and other protections shall be provided as may be necessary.

12.00.00 DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL

Besides submitting the enclosed Technical Proposal Particulars Sheets duly filled in, the proposal shall also include the following drawings, curves and information wherever applicable:

12.01.00 Preliminary equipment layout drawings for Air Washer and UAF units, as well as preliminary ducting layout drawing.

12.02.00 Characteristic curves of each type of centrifugal and axial flow fans.

12.03.00 Characteristic curve of each pump.

12.04.00 Descriptive and illustrative literature / catalogues / leaflets on each of the equipment and components offered.

12.05.00 Sectional drawings for air diffusers and grilles, as applicable.

12.06.00 An experience list about supply of similar plant and equipment. The list shall indicate the salient technical parameters in each case, the status of execution and the scope of approx. value of the work undertaken by the bidder.

- 12.07.00 A comprehensive write-up and / or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.
- 12.08.00 Any other relevant data and particulars as needed.
- 12.09.00 Guaranteed motor input power requirement for each and every equipment.
- 13.00.00 **POST AWARD DOCUMENTS, DATA TO BE FURNISHED**
- 13.01.00 Particulars of drawings, data and documents
- 13.01.01 Design Calculation supporting sizing of Ventilation equipment.
- 13.01.02 Equipment layout and sectional drawings of
- a. Air Washer Unit.
 - b. UAF Unit.
- 13.01.03 Schematic flow and instrumentation diagram of the complete system indicating the limits of supply and erection.
- 13.01.04 Ducting layout drawing including sectional views indicating the details of duct sizes, duct joints, duct insulation, duct supports, diffusers, grilles, dampers etc for various floors of Power House Building, ESP, AHP & CHP Control Building and other auxiliary buildings, as applicable.
- 13.01.05 Layout drawings showing the roots of water pipe line with details of hangers, supports etc.
- 13.01.06 Outline drawings incorporating all principal dimensions, civil foundation drawings and weight etc. and also sectional drawings incorporating data of material of construction wherever applicable for following equipment:
- a. Air Washer Units
 - b. UAF Units
 - c. Centrifugal Air Blower with the Drive Motors
 - d. Centrifugal Pump sets with Drive Motors for circulation of water
 - e. Fan Filter Units, Supply Fans and Exhaust Fans with drive Motors
 - f. Roof Extractor fans with Drive Motors
 - g. Supply Air Grilles / Diffusers
 - h. Fire Dampers
 - i. Back Draft Dampers
- 13.01.07 Technical Catalogues and data sheet for each Equipment and instrument.
- 13.01.08 Drawings and data sheets for Dry Panel Type Filters.
- 13.01.09 Location details of all wall mounted type Axial Flow Fans.

- 13.01.10 Write up on system interlock and / or interlock block diagram.
- 13.01.11 Electrical schematic and wiring diagram for Electrical Panels and the system as applicable with back-up write-up.
- 13.01.12 Control panel outline drawings, Bill of instruments and drawings showing construction of control panels.
- 13.01.13 Material Test Certificates.
- 13.01.14 Layout drawing showing route of cables and trays.
- 13.01.15 Cable schedule.
- 13.01.16 Manufacturer's Quality Assurance Plan for various equipment.
- 13.01.17 Shop test reports and certificates.
- 13.01.18 Operation, maintenance and overhauling manuals as per specification.

14.00.00 LIST OF DRAWINGS

Sl. No.	Drawing no.	Description
01.	13A06-002-DWG-VA-001	Typical Scheme for Air Washer Unit
02.	13A06-002-DWG-VA-002	Typical Scheme for Unitary Air Filtration Unit
03.	13A06-002-DWG-VA-003	Typical Detail of Wall Mounted Axial Flow Fan and Roof Extractor Units
04.	13A06-002-DWG-VA-004	Typical Scheme of Air Distribution System for Power House Building
05.	13A06-002-DWG-VA-005	Scheme of Ventilation System for Different Auxiliary Buildings

ANNEXURE-III TO SECTION - 2

**TECHNICAL SPECIFICATION
FOR
415V PMCC/MCC, 415V ACDB AND 220V DCDB**

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CLAUSE NO.	DESCRIPTION
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TYPICAL SINGLE LINE DIAGRAM
TYPICAL CONTROL SCHEMATIC

VOLUME :V-A

SECTION-VII

**TECHNICAL SPECIFICATION
FOR
415V PMCC/MCC, 415V ACDB AND 220V DCDB**

1.00.00 SCOPE OF SUPPLY

1.01.01 Requisite nos. of following equipment shall be furnished with all accessories :-

- a. Power cum Motor Control Centre (PMCC)
- b. Motor Control Centres (MCC)
- b. A.C. Distribution Board (DB)
- c. D.C. Distribution Board (DB)
- d. D.C. Starters
- e. Lockout Switches
- f. A.C./D.C. fuse boards

1.01.02 The base channel frame with hardware and lifting angles.

1.01.03 One set of special tools and tackles.

1.01.04 Set of accessories as listed below :

- a) Breaker lifting and handling trolley.
- b) Test cabinet with coupling cables for testing the breaker in drawout position.
- c) Racking in/out handle for breakers.

1.01.05 12kV rubber mats shall be provided both at front and rear of LT Switchgear.

1.01.06 Mandatory Spare parts.

1.01.07 All relevant drawings, data and instruction manuals.

2.00.00 CODES AND STANDARDS

2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.01.02 Equipment and material conforming to any other international standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

- 3.01.00 The PMCCs/MCCs/DBs will be used to provide power, control and protection for 415/240V A.C. and 220V D.C. auxiliary services (Motors & Feeders) of generating units.
- 3.02.00 Duty involves direct-on-line starting of large squirrel cage motors below 175kW. The starting current varies from 6 to 8 times rated current at very low power factor.
- 3.03.00 The equipment will be located in a hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.
- 3.04.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values stipulated in relevant standards and/or this specification.
- 3.05.00 Equipment ratings and quantities are detailed in the enclosed drawings and annexure. Equipment shall be furnished in strict compliance with the same.
- 3.06.00 All equipment and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents without any damage or deterioration of the materials.
- 3.07.00 The PMCCs/ MCCs / DBs shall have two incomers and one bus-coupler. In addition to electrical interlocks, mechanical castle key interlock shall be provided between the two incomers and the bus-coupler so that any two of the three may be closed at a time.
- 3.08.00 Busbars of PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20% margin.
- Busbars of MCC/DBs shall be sized to carry continuously the total running load of MCC/DB plus a 20% margin.
- 3.09.00 In cubicle of incomers & bus section breakers/MCCBs shall be identical to the associated busbar rating.
- 3.10.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values specified in relevant standards and/or this specification.
- 3.11.00 Circuit breakers shall not produce any harmful over voltage during switching off of induction motors. If required, surge protective devices shall be included in the scope of supply to limit over voltages.
- 3.12.00 Incomers, Bus-couplers & outgoing feeders rated upto & including 630A shall be MCCB controlled. Above 630A all incomers, Bus-couplers & outgoing Feeders shall be ACB controlled. For critical loads ACB controlled feeders shall be provided which will be decided during detail engineering.
- 3.13.00 All motor rated 110kW & above, below 175kW shall be ACB controlled. Motor rated upto 110kW shall be contactor operated.

- 3.14.00 MCC & PMCC shall have sufficient number of spare modules (at least 20% of various sizes used with a minimum of 1 no. for each rating and type).
- 3.15.00 Outgoing feeders of PMCC shall be limited to minimum number of different sizes so that max. standardization is achieved from MCCB & contactor size point of view.
- 3.16.00 Incomers & bus section breakers of PMCCs/MCCs shall have provisions for remote operation from control room.
- 3.17.00 All breaker operated motor feeder shall be supplied from PMCC.
- 3.18.00 One no. Normal/Emergency switchgear to cater power supply to important emergency load / motors for safe shut-down of unit including 220V battery chargers shall be provided for each unit. The main incoming supply shall be from 415V unit service switchgear. When main incoming supply fails, reserve incoming supply shall be switched ON automatically from 415V station service switchgear. In case of total failure of AC supply of the power station, the supply from DG shall be switched ON automatically.
- 3.19.00 Each switchgear shall be provided with two bus sections, two incomer and a bus coupler rated for 100% of the loads connected to the switchgear.
- 3.20.00 For each auxiliary or load, one feeder shall be provided except for the following cases:
- One feeder for a maximum 2 nos. isolator motor operating mechanism.
- 3.21.00 The switchgears shall be provided with suitable number and type of outgoing feeders for the respective auxiliary loads of the system/area, power supply feeders to various panels, lighting transformer, space heating panels, control cabinets and all other loads encountered in the plant. In addition, following feeders shall be provided in each bus section of each switchgear.
- a) Bus VT module: One (1) no.
 - b) Switchgear test supply module: One (1) no.
 - c) 240V, 1 phase essential supply module with five nos. 1 phase outlets: One (1) no.
Necessary 415V/240V dry type transformer shall be provided.
 - d) Alarm module for common alarm for outgoing feeder fault: One (1) no.
 - e) DC supply alarm module for incomer, bus coupler fault: One (1) no.
- 3.22.00 Each feeder shall be provided with two nos. interposing relays for start & stop. These interposing relays shall be located in separate IPR panel described under C&I specification.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **Construction**

4.01.01 PMCC / MCC / DB shall be indoor, metal-clad, air insulated and floor mounting type. All MCCs shall be fully draw out type and DBs shall be fixed type. ACB modules of PMCCs/MCCs shall be fully drawout type. MCCB / Switch Fuse modules shall also be fully drawout type. The design and construction shall be such as to allow extension at either end.

4.01.02 All PMCC/MCC shall be of double front construction.

4.01.03 PMCC /MCC/DB enclosure shall be dust and splash proof, conforming to a degree of protection IP-54. All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness 2.0mm. Frames shall be enclosed in cold rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot/cold rolled sheet steel and 4.0 mm for non-magnetic material.

4.01.04 PMCC / MCC / DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multi tier formation.

4.01.05 The design shall be fully compartmentalized with metal/insulating partitions between compartments. The working height shall be limited within 750 mm to 1800 mm from floor level.

4.01.06 Each control module shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section shall have a removal back cover. All doors and covers shall be gasketed.

4.01.07 All push buttons, lamps, indicating instruments shall be flush / semi-flush mounted on respective module compartment.

4.01.08 A full height vertical cable chamber with cable supports shall be provided in each section to facilitate unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

4.01.09 A horizontal wireway, extending the entire length, shall be provided at the top of each PMCC / MCC / DB for inter panel wiring.

4.01.10 The width of the cable alley shall not be less than 250 mm.

4.02.00 **Bus and Bus Taps**

4.02.01 All PMCCs/MCCs/DBs shall be provided with three phase & neutral bus bars . All DCDBs shall be provided with two busbars. All busbar compartments shall be completely enclosed.

- 4.02.02 The main buses and connections shall be of high conductivity Aluminium / Aluminium alloy, sized for specified current ratings with maximum temperature limited to 85°C (i.e., 35°C rise over 50°C ambient).
- 4.02.03 Vertical busbars shall be designed for minimum current rating of 200A. Separate vertical busbars shall be provided for each vertical panel.
- 4.02.04 All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two-bolt connection with plain and spring washers and locknuts.
- Bimetallic connector shall be furnished for connection between dissimilar metals.
- 4.02.05 Busbars and connections shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and shrouds for joints and tap-off points shall be provided.
- Bus insulators shall be flame retardant, non-hygroscopic track-resistant type with high creepage surface.
- 4.02.06 Busbars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.
- 4.02.07 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear when viewed from the front of the assembly.
- 4.03.00 **Control Modules**
- 4.03.01 Draw-out type control module shall have self-aligning power/control disconnects. All disconnects shall be silver plated to ensure good contacts.
- 4.03.02 The design shall be such as to permit easy withdrawal/reinsertion of the unit with guide rails to ensure correct alignment.
- 4.03.03 Control Module shall house the control components for a circuit such as switch fuse / MCCB, contactors, relays, push buttons, lamps etc. as per requirement of the control circuit.
- 4.03.04 The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.
- 4.03.05 Various module/compartments sizes shall be multiple of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical bus bars.
- 4.03.06 Draw-out type control modules of same size and type shall be electrically and physically interchangeable.
- 4.04.00 **Air Circuit Breaker**
- 4.04.01 Circuit breaker shall be provided on the incomer having minimum interrupting capacity equal to the 50kA(r.m.s) fault level.

- 4.04.02 Circuit breaker shall be three pole, single throw, air-break type with independent manual spring closing, trip-free mechanism and shunt trip. However Incomer breaker shall be four pole type.
- 4.04.03 Circuit breaker shall be draw-out type, having service, test & isolated position with positive indication for each position.
- 4.04.04 Circuit breakers of identical rating shall be physically and electrically interchangeable.
- 4.04.05 Each breaker shall be provided with microprocessor based protection unit having three overload protection with adjustable current and time, three short circuit protection with adjustable current and time and three instantaneous short circuit protection. The operating characteristic shall be suitable for co-ordination with down-stream fuses.
- 4.04.06 Circuit breakers shall be provided with motor wound spring charging mechanism. Spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor. In addition, facility for manual charging of spring shall be provided.
- 4.04.07 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed. It shall not be possible to open the circuit breaker door cubicle unless the breaker is in 'OFF' position.
- 4.04.08 Automatic safety shutters shall be provided to cover up the stationary disconnects when the breaker is withdrawn.
- 4.04.09 Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF indicator, an operation counter and spring mechanism charge/discharge indicator, and electrical anti-pumping feature.
- 4.04.10 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with the following for interlocking purpose :-
- a. Position/Cell switch with 4 NO + 4 NC contacts.
 - b. Auxiliary switch, with minimum 6NO + 6NC contacts,
- 4.04.11 Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches shall be provided with minimum 2NO + 2NC contact.
- 4.04.12 Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.
- 4.04.13 Each breakers operated feeder shall be provided with protective devices as specified in Annexure–B.

4.05.00 **Switches**

4.05.01 Switches shall be triple pole, air break, AC23 motor duty for motor feeders and AC22 heavy duty for other feeders.

Motors duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.

4.05.02 The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.

4.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

4.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.

4.05.05 Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of the three can be closed at time.

Wherever two incoming switches are provided for an assembly, these shall be mechanically/key interlocked to ensure that one of the two can be closed at time.

4.05.06 All incoming and outgoing feeders shall be provided with bolted disconnect link for isolation of neutral if necessary.

4.06.00 **Fuses**

4.06.01 Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the short circuit current of the LT system. Fuses shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of base. In such cases, one set of insulated fuse pulling handles shall be supplied with each board.

4.06.02 Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element.

Visible indication shall be provided on blowing of the fuse.

4.06.03 Motor fuse characteristics and ratings shall be chosen to ride over starting period without blowing. The fuse on incoming feeder wherever provided, shall be chosen to provide discrimination with motor/feeder fuses.

4.07.00 **Moulded Case Circuit Breaker (MCCB)**

4.07.01 The MCCBs shall be of drawout type with trip-free operating mechanism of quick make & quick break type. Each MCCB shall be equipped with thermal release for thermal overload and magnetic release for short circuit protection on each pole.

- 4.07.02 MCCBs / MPCBs shall be suitable for manual closing and opening and also automatic trip on overload and short circuit. MCCB shall have intermediate position to indicate trip condition.
- 4.07.03 The MCCBs shall be provided with mechanical ON-OFF indicator at the front panel. The MCCB handles, after the breaker tripped due to faults, shall occupy a mean position indicating trip condition.
- 4.07.04 The compartment door shall be interlocked mechanically with the MCCB such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for releasing this interlock at any time.
- 4.07.05 All feeders of PMCC / MCC rated up to & including 630 Amp shall be provided with MCCB. Air circuit breaker shall be provided for feeders rated above 630 Amp. For critical loads ACB controlled feeders shall be provided which will be decided during detailed engineering.
- 4.07.06 Motors rating above 110 KW will be operated by Air circuit breaker and protected by consolidated numerical motor protection relay.
- 4.08.00 **A.C. Starter**
- 4.08.01 Contactors
- a. The contactors shall be three pole, air break type designed for duty class III - Category AC3 (for unidirectional motor) with non-bouncing silver/ silver alloy contacts. Contacts for reversible motors will be of AC4 duty.
 - b. Each contactor shall be provided with minimum two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V A.C.
 - c. Reversing contacts shall be electrically and mechanically interlocked.
 - d. Contactors with delayed dropout feature shall be provided for some essential auxiliaries. These contactors shall not dropout on power failure if the voltage is restored within 3 seconds.
- 4.08.02 **Protection**
- a. Thermal overload relays shall be three element, positive acting, ambient temperature compensated with adjustable settings.
 - b. Single phase preventor relay shall be provided, preferably as an inbuilt feature of thermal overload relay.
 - c. Relays shall be manual reset type with two changeover potential-free contacts. Resetting of relays shall be possible with compartment door closed. Colour of the resetting button shall be BLACK.
 - d. Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply.
 - e. Motor starters shall have type '2' co-ordination according to IEC 947-4.

- f. Earth fault relays with adjustable settings and time delays fed from core balance CT shall be provided.
- g. Numerical / Digital Motor protection relay with short circuit, over load, earth fault, locked rotor and unbalance (NPS) load protection functions shall be provided for motor rated above 90 kW.

4.09.00 Control Transformer

4.09.01 LT Switchboard control supply

The Bidder shall provide one (1) no. adequately rated 415V/110V Control Transformer in each bus section with necessary taps and auto changeover facility for providing control power supply to various modules of the board, except motor feeders. Each motor feeder shall be provided with 415/110V control transformer of adequate capacity (min. 75VA) for control supply to such module. The sizing of control transformer shall be carried out by the Bidder considering the actual load of power contactors, auxiliary contactors, indicating lamps and other equipment in the module circuit. An additional load of 15watts shall be considered for each module for remote auxiliary relays and lamps to be connected in the control circuit of modules. Bidder shall also ensure that control transformer are adequately designed for meeting the momentary loading requirements and the voltage drop during this condition shall not be more than 5%. Each transformer shall be sized for catering to control supply of both bus sections.

4.09.02 LT Switchboard space heater supply

The Bidder shall provide one (1) no. adequately rated 415V/240V Control Transformer in each bus section with necessary taps and auto changeover facility for providing power supply to panel space heater, Motor space heater of motor rated 30 KW & above, Panel Illumination & Socket. The supply of these two (2) nos. control transformer are tapped from incoming supply of 415V PMCC/MCC before the incoming breaker. Incoming circuit to the space heater auxiliary bus shall be through isolating switch HRC fuse and neutral link of suitable rating. The supply of different modules shall be tapped individually from the auxiliary bus bars. Control supply healthy indication shall be provided. Each transformer shall be sized for catering to space heater supply of both bus sections.

4.10.00 D.C. Starters

4.10.01 D.C. Starter for emergency oil pump shall be fixed resistance type, designed to provide fast acceleration during starting.

4.10.02 DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push-buttons, lamps, etc.

4.10.03 Starters shall be furnished in totally enclosed floor-mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2mm.

4.10.04 The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54.

The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.

4.10.05 Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.

4.11.00 **Relays**

4.11.01 All incoming and bus-coupler circuits and circuit breaker operated outgoing feeders shall be provided with numerical relays. Breaker operated motor feeders shall be provided with numerical motor protection relay.

4.11.02 The numerical relays shall have provisions for interfacing with Plant DDCMIS / PLC.

4.11.03 Relays shall be of drawout design with built-in testing facilities. Small auxiliary relays may be in non-drawout execution.

4.11.04 All protective relays, auxiliary relays, and timers shall be provided with hand reset operation indicator (flag).

4.11.05 Relays shall be rated for operation on 110V secondary voltage and 5 A or 1 A. Number and rating of relay contacts shall suit the job requirements.

4.12.00 **Control and Indication**

4.12.01 Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following :

i) One (1) TEST-NORMAL-TRIAL selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism.

ii) On-Off control switches shall have three positions (T-N-C) and shall be spring return to 'Neutral' from close and trip positions. They shall have two contacts closing in close position and two contacts closing in trip positions, and shall have Pistol Grip handles. Lost motion feature shall be provided wherever required.

iii) Following indicating lamps on the front of the compartment:

Breaker open - GREEN

Breaker closed - RED

Breaker tripped - AMBER

Spring charged - WHITE

Trip Ckt. Healthy - BLUE

Motor Space heater 'ON' for motor circuit - YELLOW

- 4.12.02 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.
- 4.12.03 Each push button shall have minimum two (2) nos. normally open and two (2) nos. normally closed contacts rated 10 A at 240 V.
- 4.12.04 One (1) NORMAL-TRIAL selector switch shall be provided for all motor feeders.
- 4.12.05 Selectors switches shall be stay-put, rotary type with escutcheon plates marked to indicate the function and positions, and shall be lockable in each position. Selector switch contacts shall be rated for 10A at 240 V A.C.
- 4.12.06 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.
- The exact requirements of contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.
- 4.12.07 Lamps shall be clustered LED type with series resistor and coloured lens. Lens and lamps shall be replaceable from the front. Lamps shall be located just above the associated push button/control switch
- 4.12.08 The general scheme of connections for control, interlock and protection is shown in the enclosed drawings. Detailed requirements of individual circuits will be intimated later to the successful bidder, who shall develop and furnish the schemes accordingly.
- 4.13.00 **Meters**
- 4.13.01 All indicating instruments (96 x 96 mm) shall be switchboard type, with 250` scale, anti-glare glass and accuracy class of $\pm 2\%$ full scale. Each meter shall have zero adjuster on the front.
- 4.13.02 Motor ammeter shall be suitable to indicate starting current (6 to 8 times full load current) for DOL starting of motor.
- Motor ammeter shall be provided for motor rated 30 kW and above and for critical drives, to be finalized during detail engineering.
- 4.13.03 All incomers, tie feeders, circuit breaker operated motor feeders shall be provided with 3-phase multifunction meter with pulse output and communication port for interfacing with Plant DDCMIS / PLC.
- 4.13.04 Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.
- 4.14.00 **Current Transformer**
- 4.14.01 Current Transformer, shall be cast resin type rated 10 VA. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.

- 4.14.02 Accuracy class of the current transformers shall be:
- a) Class PS for REF
 - b) Class 5P20 for other relaying.
 - c) Class 1.0 ISF < 5 for metering.
 - d) Class 0.5 ISF < 5 for metering (Incomer & Bus coupler of PMCC)
- Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the bidder.
- 4.14.03 CT secondary shall be rated for 1A for metering & either 5A or 1A for protection.
- 4.15.00 **Voltage Transformer**
- 4.15.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For Incomer and bus coupler of PMCC accuracy class of voltage transformer shall be 0.5.
- 4.15.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.
- 4.15.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.
- 4.15.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.
- 4.16.00 **Transducers**
- 4.16.01 Transducer for conversion of AC electrical quantities such as voltage, current, KW etc. shall be supplied as required for remote connection to Plant DDCMIS / PLC. All transducers shall be dual output type.
- 4.16.02 The transducers for indicating type instruments shall be of very low burden type having 4-20 mA DC linear, galvanically isolated output, compatible with secondary instruments and Plant DDCMIS system.
- 4.17.00 **Secondary Wiring**
- 4.17.01 The PMCC/MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection and interlocking schemes.
- 4.17.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, push buttons and other devices shall be wired upto terminal blocks.

- 4.17.03 Wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated switchboard wires with stranded Copper conductors of 2.5 mm² for control & current circuits and 1.5 mm² for voltage circuits.
- 4.17.04 Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring diagrams.
- 4.17.05 Wire terminations shall be made with crimping type connector with insulating sleeves. Wires shall not be spliced between terminals. Separate colour code shall be used for AC & DC circuit wiring for easy identification.
- 4.18.00 **Terminal Blocks**
- 4.18.01 Terminal blocks shall be 1100V grade box-clamp type with marking strips similar to ELMEX 10 mm² or equal. Terminals for C.T. secondary leads shall have provision for shorting.
- 4.18.02 Terminal blocks used for interface with DDCMIS / PLC via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.
- 4.18.03 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
- 4.18.04 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- 4.19.00 **Cable Terminations**
- 4.19.01 PMCC shall be designed for cable entry from bottom. MCC/DB shall be designed for cable entry both from top and bottom. Actual configuration shall be intimated later sufficient space shall be provided for ease of termination and connection.
- 4.19.02 Power cables shall be 1100V, Copper/Aluminum conductor, XLPE insulated, armoured, FRLSH PVC overall sheathed.
- Control cables shall be 1100V, PVC insulated, armoured, PVC overall sheathed with 2.5 mm² stranded Copper conductor.
- 4.19.03 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned Copper/Aluminium lugs, brass compression glands with tapered washer (Power Cables only) and Terminal blocks.
- 4.19.04 Sufficient space shall be provided between the lower most power cable termination and gland plate for easy cable connection.
- 4.20.00 **Bus Duct Connection**
- 4.20.01 Bus duct connections shall be furnished along with transition panel, if required. Unless mentioned otherwise bus duct connections shall generally be from the top.

- 4.20.02 All connecting bus work shall have the same continuous current rating as associated PMCC bus and shall be fully braced for the LT system short circuit current.
- 4.20.03 All provisions such as matching flange and other accessories shall be furnished for connection to bus duct.
- 4.21.00 **Ground Bus**
- 4.21.01 A Cu / Al ground bus rated to carry the maximum fault current, shall extend full length of the MCC/DB.
- 4.21.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts & nuts at each end to receive 50 x 6 mm G.I. flats.
- 4.21.03 All stationary structures shall be directly connected to the ground bus for effective grounding.
- 4.21.04 The frame of draw out module shall be grounded at all times except when the power disconnects are separated by a safe distance.
- 4.21.05 All hinged doors shall be earthed through flexible copper braid wire.
- 4.22.00 **Nameplate**
- 4.22.01 Nameplate of approved design shall be provided for each control compartment and also at the top of each PMCC / MCC / DB.
- 4.22.02 The material of the name plate shall be anodized aluminium / lamicaid or approved equal, 3 mm thick, with white letter on black background. Name plates shall be minimum 20 x 75 mm for instrument / devices and 40 x 150 mm for panels.
- 4.22.03 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.
- 4.23.00 **Space Heater**
- 4.23.01 Panel and motor space heater shall be fed from separate AC auxiliary busbars running throughout the switchboard. The space heater bus shall be fed from control transformer described earlier. Suitable terminals shall also be provided to facilitate energisation of the control transformer from outside during long shutdown of the board.
- 4.23.02 Each vertical section of the PMCC / MCC / DB shall be furnished with thermostat controlled space heater and 5A, 5 pin plug socket.
- 4.23.03 In addition, motor feeders 30 KW and above shall be wired up for feeding motor space heater through starter auxiliary 'OFF' contacts.
- 4.23.04 Cubicle heater, Motor heater and plug socket circuit shall be provided with individual MCB/switch fuse units.

4.24.00 **A.C./D.C. Power Supplies**

4.24.01 Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C. supply and duplicate feeder shall be arranged for D.C. supply.

4.24.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C. Molded case circuit breaker (MCCB) shall also be accepted as an alternative.

4.24.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units / MCCB shall be provided at each cubicle for A.C/D.C. supplies.

4.24.04 A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.

4.25.00 **Tropical Protection**

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

4.26.00 **Painting**

4.26.01 All steel surfaces shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.

4.26.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.

4.26.03 For paint shade of finish coat, refer clause no.1.16.00 of Section E1, Volume V-A.

4.26.04 Sufficient quantity of touch-up paint shall be furnished for application at site.

4.26.05 Caution notice plate shall be affixed at the back of each vertical panel.

5.00.00 **TESTS**

5.01.00 All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

5.02.00 **Routine Test**

The tests shall include but not necessarily be limited to the following :-

- a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

- b. All wiring and current carrying part shall be given appropriate High Voltage Test.
- c. Primary current & voltages shall be applied to all instrument transformers.
- d. Routine test shall be carried out on all equipment such as circuit breakers, switch - fuse, contactors, relays, meters etc.

5.03.00 Type Tests

The type test certificates for the following tests carried out on an identical & similar type of switchgear shall be furnished. The date of tests shall be within the last five years.

- a. Temperature rise Test
- b. Short time current test on main circuit and earth circuit.
- c. Verification of making and breaking capacity.

Type test certificates of any equipment shall be furnished if so designed by the purchaser/ owner. Otherwise the equipment shall have to be type tested free of charge, to prove the design. Type test performed before five (5) years are not acceptable.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

6.02.00 To be submitted with the bid :-

- a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points etc.
- b. Typical foundation plan
- c. Typical control schematic
- d. Bill of materials
- e. Type test reports on circuit breaker
- f. Technical leaflets on :-
 - i) Circuit breaker
 - ii) Switch-fuse units
 - iii) Contactors
 - iv) Relays, meters, push buttons, selector switches etc.
 - v) Glands/terminals blocks

6.03.00 To be submitted for Owner / Purchaser's Approval and Distribution

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS AND REQUIREMENTS

1.0 General

Type	:	ACB Modules - Drawout type MCCB Modules – Drawout type
Service	:	Indoor
Enclosure	:	IP52

2.0 System

		AC	DC
Voltage	:	415V $\pm$ 10%	220V (187-242V)
Phase	:	3-phase, 4-wire	2- wire
Frequency	:	50 Hz +3% to - 5%	
Combined voltage and Frequency variation	:	10% (absolute sum)	
System grounding	:	Solidly grounded	Ungrounded

3.0 Rating

Rated current	:	To be decided by the tenderers.
Design Ambient Temperature	:	50°C
Short Circuit Current Symm.	:	50 KA 25* KA

* Indicative only, the actual value will be decided by the tenderers.

S/C Withstand Time	:	----- 1 second -----
High voltage test for 1 minute	:	2.5 kV 1.5 kV

4.0 Duty

Circuit Breaker	:	0-3'-CO-3'-0
Contactor (AC)	:	Class III - Category AC3 for unidirectional drives and AC4 for bi- directional / inching duty drives
Contactor (DC)	:	Class I – category DC2
MCCB / Switch Duty for		AC DC
Motor Feeder	:	AC23 DC22

	Other Feeder	:	AC22	DC22
5.0	A.C. / D.C. Power Supply			
	Control Voltage for Circuit breaker	:	220V DC +10% to -15%	
	Control voltage for MCCB modules	:	110V AC $\pm$ 10%, 1Ph, 50Hz +3% to - 5%	
	Service voltage	:	240V AC $\pm$ 10%, 1Ph, 50Hz +3% to - 5%	

ANNEXURE-B

PROTECTIONS

- 1.0 All Protective relays shall be numerical type having communication facility with Plant DDCMIS system / PLC.
- 2.0 The minimum protections to be provided for different types of circuits are listed below:
 - a. Incoming Feeder & Bus-coupler with ACB:
 - 3 - inverse time O/C relays (51) for phase fault.
 - 1 - Inverse time O/C relay (51N) for Earth fault.
 - 3 - Under Voltage (27), Range : 40-80% with timer
 - b. Motor Feeder with ACB: (above 110 kW)
 - 1 - Composite Motor protection relay (99) for protection against
 - Thermal overload
 - Phase faults
 - Unbalance (negative sequence)
 - Locked rotor
 - Excessive Start-up time and Start-Stop.
 - Earth fault
 - c. Outgoing Feeder : with ACB
 - 3 - Inverse time O/C relays (51) for phase fault.
 - 1 - Inverse time O/C relay (51N) for Earth fault.
- 3.0 Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip circuit supervision (74) relays. Lockout relay shall be hand reset type.
- 4.0 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided..
- 5.0 For Auto-bus change-over as well as live bus change-over through synchronization refer enclosed Control Schematic drawings.
- 6.0 Each incomer shall be provided with three (3) nos. Bus Energised indicating lamps – Red/Yellow/Blue for each phase.

ANNEXURE-C

FITTINGS & ACCESSORIES

Each switchboard shall be furnished complete with fittings and accessories as listed below: -

1. Operating mechanism complete with all accessories, fittings and tripping coil and closing coil, pole discrepancy feature etc. as required.
2. Base frame and anchor bolts and nuts.
3. Auxiliary contacts and relays.
4. LOCAL/REMOTE Selector switch, TRIP/CLOSE Push Buttons.
5. Manual tripping devices with protective flap.
6. Mechanical ON-OFF indicator.
7. Operation counters.
8. Set of switch fuse units/MCCB for A.C. and D.C. supply.
9. Space heater with thermostat and ON-OFF switch.
10. Cubicle illumination lamp with ON-OFF switch.
11. 3 Pin 5A Socket with ON-OFF Switch.
12. Terminal blocks and internal wiring - lot as required.
13. Other standard accessories which are not specifically mentioned but supplied with breakers of similar type and rating for efficient and trouble-free operation.

14. Bimetallic terminal connectors.

ANNEXURE-D

BUS TRANSFER SCHEME FOR PMCC

1.0 The manual bus transfer shall be arranged in such a way that any of the following modes of operation is possible.

1.1 **Manual Bus Transfer**

a) Without voltage interruption

This means by allowing momentary parallel operation of two sources.

b) With voltage interruption

i) Slow Transfer

ii) Fast Transfer

NOTE : For CHP/AHP system 'Manual bus transfer without voltage interruption' and 'dead bus transfer with voltage interruption' shall be provided.

Synchronization of Incomer & Bus coupler for each of the 415V PMCC shall be implemented through PLC in CHP electrical cum control room building. Synchronization check relay, guard relay and auxiliary relay shall be provided in each PMCC. Synchroscope along with cut off switch, double voltmeter, double frequency meter shall be provided in the Main CHP electrical building cum control room. Separate synchronization switch and trip selector switch for each of the PMCC shall also be provided in the CHP electrical building cum control room.



CLIENT – TELANGANA STATE POWER GENERATION COMPANY

CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD

PROJECT: 1 x 800 MW KOTHAGUDAM TPS - 400 KV SWITCHYARD

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SECTION 3

LIST OF DRAWINGS & DOCUMENTS

GENERAL TECHNICAL REQUIREMENTS

1.0 PROJECT DETAILS

A) Kothagudem TPS

Customer	:	M/s Telangana State Power Generation Corporation Ltd.
Project Title	:	1x800MW Kothagudem Thermal Power Station Stage VII, Unit 12
Project Location	:	Paloncha Village, Khammam District, Telangana
Nearest Railway station	:	Bhadrachalam Road railway station.
Nearest Road Head	:	Khammam 16 km approx., Nearest Highway NH221 (Vijaywada – Jagdalpur Highway).
Nearest Airport	:	Hyderabad (about 200 Km) Chief Engineer (O&M), Kothagudem Thermal Power Station Stage
Postal Address	:	VII, Unit – 12, TSGENCO, Village - Paloncha, Dist. – Khammam, Telangana -507115

1.1. SITE CONDITIONS (FOR DESIGN PURPOSES)

1.1.1 SITE CONDITIONS

a).	Average rainfall per year	:	1124 mm
b).	Maximum hourly rainfall intensity	:	102 mm
c).	Altitude	:	1000 m

1.1.2 DESIGN AMBIENT

a).	Minimum Temperature	:	13.5°C
b).	Maximum Temperature	:	45°C
c).	Design Ambient Temperature	:	50 °C



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1.1.3 RELATIVE HUMIDITY

a). Maximum :: 85%

1.1.4 WIND PRESSURE (AS PER IS:875-1987)

a). Design wind speed : 44 m/sec.

1.1.5 SEISMIC FACTORS

a). Horizontal Seismic Coefficient : As per latest IS : 1893
b). Vertical Seismic Coefficient : As per latest IS : 1893
} **Zone – III**

1.1.6 ELECTRICAL DATA

		400 kV System	415V AC System	240V AC System	220 V DC System	48 V DC System
1.	Nominal Voltage	400 kV	415 V	240 V	220 V	48 V
2.	Highest System Voltage	420 kV	457 V	264 V	242 V	55 V
3.	No. of phases	3	3	1	NA	NA
4.	Frequency	50 Hz	50 Hz	50 Hz	NA	NA
5.	Voltage variation	± 5%	± 10 %	± 10 %	+10 % to - 15%	± 10 %
6.	Neutral Earthing	Effectively Earthed	Solidly Earthed	Solidly Earthed	-	-
7.	Fault Level	50 kA for 1 sec.	50 kA for 1 sec.	50 kA for 1 sec.	15 kA for 1 sec.	-

1.1.7 SYSTEM PARAMETERS

Dry and wet one minute power frequency withstand voltage 630 kVrms
Dry impulse withstand voltage positive and negative 1425 kVpeak
Minimum Total Creepage 25 mm/kV

1.1.8 MINIMUM CLEARANCE (AS PER IS: 10118)

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Phase to phase (PP)	4200 mm
Phase to earth (PE)	3500 mm
Section clearance	6500 mm
Minimum ground clearance from plinth level (Plinth level : 300 mm)	8000 mm
Vertical ground clearance to nearest part not at earth potential of an insulator supporting live conductor/ equipment	2440 mm

1.2. INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification. It is recognised that the Manufacturer may have standardised on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously.

1.3. STANDARDS

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other. When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.



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In case governing standard for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in the offer along with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Purchaser's / owner's approval. The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

1.4. TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

All equipment being supplied shall conform to type tests and shall be subject to routine and acceptance tests in accordance with requirements stipulated under respective sections. Purchaser reserves the right to witness any or all the tests. The Manufacturer shall intimate the Purchaser the detailed programme about the tests at least three (3) weeks in advance in

case of domestic supplies & six (6) weeks in advance in case of foreign supplies. Purchaser reserves the option for getting any or all the type tests repeated on the equipment. The Manufacturer shall also submit type test procedure for approval of the Purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the technical specification or any/all additional type tests not carried out without any additional cost implication to the Purchaser.

The price of conducting all tests and additional type tests is deemed to be included in Bid price. In case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

The purchaser intends to repeat the type tests and additional type tests on cables for which test charges shall be payable as per provision of contract.

The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractors premises or Works and shall have the power, at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Manufacturer shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Manufacturer's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

The Manufacturer shall give the Purchaser/inspector thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Manufacturer's account except for the expenses of the inspector. Unless witnessing of the tests is virtually waived, the Purchaser/ inspector will attend such tests within thirty (30) days of the date of which the equipment is notified as being



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ready for test/ inspection, failing which the Manufacturer may proceed with the test which shall be deemed to have been made in the Inspector's presence and the Manufacturer shall forthwith forward duly certified copies of test reports in triplicate to the Inspector.

The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein, give notice in writing to the Manufacturer, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Manufacturer shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser/ inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

When the factory tests have been completed at the Manufacturer's works, the Purchaser/ inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser/inspector, the certificate shall be issued within fifteen (15) days of receipt of the Manufacturer's Test certificate by the Engineer/ Inspector. Failure of the Purchaser/inspector to issue such a certificate shall not prevent the Manufacturer from proceeding with the Works. The completion of this test or the issue of the certificate shall not bind the Purchaser to accept the equipment should it, on further tests/ after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Purchaser.

In all cases where the Contract provides for tests whether at the premises or at the works of the Manufacturer or of any Sub-Contractor, the Manufacturer except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser Inspector or to his authorised representative to accomplish testing.

The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Manufacturer in respect of the agreed quality assurance programme forming a part of the Contract.

The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carded out at Manufacturer's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Purchaser.



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1.5. MATERIAL/WORKMANSHIP

1.5.1 GENERAL REQUIREMENT

Where the specification does not contain characteristics with reference to workmanship, equipment, materials and components of the covered Equipment it is understood that the same must be new, of highest grade of the best quality of their kind conforming to best engineering practice and suitable for the purposes for which they are intended.

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

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

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

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



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

1.5.2 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

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

1.6. COLOUR SCHEME AND CODES FOR PIPE SERVICE

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

Finishing colour of Indoor equipment

Finishing colour of Outdoor equipment.

Finish colour of all cubicles.

Finishing colour of various auxiliary system equipment including piping

Finishing colour of various building items.

All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all electrical equipment in switchyard are painted with shade 631 of IS-5. All The indoor cubicles shall be of same colour scheme and for other miscellaneous items, colour scheme will be approved by the purchaser.

1.7. PAINTING

- a) All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with IS: 6005 "Code of practice for Phosphating Iron and Steel".
- b) Oil, grease, dirt and swerve shall be thoroughly removed from emulsion by cleaning.
- c) Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- d) After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute bichromate solution and over drying.
- e) The phosphate coating shall be sealed by the application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "Flash dried" while the second coat shall be stoved.

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- f) After application of the primer, two coats of finishing epoxy paint shall be applied, each coat followed by stoving. The panel shall have colour conforming to shade 631 of IS-5 for outside and inside of the panel with black colour for base frame.
- g) Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.
- h) Finished painted appearance of panel shall present an asthetically pleasing appearance free from dents and uneven surface.
- i) A small quantity of finishing paint shall be supplied for minor touching up required at site after the installation of the panels.

1.8. PROTECTION

- a) All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves, pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.
- b) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.
- c) The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.
- d) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

1.9. FUNGISTATIC VARNISH

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

1.10. SURFACE FINISH

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

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a



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suitable preventive compound and suitably wrapped or other wise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limit specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

1.11. GALVANIZING

All ferrous parts including all sizes of nuts, bolts, Plain and spring washers, support channels, structures, shall be hot dip galvanised conforming to latest version of IS:2629 or any other equivalent authoritative standard. However, hardware less than M12 size shall be electro-galvanized. Minimum weight of zinc coating shall be 610 gm/sq.mm and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6 mm thickness, requirement of coating shall be as per relevant ASTM.

1.12. AUXILIARY POWER SUPPLY

1.12.1 A.C power supply for auxiliaries will be available at 240 V, 50 C/s 1-phase, 2 wire and 415V, 50 C/s, 3-phase, 4 wire, neutral solidly earthed with variation in frequency of +/-5% and variation in voltage +/-10%

1.12.2 D.C. power supply at 220 V, 2-wire ungrounded will be available 187 V to 242 V.

1.13. INSPECTION AND TESTING

All tests and inspection of the equipment specified shall be performed to the extent and in the manner as stipulated in the relevant standards and in this specification. All type tests/routine tests/acceptance tests as specified shall be conducted in the presence of purchaser. Wherever equipment similar to the one being offered has already been type tested within 5 years from the date of opening the bid. Type tests done in an independent government laboratory or in the presence of representative of State Electricity Board or other reputed public undertakings, the type test reports of the same shall be submitted for scrutiny /approval. If these are found suitable and technically acceptable, conducting of type tests shall be waived off. Otherwise the subcontractor will have to carry out the type tests without any extra cost and without any delivery implications.

1.14. PACKAGING

Aluminium Tube shall be partially packed with Hessians cloths. Similar items shall be grouped and tied with steel wires/strip for convenient handling during transits.

MARKINGS

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

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

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e) Tare weight.

f) Gross weight.

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the purchaser, the Contractor shall also submit packing details/associated drawing for any equipment material under his scope of supply, to facilitate the purchaser to repack any equipment/ material at a later date, in case the need arises, while packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage wagons and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

1.15. HANDLING, STORING AND INSTALLATION

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the purchaser.

Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than one section, contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the contractor at his own expenses.



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Contractor shall be responsible for examining all the shipment immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, pilferage and other such charges claimed by the transporters, railways etc. shall be to the Contractor's account.

The Contractor shall be fully responsible, for the equipment/material until the same is handed over to the purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance to the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of such nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipments which require indoor storage.

The words erection and installation used in the specification are synonymous. Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

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

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

1.16. TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

1.17. EQUIPMENT BASES

A cast iron or welded steel base-plate shall be provided for all rotating equipment, which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base-plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units shall have a raised lip all around, and shall have threaded drain connections.

1.18. QUALITY

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

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1.19. DOCUMENTATION

DRAWINGS

All drawings shall be prepared in AutoCAD and ultimate documentation would include drawings/documents on CDs. All dimensions and data shall be in SI metric units.

All items of the equipment should be clearly identified by proper part nos. in the contract drawings. Such parts, which are to be dispatched to site from works in dispatchable units and are reassembled at site, should be marked by proper identification marks at works and indicated in the drawings and quantified. The shipping list should be sent along with the general arrangement drawings for engineer's approval. All the items of the shipping list should be identified in the drawing.

The drawing submitted by the supplier shall be reviewed by the purchaser as far as practicable within two weeks of receipt of drawings and shall be modified by the sub-contractor if any modifications and/or corrections are required by the purchaser. The sub-contractor shall incorporate such modifications and / or corrections and submit the final drawings for approval. Any delay arising out of failure of the subcontractor to rectify the drawings shall not alter the contract completion date.

Further work by the subcontractor shall be in strict accordance with these drawings and no deviation shall be allowed without the written approval of the purchaser.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at supplier's risk.

Approval of drawing or work by the purchaser/consultant shall not relieve the subcontractor of any of his responsibilities and liabilities under the contract.

In case of any modifications that may be necessary during erection or commissioning of the equipment, the subcontractor shall carry out modifications in the original drawing & submit 'As Built drawings' and required no. of prints thereof.

INSTRUCTION MANUALS

The supplier shall submit to the purchaser, draft instruction manuals for approval within 30 days of placement of order. The final instruction manuals complete in all respects shall be submitted 60 days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipment furnished, the erection procedures, testing, operation & maintenance procedures of the equipment.

If after the commissioning and initial operation of the plant, the instruction manuals require any modification/ addition / changes, the same shall be incorporated and the up- dated final instruction manuals shall be submitted as required.



TITLE BLOCK & DRAWING/ DOCUMENT NUMBERING SCHEME

Title block for drawing / document should be followed as per ANNEXURE-3

DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A.	<u>For approval</u>	<u>No of Copies</u>
	Copies of all drawings with project details, dimension, shipping weights, No. of cases & dimensions, fixing details, tolerance etc.	10
	Copies of type test reports.	5
	Copies of works quality plan & field quality plan.	5
	Copies of installation, operation & maintenance manual.	5
	Copies of drawings on floppies/CDs	1 set
B.	<u>After approval and for information / distribution</u>	
	Copies of all drawings	15
	Copies of installation, operation & maintenance manual including Routine test reports	15
	Sets of RTF of drawings	2
	CDs of Drgs.	3
C.	<u>As Built Drawings</u>	
	Hard copies of Drawings	15
	CDs	3

NOTE:

1. Any revision of drawings / documents shall be submitted in the same no. of copies submitted first time for approval
2. Final drawings / documents shall be submitted in bound volume with customer and project details etc. written on the top.



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SECTION 4

LIST OF DRAWINGS & DOCUMENTS

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

DRAWING NOS.	DRAWING NAME
TB-DG-377-553-001	P & I Diagram for AC system
TB-DG-377-553-002	A C Ducting layout for Control building
TB-DG-377-553-003	AHU room layout
TB-DG-377-553-004	Ventilation fan layout for Control building
TB-DG-377-553-005	Schematic, GA & SLD for HVAC PDB
DATA SHEETS	DATA SHEETS NAME
TB-DS-377-553-01	TDS For Precision Packaged AC unit
TB-DS-377-553-02	TDS For Split AC units
TB-DS-377-553-03	TDS For GI Sheet for Ducts
TB-DS-377-553-04	TDS For Insulation
TB-DS-377-553-05	TDS For Supply & Return Air Diffuser
TB-DS-377-553-06	TDS For Fire Damper
TB-DS-377-553-07	TDS For Pre-filter & Fine filter
TB-DS-377-553-10	TDS For Instruments
TB-DS-377-553-14	TDS For Supply Air Fans
TB-DS-377-553-15	TDS For Exhaust Fans
TB-CL-377-553-16	Ventilation Fans Calculation
TB-BQ-377-553-17	BOQ - HVAC SYSTEM

- ❖ First submission of all the data sheets shall be done within 30 days of placement of order on the successful bidder.



CLIENT – TELANGANA STATE POWER GENERATION COMPANY
CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD
PROJECT:1 x 800 MW KOTHAGUDAM TPS - 400 KV SWITCHYARD
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SECTION 5

ENCLOSURES TO SPECIFICATION

SCHEDULES TO BE FILLED UP BY THE BIDDER

- Schedule 1 **Schedule of Deviations**
- Schedule 2 **Schedule of past experience and qualifying requirements**
- Schedule 3 **Schedule of performance certificates**
- Schedule 4 **Schedule of type test and special tests**
- Schedule 5 **Details of contact persons (technical & commercial)**
- Schedule 6 **Enclosures to Specification**
 - a. ANNEXURE-A **Drawings**
 - b. ANNEXURE-B **List of Makes**



CLIENT – TELANGANA STATE POWER GENERATION COMPANY

CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD

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SCHEDULE-1

SCHEDULE OF TECHNICAL DEVIATION

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

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

- 1) In case, this schedule is not submitted, it will be presumed that the equipment /material to be supplied under this contract 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

Signature of the authorized representative of Bidder

Name -----

Date

Designation-----

Company seal-----



CLIENT – TELANGANA STATE POWER GENERATION COMPANY

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SCHEDULE – 2

SCHEDULE OF PAST EXPERIENCE AND QUALIFYING REQUIREMENT

Following is the list of earlier orders executed by us for supply of equipment / material of Similar nature over the last past five years:

S.No.	Item	Brief rating	Qty	customer	Date of order	Date of supply	Order value
-------	------	--------------	-----	----------	------------------	-------------------	----------------

Place

Signature of the authorized representative of Bidder

Date

Name-----

Designation-----

Company seal -----

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



CLIENT – TELANGANA STATE POWER GENERATION COMPANY
CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD
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SCHEDULE – 3

SCHEDULE OF PERFORMANCE CERTIFICATE

Bidder shall furnish the performance certificate of the similar equipment having
The following details:

S.No.	Item	Brief rating	Qty	Customer	Date of supply
-------	------	--------------	-----	----------	-------------------

Place _____ Signature of the authorized representative of Bidder

Date _____ Name-----

Designation-----

Company seal -----

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



CLIENT – TELANGANA STATE POWER GENERATION COMPANY

CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD

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SCHEDULE-4

SCHEDULE OF TYPE TESTS AND SPECIAL TESTS

The following type tests and special tests as called for in the Specification shall be conducted (all type tests / special tests as mentioned in the relevant clauses of the Specification shall be listed here):

Sl no.	Clause no/ page no of Specification	Details of test	Lab in which to be conducted	Whether test to be conducted free or on chargeable basis. Mention 'FREE' or 'CHARGEABLE'	If charges per test have been quoted for in the price bid. YES / NO
		A. Type Tests			
		1.			
		2.			
		B. Routine Tests			DO NOT
		1.			MENTION
		2.			ANY PRICE
		C. Site Tests			IN THIS
		1.			COLUMN
		2.			
		D. Special Tests (specified)			
		1.			
		2.			
		E. Other tests at works / site recommended by the Bidder			
		1.			
		2.			

NOTE:

- 1) Details have to be furnished on cables as well as accessories, each separately.
- 2) **NO PRICE SHALL BE FURNISHED IN THIS FORMAT.**

Place

Signature of the authorized representative of Bidder

Name-----

Date

Designation-----

Company seal-----

Section - 5



CLIENT – TELANGANA STATE POWER GENERATION COMPANY
CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD
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SCHEDULE-5

DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL

Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Signature of the authorized representative of Bidder

Date

Name-----

Designation-----

Company seal -----

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



CLIENT – TELANGANA STATE POWER GENERATION COMPANY
CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD
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SCHEDULE – 6

ENCLOSURES TO SPECIFICATION

(ANNEXURE-A)

DRAWINGS

1. CONCEPTUAL 400 KV SWITCHYARD CONTROL ROOM BUILDING LAYOUT
DRG. NO. TB-3-377-316-008 (3 SHEETS)



CLIENT – TELANGANA STATE POWER GENERATION COMPANY
CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD
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(ANNEXURE B)

LIST OF MAKES

Bidder shall choose make of materials from list below. However final approval for the makes will be given by the customer during the detailed engineering stage inline with Cl. No. 3.1.2 g), Sec-1.

A. AIR CONDITIONING & VENTILATION SYSTEM MAKES

S.N.	Description	Makes
1.	Precision Package AC	STULZ / UNIFLAIR / EMERSON/ BLUEBOX / CLIMADENTA
2.	Split Air Conditioner	Voltas / Blue Star / Carrier / Hitachi
3.	Air Filters	John Fowler /Spectrum
4.	Axial Fans/F.A. Fans	Marathon / Flakt / C Doctor / Humidin/ Krugger
5.	Insulation Material	Lloyds UP Twiga
6.	Butterfly Valve	Audco / Fouress / Inter Valve / Keystone / BDK
7.	Non Return Valves	Fluid line//Hi-tech Valves/ Cresent/Leader/AV Valves /H.Sarkar
8.	Relief/ Purge Valve	Brassomatic
9.	Piping	Tata / Jindal / SAIL/ BST.
10.	GI Sheets for Ducting	SAIL / Jindal/ Bhushan / TATA.
11.	Thermostats	Honeywell / RANCO / Penn / Danfoss / Indfoss
12.	Humidistat	Honeywell / Penn.
13.	Antifreeze thermostat	RANCO / Honeywell / Penn / Danfoss / Indfoss
14.	Strip Heaters	Escorts / RACOLD / Daspass/ALCO/HEATCO/Hotset
15.	Pressure Gauges	A.N.INST/ GENERAL INST/CONSORTIUM/ GLUCK/H.GURU IND/H.GURU INST/ WAAREE INSTRUMENTS
16.	Temperature Gauges	A.N.INST/ INSTWAAREE INSTRUMENTS
17.	Level Gauge	Levcon /General Instruments/ Chemtrols /SBEM, Pune/V, Automat Mumbai
18.	Pressure Switches	Switzer / Indfoss
19.	DP Switches	SWITZER
20.	Temperature Switch	SWITZER
21.	Flow Element	MICROPRECISION /STAR-MECH
22.	Temperature Element	GENERAL INST CONSORTIUM/ PYRO ELECTRIC WAAREE INST
23.	Level Switch	BLISS ANAND / CHEMTROLS / Levcon / V. AUTOMATE
24.	Pan Humidifier	Rapid Cool / Hotset/ALCO
25.	Fire Damper	TSC /Carryaire/ Ravistar.



CLIENT – TELANGANA STATE POWER GENERATION COMPANY

CONSULTANT- DEVELOPMENT CONSULTANTS PVT. LTD

PROJECT:1 x 800 MW KOTHAGUDAM TPS - 400 KV SWITCHYARD

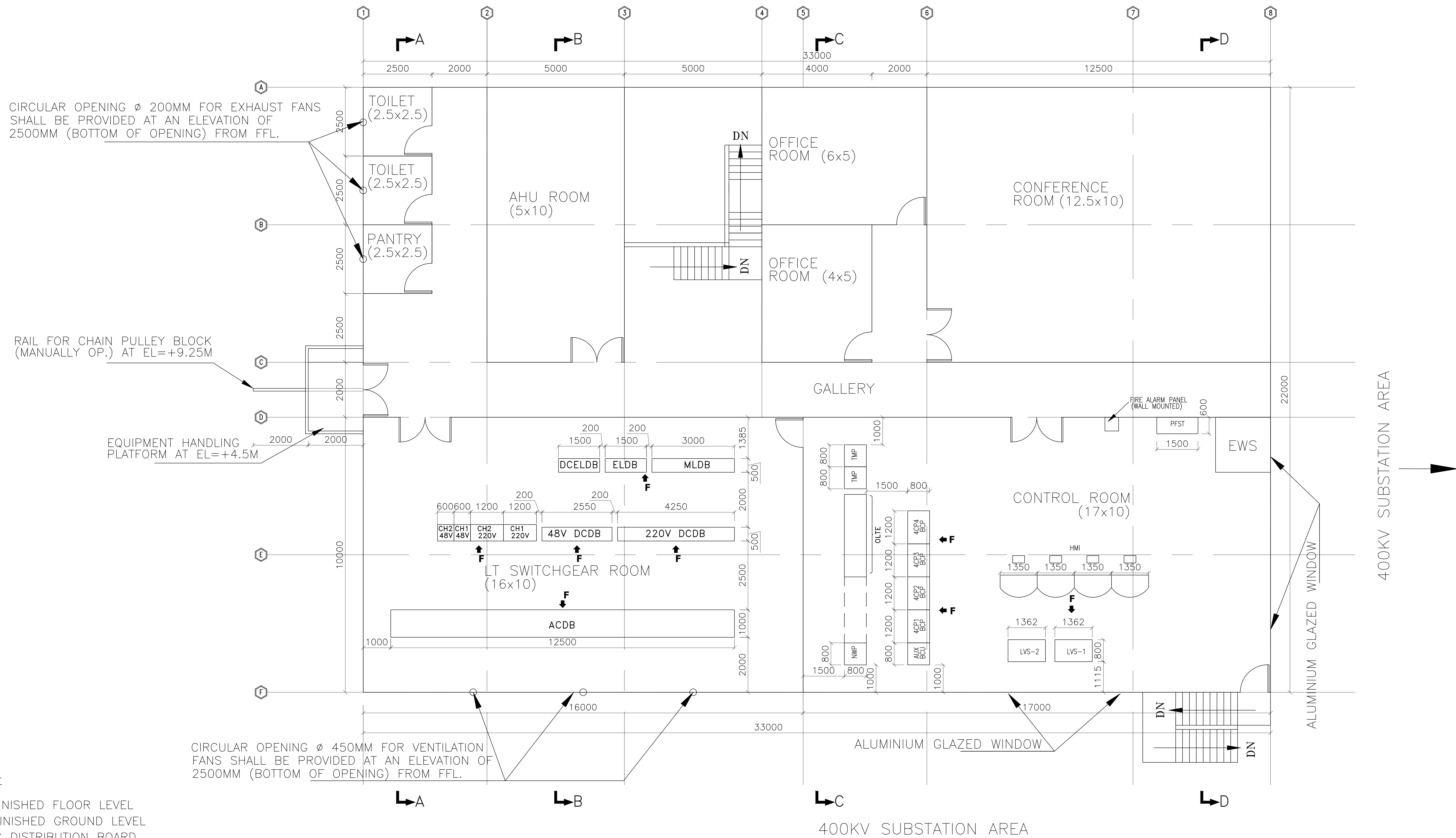
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26.	Control Panel	Industrial Control & Appliance / Control & Switchgear / Pyrotech/ Positronics /Rittal
27.	LV Switchgear – PMCCs, MCCs, Process DBs	L&T LTD, MUMBAI,SIEMENS LTD., MUMBAI, CONTROL SWITCHGEAR CO.,NEW DELHI, SCHNEIDER, AREVA
28.	Annunciator for Panels	Procon/ PECON/ ICC
29.	Temp/RH Sensor	Siemens Building Technology/Johnson/ Honeywell
30.	Motorized Butterfly Valve with single phase actuator	Siemens Building Technology/Johnson/Honeywell
31.	Axial Flows Fans	Marathon / Flakt / CB Doctor/ Hyderabad Pollution/ SK System / Advance Ventilation / Patel Air Flow / Kruger / Nicotra
32.	Electrical Motors (HT & LT)	CGL KEC ABB SIEMENS AREVA (MARATHON)



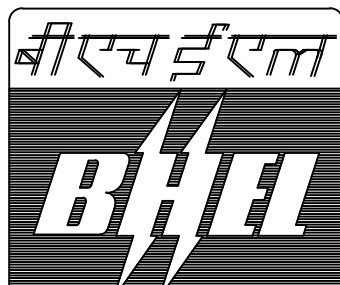
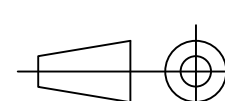
LEGEND—

FFL = FINISHED FLOOR LEVEL
FGL = FINISHED GROUND LEVEL
ACDB = AC DISTRIBUTION BOARD
DCDB = DC DISTRIBUTION BOARD
MLDB = MAIN LIGHTING DISTRIBUTION BOARD
ELDB = EMERGENCY LIGHTING DISTRIBUTION BOARD
CH = CHARGER
AHU = AIR HANDLING UNIT
TMP = TARIFF METERING PANEL
BCP = BACK UP CONTROL PANEL
HMI = HUMAN MACHINE INTERFACE (MAIN OWS,
BACKUP OWS, METERING WORK STATION)
LVS = LARGE VIDEO SCREEN
PFST = PRINTER CUM FILE STORAGE TABLE
AUX = AUXILIARY PANEL
NWP = NETWORKING PANEL
OLTE= OVERHEAD LINE TELECOMMUNICATION EQUIPMENT
EWS = ENGINEERING WORK STATION

REV.	DATE	ALTERED	REV.	DATE	ALTERED	MVK
		CHECKED			CHECKED	MVK
		APPROVED			APPROVED	AS
ZONE			ZONE	03	23.11.15	1) REVISED AS PER CUSTOMER COMMENTS & LOCATION OF AHU ROOM MODIFIED.

REV.	DATE	ALTERED	MVK	SD/-
02	11.10.15	CHECKED	MVK	SD/-
		APPROVED	AS	SD/-
ZONE	1) REVISED AS PER CUSTOMER COMMENTS.			

REV.	DATE	ALTERED	MVK	SD/-
01	21.08.15	CHECKED	MVK	SD/-
		APPROVED	AS	SD/-
ZONE	1) REVISED AS PER CUSTOMER COMMENTS.			

ADDITIONAL INFORMATION W.O.No.				84005		ग्राहक/परियोजना का नाम NAME OF CUSTOMER/PROJECT		TSGENCO 400KV SWITCHYARD AT 1x800 MW KOTHAGUDEM TPS									
STATUS OF DRAWING						CONTRACT						CONSULTANT:- DEVELOPMENT CONSULTANTS PVT. LTD.					
DISTRIBUTION OF PRINTS								भारत हेवी इलेक्ट्रिकल्स लिमिटेड ट्रांसमिशन परियोजना विभाग BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP		खनका DRAWN	नाम /NAME PR/RK	हस्ता./SIGN. SD/-	दि./DATE 28.05.15				
										चेका CHECKED	PR/SKS	SD/-	28.05.15				
										स्वीकृत APPROVED	AS	SD/-	28.05.15				
REV.	DATE	ALTERED	MVK	SD/-	विभाग	TBEM		अनुपात / SCALE	कार्ड कोड CARD CODE								
01	21.08.15	CHECKED	MVK	SD/-	कोड	422											
		APPROVED	AS	SD/-													
ZONE	1) REVISED AS PER CUSTOMER COMMENTS.				शीर्षक/TITLE CONCEPTUAL 400KV SWITCHYARD CONTROL ROOM BUILDING LAYOUT					ड्राईंग.क./DRAWING NO. TB-3-377-316-008		पुनः/REV. 03					
										पृष्ठ क्र./SHEET No. 2		अगला पृष्ठ/NEXT SHEET 3					

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)																							
DRAWING No. TB-3-377-316-008		7		6		5		4		3		2		1									
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					SECTION-DD											E							
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