भारत हैवी ईलैक्ट्रिकल्स लिमिटेड

BHARAT HEAVY ELECTRICALS LIMITED

पारेषण व्यापार अभियांत्रिकी प्रबंधन

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TITLE/ शीर्षक	AC & VENTILATION SYSTEM (SWITCHYARD CONTROL BUILDING)			नाम / NAME	TDT	SKS	NSR
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				समूह/GROUP	TBEM	W.O. No	83011

ग्राहक/ CUSTOMER	NATIONAL THERMAL POWER CORPORATION LTD (NTPC)
परियोजना/ PROJECT	3 x 660 MW NORTH KARANPURA STPP – 400/ 220 KV SWITCHYARD

विषय-सूचि/ CONTENTS

ENCLOSURES

a. ANNEXURES TO SECTION - 1

Annexure-I – List of cables procured by BHEL.

b. ANNEXURES TO SECTION - 2

Annexure-II- NTPC Specification for AC & Ventilation system

c. ANNEXURES TO SECTION - 5

Annexure-A - Architectural Layout of Control Room building, Rev.01

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS

Distribution	To	TBEM	TBMM	TBQM	Vendor
	Copies	1	1	1	4

SECTION-1

INTENT, SYSTEM REQUIREMENT AND SCOPE

1.0.0 INTENT OF SPECIFICATION

1.1.0 This specification covers the manufacturing, inspection/testing, packaging, dispatch and erection, testing & commissioning at site of **Air-Conditioning & Ventilation System** as mentioned in different sections of this specification for **400/220 kV Sub-station at North Karanpura Super Thermal Power Plant**.

1.2.0 The requirements specified under '**SECTION 2, SECTION 3, SECTION 4 & SECTION 5**' of the specification shall be considered as part of this section. In case of variance between various sections, the requirements of **SECTION 1** shall prevail.

1.3.0 The Bidder shall be deemed to have understood completely all the tender drawings and documents and quoted accordingly.

1.4.0 The Contract shall be on unit rate basis for the quantities furnished by BHEL. Variations (upward/ downward) in quantities during contract stage shall be settled on the basis of unit rates furnished in the bid.

1.5.0 During contract stage, quantities of various items of BOQ may vary to any extent and same rates will be applicable so far the resultant variation in total contract value is within ±30%. Variations beyond ±30% shall be negotiated mutually.

1.6.0 It is recommended that Bidders have no deviation on technical requirement & scope. Bidder shall submit signed and stamped copy of "Certificate of No deviation" (Schedule 1 of Section 5) for 'NIL DEVIATION'. 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.

1.7.0 The term **'Owner'** appearing in this specification shall refer to National Thermal Power Corporation (NTPC), the term **'Purchaser'** shall refer to **BHEL** and the term **'Contractor'** shall refer to the successful Bidder.

1.8.0 The system / equipment shall be capable of performing the required duties as per the specification requirements.

2.0.0 AIR CONDITIONING REQUIREMENT FOR VARIOUS AREAS

Air Conditioning System for Control Room Building

a) Air-conditioning units for control room building shall be set to maintain the following inside conditions:

b) Design Criteria:

Ambient Conditions	DB in °C	WB in °C
Summer	41	25
Monsoon	32.5	27
Winter	9	7.1
Desired Inside Condition	$24^0C \pm 1^0C$ 50%±5% RH	
Floor Area	As per Control building layout	
Exposed glass area	As per Control building layout	
Exposed wall area	As per Control building layout	
Illumination Heat load	2 Watt per sq. ft.	
Equipment heat load	3 kW (For SAS room) & 1kW (For Batt. Ch. Room)	
Occupancy (No. of person)	SAS room (8), Test Lab (3), Conf. room (3), office (3), Batt. Charg. Room (2)	

Bidder to submit Heat load calculation to check the adequacy of the offered system and ensure that offered AC system caters to both tonnage and CFM requirements for area to be cooled.

c) Air-conditioning shall be provided through Cassette AC units to maintain the specified inside conditions for the following rooms in the building.

Sl no.	Name of the Area	Nos. of Cassette AC x AC Capacity
1	SAS Room #	8 x 4 TR (4 W + 4 S)
2	Office Room	2 x 4 TR
3	Conference room	1 x 4 TR
4	Test Lab	4 x 4 TR
5	Battery Charger room#	4 x 4 TR (2 W + 2 S)

100% Standby units shall be provided for SAS room & Battery charger room.

Standard Control Room Building drawing no. TB-0-369-607-626-1, Rev.1 is also enclosed as a part of the specification for bidder's reference.

Ceiling Mounted Cassette Type Unit (Multi Flow Type)

d) The Cassette AC units will be complete with indoor evaporator unit, outdoor condensing units, hermetically sealed rotary/scroll compressor, filters, piping, valves, refrigerant strainer, Controls, instruments, control panel/ starter panels, vibration isolator pads and cordless remote control units.

e) Outdoor unit shall comprise of hermetically sealed reciprocating/ rotary compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air. Outdoor units will be placed on outer wall or top of roof.

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

Unit shall have four way supply air grills on sides and return air grill in centre.

Each unit shall have high lift drain pump and very low operating sound.

Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.

Copper refrigerant piping, wiring of indoor/outdoor unit shall be provided inline with distribution of AC units in various rooms and placement of outdoor units.

3.0.0 VENTILATION SYSTEM FOR SWITCHYARD CONTROL BUILDING

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

All the ventilation fans shall operate on 100% fresh air considering 30 air changes per hour (ACPH) for LT Switchgear room & 30 ACPH for battery room.

Wall mounted 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 along with gravity louvers 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.

Exhaust fans of suitable capacity (CMH) each having rain protection cowl, bird screen and mounting arrangement shall be envisaged for the following rooms:

Battery room - Motors for the fans of this room shall be flameproof with epoxy painting. These exhaust fans for shall be of bifurcated construction with motor away from the air stream. These fans shall have spark proof construction. Supply of air to battery room shall be through intake louvers provided at suitable location in the room.

Fan requirement has been tabulated below:

Sl. No.	Area	Nos. x Capacity in CMH (Static Head mm WC)	Type of Fan
1	LT Switchgear Room	6 x 8000, (30.0)	SUPPLY FAN
2	Battery room	3 x 8000, (10.0)	EXAUST FAN

4.0.0 ELECTRICAL SYSTEM REQUIREMENTS

BHEL will provide 3-ph, 415V power supply point with MCB as per distribution of ACs in various rooms. All power cabling between the indoor and outdoor unit and AC to power supply point shall be done by contractor.

Similarly 3-ph, 415V power supply point with MCB shall be provided for ventilation fans in LT switchgear room & Battery room.

5.0.0 SCOPE OF SUPPLY & SERVICES

The scope of equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provisions contained in other sections/ clauses. The scope of work under the contract shall be deemed to include all such items, which although are not specifically

mentioned in the bid documents and / or in Bidder's proposal, but are required to make the equipment/ system complete for its safe, efficient, reliable and trouble free operation. **NO EXTRA COST** implication to BHEL shall be considered during contract stage on account of supply & installation of these unaccounted items.

5.1.0. SCOPE OF SUPPLY

i. The Bill of Quantities shall be read in conjunction with the Instructions to Bidders, General and Special Conditions of Contract, Technical Specifications, and Drawings.

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

iii. A rate or price shall be entered against each item in the priced Bill of Quantities. Cost of items against which the Contractor has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities.

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

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

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

A. <u>Control Room Building Air conditioners & Ventilation fans quantities</u>:

Sl. No.	Item Description	Unit	Qty
1.	Cassette AC unit of 4 TR capacity along with copper refrigerant piping as per clause ref 2. Sec-1 of Technical Specification.	Nos.	19
2.	8000 CMH @ 30 mm WC Axial flow supply air fan complete with pre-filters, fine filter, bird screen, rain protection cowl, gravity louvers and mounting accessories etc. for LT Switchgear room.	Nos.	6

3.	8000 CMH @ 10 mm WC Axial flow Exhaust fan with flame proof motor complete with bird screen, rain protection cowl, intake louvers and mounting accessories etc. for Battery room.	Nos.	3

✓ Prices of following shall be deemed to be inclusive in unit's rates of above items :

a. PVC drain piping from IDU, Copper refrigerant pipe & cable between IDU/ODU.

b. MS brackets and M.S. frame for indoor & outdoor units respectively and fixing hardware like anchor bolts, nuts, fittings etc. as would be necessary for installation of above equipment 1 lot for each AC unit and each capacity.

c. Any other item required for operation of the system satisfactorily inline with technical specification requirement.

5.2.0. SERVICES TO BE PERFORMED BY CONTRACTOR

5.2.1 Erection, Testing & Commissioning (ETC) requirements

a) The scope of ETC shall include receipt of material at site, erection, system testing and commissioning of the system.

b) Laying and termination of power cables to individual ACs is under the scope of this specification. In addition laying and termination of power cables for power supply to ventilation fans is under the scope of this specification.

c) Bidder shall arrange all machinery tools & tackles and consumables required for erection of the system.

d) PVC drain piping for the condensate drain.

e) Refrigerant piping connections as required.

f) Earthing of all equipments through GI Flat/ Wire of suitable size.

g) 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 for approval by owner/ purchaser*.

Bidder shall ensure that sufficient quantity of commissioning spares is made available for timely completion of commissioning of the system. These commissioning spare shall be in addition to mandatory spares.

h) Submission of following documents for approval.

1. Data sheet for Cassette AC along with catalogue for the model being offered.
2. Layout showing distribution of cassette AC & ventilation fans in the building, placement of indoor & outdoor units & routing of refrigerant piping.

Any other service not explicitly illustrated herein but which may be required to complete the system with its desired functionality shall be deemed to be included in the scope of the bidder.

5.2.2 Civil Works

Following is covered under contractor's scope:

5.2.3 Wall openings at suitable locations for refrigerant and drain piping.

5.2.4 Any other damage caused to civil works during ETC work of the equipment/system shall be made good to the original finish at no extra cost to the Purchaser.

5.2.5 **Exclusions**

i. Supply of power & control cables (except for cable between IDU-ODU / cable with standard equipment and AC unit to power supply point in the room) have been excluded from contractor's scope of supply. *Bidders shall submit the requirement of power & control cables (cable size, type & quantity) for AC system along with 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.

ii. Supply & installation of false ceiling.

iii. Underdeck insulation of the air conditioned areas.

iv. 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.

v. 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.

6.0.0 INSPECTION AND TESTING

Inspection of the items shall be as per approved quality plan by BHEL/ NTPC.

7.0.0 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 without any cost implication to BHEL/ Customer.

Annexure – I

Cable List

SlNo	Item_Desc
1	2C x 2.5 sq mm PVC/Copper, Armoured Control cable
2	5C x 2.5 sq mm PVC/Copper, Armoured Control cable
3	10C x 2.5 sq mm PVC/Copper, Armoured Control cable
4	14C x 2.5 sq mm PVC/Copper, Armoured Control cable
5	19C x 2.5 sq mm PVC/Copper, Armoured Control cable
6	4C x 10 sq mm PVC/Copper, Armoured Control cable
7	2C x 6 sq mm PVC/Aluminium, Armoured Aux. Power cable
8	4C x 16 sq mm PVC/Aluminium, Armoured Aux. Power cable
9	3.5C x 70 sq mm PVC/Aluminium, Armoured Aux. Power cable
10	3.5C x 150 sq mm XLPE/Aluminium, Armoured Aux. Power cable
11	3.5C x 300 sq mm XLPE/Aluminium, Armoured Aux. Power cable
12	2C x 150 sq mm XLPE/Aluminium, Armoured Aux. Power cable

ANNEXURE II TO SECTION - 2
NTPC SPECIFICATION

AIR CONDITIONING AND VENTILATION SYSTEM

1.00.00 **GENERAL**

1.01.00 This section of specification covers details of system specifications, detailing the areas to be air conditioned, basis of design, brief description of the system, equipment and services to be furnished by bidder. The supply, delivery and erection of the entire equipment listed here shall be in bidder's scope of work.

2.00.00 **AREAS TO BE COVERED UNDER AIR CONDITIONING SYSTEM**

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

a) Control rooms/Central Control Rooms, Control Equipment Rooms, UPS & battery charger room, SWAS room, etc.

b) ESP control rooms

c) Water system control room.

d) Switchyard building.

e) Service building: Various office areas, entrance lobbies, visitor & VIP lounge, reception area, etc.

f) Administrative building: Various office areas, entrance lobbies, visitor & VIP lounge, reception area, Satcom area, Canteen, etc.

g) Auditorium building

h) Fire water pump house control room.

i) Fire water booster pump house control room.

j) CPU Regeneration control room

k) Ash Water recirculation control room

l) Auxiliary Boiler Control Room

m) Hydrogen Plant Control room

n) Make- up water pump house control room.

o) Fuel oil Pump house control room.

p) CT SWGR control room.

q) Satcom building (if applicable).

r) Static excitation control room (if applicable).

v) Various remote I/O rooms associated with PT Plant, Coal slurry sludge pond (CSSP), AWRS, DM & CW Chemical plant and CPU services vessel, CW Chlorination & CW treatment, CT SWGR, Waste service water , Raw water, Service water etc.

w) DM plant and Lab building.

3.00.00 **REDUNDANCY OF EQUIPMENTS**

3.01.00 Redundancy of various A/C system equipments shall be as follows:

a) For Main Plant Areas (control room, control equipment room, UPS room and SWAS room):

i) Vapour Compression type water chilling units: 3X50%
ii) Chilled water Pumps: 3X50%
iii) Condenser water Pumps : 3X50%
iv) Cooling Towers: 3X50%
v) AHUs: Atleast one (1) number unit, capacity same as each working unit shall be provided as common standby. AHUs shall be Variable voltage variable frequency driven (VVVFD).

b) ESP Control Room Building:

i) Water Cooled /Air Cooled condensing units/Precision Air conditioners: 2X100%
ii) AHU (with VVVFD): 2 X 100% (if applicable)
iii) Condenser water pumps: 2X100% (if applicable)
iv) Cooling Towers (with VVVFD Fan): 2X100% (if applicable)

c) Service Building:

i) Screw/Centrifugal type water chilling units: 2X100%
ii) Primary Chilled water pumps: 2X100%
iii) Secondary chilled water pumps (with VVVFD): 2X100%
iv) Condenser water pumps (with VVVFD) : 2X100%
v) Cooling Towers (with VVVFD Fan) : 2X100%
vi) All AHU's working & no standby AHU. AHUs shall be Variable frequency driven(VVVFD)

d) Administrative Building:

i) Screw/Centrifugal type water chilling units: 2X100%
ii) Primary Chilled water pumps: 2X100%
iii) Secondary chilled water pumps (with VVVFD): 2X100%
iv) Condenser water pumps (with VVVFD): 2X100%
v) Cooling Towers (with VVVFD Fan) : 2X100%
vi) All AHUs working & no standby AHU. AHUs shall be Variable frequency driven (VVVFD)

e) Water system control Room Building:-

i) Air / water cooled condensing unit/ Precision Air conditioners: 2X100%
ii) AHU : 2X100%.
iii) Condenser water pump :2X100%(If applicable).
iv) Cooling Towers(with VVVFD Fans):2X100%(If applicable)

f) Auditorium building:-

i) Air Cooled condensing units: - 2X50%

ii) AHU (with VVVFD): 2 X 50%

g) 100% standby shall be provided for area served by Precision/Cassette / Hi-wall Split type Air conditioners for all other offsite control rooms.

h) Fresh air fans shall be 1 x 100 % Capacity for each AHU room.

4.00.00 EQUIPMENT DESCRIPTION – AIR CONDITIONING SYSTEM

4.01.00 **Vapour compression type machines**

4.01.01 Each chilling unit shall comprise of compressor with drive motor, Condenser, Water Chiller/evaporator, and other accessories such as supporting structure, vibration isolators, insulation, pipings, valves, instrumentation, microprocessor / PLC based Control panel, etc. Chilling unit shall have **stepless** capacity control. The screw/centrifugal compressor based chilling unit to be supplied shall be ARI /Eurovent/Equivalent standard certified.

4.02.00 **Chilling Unit**

Type		Water-cooled type. (Chillers for main plant shall be with multiple compressors)
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor		
Type	:	Compressor shall be open/semi-hermetic/multiple hermetic in case of screw or centrifugal
Type of drive	:	Motor driven, through direct/V-belt along with Star delta/Double delta Starter.
Capacity	:	Minimum capacity shall be suitable for the identified/selected evaporating temperature and condensing temperature.
Condenser		
Type	:	Water cooled shell and tube type.
Fluid	:	Shell side – Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective compressor and to provide

		atleast 2 deg. C sub-cooling. To store full charge of refrigerant.
Design fouling Factor	:	Not less than 0.0002 (in MKS units)
Shell material	:	Mild steel (IS: 2062) / SA 106 Gr. B
Tube material	:	Replaceable seamless copper
Fin material		Copper
Accessories	:	As required such as Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, pressure & temperature indicators at inlet and outlet etc.
Refrigerant	:	The refrigerant shall be R-134a/R-410A/R-407C or any other environment friendly refrigerant.
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Inlet temperature		33 ° C.
Leaving temperature differential	:	Maximum 5 ° C.
Evaporator		
Type	:	Shell and tube type
Superheating of	:	At least 2 deg.C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective plant capacity.
Shell material	:	Mild steel (IS : 2062) / SA 106 Gr. B
Tube material		Plain tube internally /externally finned copper as per the manufacturer's standard practice.
Fin material	:	Integral
Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, electronic

expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame, etc.

Steel Structure : The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

4.03.00 **Condensing Unit (Air-Cooled/Water cooled D-X type)**

Condensing unit

Type : Air cooled type / Water cooled type

Vibration isolators : Steel spring / Neoprene rubber cushy foot type with isolation efficiency not less than 85%.

Compressor

Type : The Compressor shall be Screw/scroll, serviceable, either open type or hermatic type or semi-hermetic type with load, unload and automatic capacity control (minimum 3 steps).

Type of drive : Motor driven, direct or through V-belt.

Refrigerant : The refrigerant shall be R-134a/ R-410A/R-407C or any other environment friendly refrigerant.

Accessories : High/Low pressure cutouts, oil pressure switches, relief valves, pressure gauges at each stage, lube oil and control oil pressure gauges, suction & discharge stop valves, Muffler, Crank case heaters, oil filters, magnetic oil separators, temperature indicators for lube oil/heaters, oil level indicators, safety thermostat for crank case heater, vibration isolators, etc.

Motor Rating : 10% more than the power required by the compressor at 50 deg C design ambient temperature.

Capacity : Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated.

NOTE: Up to 50TR cap. Chilling/Condensing unit can be of air/water cooled type however, beyond this cap. unit shall be water cooled type only.

4.04.00 **Air Handling Unit (AHU)**

4.04.01 Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene

impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs.

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

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

4.04.04 Cooling coil shall be made of seamless copper tubes with aluminium fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.

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

4.04.06 **Centrifugal fan for AHU**

a)	Fan Type	:	Double Width Double Inlet (DWDI) Centrifugal Type
b)	Fan impeller	:	Backward curved blades
c)	Casing material	:	GI /Mild steel with minimum thickness of 3 mm.
d)	Impeller material	:	Carbon steel
e)	Shaft	:	EN 8 Steel
f)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
g)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.
h)	Drive	:	Motor driven with removable belt guard.

~~4.04.07~~ **~~Mixing Box:~~**

~~Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.~~

~~4.04.08~~ **~~Pan Humidifier:~~**

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

4.05.00 HI-WALL SPLIT/CASSETTE/PRECISION AIR-CONDITIONERS

4.05.01 Hi-wall Split/cassette air conditioners shall in general consist of the following:

i) Casing

ii) Hermetically sealed rotary/scroll Compressor

iii) Condenser

iv) Evaporator and condenser cooling fan

v) Cooling coil

vi) Filters

vii) Piping, valves, refrigerant strainer, etc.

viii) Controls, instruments, control panel/starter panels.

ix) Vibration isolator pads, etc as required.

x) Refrigerant as manufacturer's standard practice.

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

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

Unit shall have four way supply air grills on sides and return air grill in center.

Each unit shall have high lift drain pump and very low operating sound.

4.05.03

Precision Air-Conditioners

Precision air conditioning system shall be designed for high sensible heat ratio. The system shall contain scroll compressor, evaporator blower & coil, heater, humidifier, air-cooled condenser, externally equalized electronic expansion valve, etc. All items except condenser shall be contained with in the cabinet of the unit, which shall be placed inside room. Air-cooled condenser shall be installed outdoor.

i) Cabinet: The frame and panels shall be constructed of heavy gauge zinc-anneal corrosion resistant sheet steel. The fan section shall be insulated with fire-retarded insulation. The cabinet shall be powder coated and have a textured finish.

ii) Evaporator Coil: The unit shall be fitted with large surface area cooling coil with split coil mechanism/ or any other equivalent method for dehumidification. The distance between fins shall not be less than 1.8mm and face velocity shall not exceed 2.5 m/s.

iii) Compressor: Compressor shall be of high efficiency (EER should not be less than 3.5) scroll design and shall have inbuilt overloads. It shall be mounted on anti vibration mountings.

iv) Refrigeration circuit: The circuit shall be direct expansion type. It shall include a manual reset HP and auto reset LP switch, filter drier, charging port, electronic expansion valve, sight glass, etc.

v) The indoor unit shall have forward / backward curved centrifugal type double inlet double width statically and dynamically balanced fans. Fan shall be of electronically commutated type fan.

vi) Humidifier: Humidification shall be provided by boiling water in a polypropylene steam generator. The steam shall be distributed evenly into bypass air stream of precision air-conditioning unit. Humidifier shall be fitted with an auto flushed cycle activated on demand from the control system. Further, humidifier shall be fully serviceable with replaceable electrodes. Waste water shall be flushed from the humidifier by initiation of water supply solenoid valve.

vii) Filters- Filter chamber shall be integral part of the system & withdraw able from the unit. Filter shall be capable of filtering air to 95% down to 5 micron efficiency.

viii) Electrical heating: The heating circuit shall include dual safety protection through loss of air and high temperature controls.

ix) Air-cooled condensers: The equipments shall be designed for 45 deg C outside ambient condition. Low ambient refrigeration controls (LARC) shall also be available. The condenser frame shall be constructed from heavy duty galvanized steel and incorporate copper tube and aluminum fins. Controls: The standard controls shall be of microprocessor based programmable PID logic controller with dew point logic. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels.

xi) The Units shall be designed for 68 DBA at 1 meter from the unit outlet quiet operation with all moving parts mounted on anti-vibration mounting and carefully balanced to ensure minimum vibration.

xii) The refrigerant shall be R-407C/ R-134a/ R-410A or any other environment friendly refrigerant.

The controls shall have separate indications for

1) Various modes of operation (cooling, heating, humidifying and de-humidifying),

2) Alarm conditions (temperature high, wet floor and loss of air flow)

3) Graphical displays of set temperature & humidity and achieved temperature & humidity

4) Date, time and unit identification display.

5) Back up battery charge status display on the controller screen

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

7) 48 hrs temperature and humidity graph display menu

8) Programmable services interval indication display

The unit shall also incorporate the following protections:

- Single phasing preventors.
- Reverse phasing
- Phase misbalancing
- Phase failure
- Overload tripping (MPCB) of all components
- Overload and underload protection

4.06.00	**COOLING TOWERS (for chilling units)**		
4.06.01	Type	:	Induced draft, cross or counter flow.
4.06.02	Casing & Sump tank	:	F.R.P/G.R.P
4.06.03	Fan	:	Cast Aluminum / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
4.06.04	Fill	:	Non combustible PVC or equivalent

~~4.06.05~~	~~Louvers~~	~~:~~	~~F.R.P. /PVC/ Aluminum.~~
~~4.06.06~~	~~Nozzles~~	~~:~~	~~Brass with chrome plating / Polypropylene.~~
~~4.06.07~~	~~Eliminators~~	~~:~~	~~In removable sections to reduce the drift loss to 0.2% of water flow.~~
~~4.06.08~~	~~Supporting structure~~	~~:~~	~~Mild steel with spray galvanization or epoxy painting.~~
~~4.06.09~~	~~Strainer at water outlet~~	~~:~~	~~Plate strainer made of GI/SS wire mesh of 16 gauge.~~
~~4.06.10~~	~~Bird screen on top of tower~~	~~:~~	~~25 mm square made of GI/SS wire mesh of 16 gauge.~~
~~4.06.11~~	~~Distribution Pipe (if any)~~	~~:~~	~~Galvanised MS pipe.~~
~~4.06.12~~	~~Accessories~~	~~a)~~	~~Drain connection with isolation valve.~~
		~~b)~~	~~Make up connection with ball – float valve, back up gate valve and a bypass with a gate valve for manual operation.~~
		~~c)~~	~~Overflow connection.~~
		~~d)~~	~~Equalizing connection to connect sump of all the towers wherever applicable.~~
		~~e)~~	~~Access door in louvers/fan deck.~~

5.00.00 **Mandatory Requirements of ECBC to be followed for A/C Equipments of service building, Administrative building & Auditorium:**

5.01.00 **1. A. Coefficient of Performance (COP) (based on AHRI conditions) of the chiller (water cooled rotary screw and scroll chiller):**

As per ECBC codes minimum coefficient of performance (COP) for the chiller shall be as follows:

Sl.No.	Chiller capacity	Min COP
01.	Upto 150 TR	4.7
02.	≤ 150 TR < 300 TR	5.4
03.	≥300 TR	5.75

B. Coefficient of Performance (COP) (based on AHRI conditions) for air- cooled chillers:

Sl.No.	Chiller capacity	Min COP
01.	Upto 150 TR	2.9
02.	≥150 TR	3.05

2. Pumping System : Chilled water and condenser water pumping system should be of variable flow type i.e pumps should be VFD driven.

3. Variable air flow : AHUs should be of variable flow type i.e VFD driven.

4. Refrigerant : Refrigerant should be CFC/HCFC free.

5. Controls & Sensors : Sensors like occupancy sensors, CO2 sensors, daylight sensors etc. shall be provided for optimum use of A/C system.

6. Insulation for supply and return air ducts **:** Supply and return ducts shall be insulated.

7. All types of Insulation used for HVAC application shall be CFC/HCFC free.

~~**6.00.00**~~ ~~**BALANCE EQUIPMENT SPECIFICATION**~~

~~6.01.00~~ ~~**Centrifugal Pumps**~~

~~a) Type~~ : ~~Horizontal Centrifugal, Axially split type casing pump~~

~~b) Impeller~~ : ~~Closed type~~

~~c) Material of Construction~~

~~i) Casing~~ : ~~2% Ni Cast Iron : IS:210 Gr. FG-260~~

~~ii) Impeller~~ : ~~Bronze IS:318 Gr-2~~

~~iii) Wearing rings~~ : ~~Bronze~~

~~iv) Shaft~~ : ~~SS 316~~

~~v) Shaft sleeve~~ : ~~SS 316~~

~~vi) Lantern ring~~ : ~~Brass / Bronze~~

~~vii) Packing~~ : ~~Asbestos free~~

~~viii) Base Plate~~ : ~~Carbon steel as per IS:2062~~

ix) Speed : Maximum 1500 rpm

x) Other requirements : To refer to **Annexure-I** titled "Horizontal Pumps" of this sub section.

6.02.00 **Material of Construction for Piping & Fittings**

a) Piping for Chilled and Condenser water lines : Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 NB with thickness as indicated in **Annexure-II**

b) Refrigerant piping : : Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).

c) Drain piping : Same as (a) above & galvanized as per IS:4736.

d) Fittings :

1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above.

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

3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5

4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534.

5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5

6.03.00 **VALVES**

6.03.01 Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.

6.03.02 Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.

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

6.03.04 Valves shall be furnished with back seating arrangement for repacking while working under full working pressure.

6.03.05 Manual gear operators be provided for valves of size 200 NB and above.

6.03.06 All valves shall be supplied with companion flanges, nut, bolts & washers, etc.

6.03.07 The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.

6.03.08 All water line valves shall be of Cast Iron body for sizes 65 NB and above conforming to IS :14846 and Gun Metal construction for sizes less than 65NB conforming to IS:778. Cast Iron parts shall conform to IS:210 Gr FG 220. Butterfly valves shall confirm to latest revision of BS:5155 or equivalent standard of required class/rating.

6.03.09 Balancing / Controller Valves:

The valves of sizes 32 mm to 65 mm dia shall be of gun metal / cast iron construction with screwed ends angular design digital hand wheel with locking facility. Whereas valves of sizes 75 mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends.

6.04.00 **AIR FILTERS**

6.04.01 **Pre Filter**

1) Type : Flange / Cassette

2) Pre-filter shall contain washable non-woven synthetic fiber or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.

3) **Other requirements : (as applicable)**

   a) Suitable aluminium spacers be provided for uniform air flow;

   b) Casing shall be provided with neoprene sponge rubber sealing.

   c) Capable of being cleaned by water flushing.

   d) Density of filter medium shall increase in the direction of air flow in case of metallic filter.

   e) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.

4) **Efficiency :**

   Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76 / EN-779.

5) Minimum thickness : 50 mm

	6)	Face Velocity	:	Not more than 2.5 m/sec.
	7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
	8)	Location	:	a) At the suction of each AHUs : b) At the suction of each Fresh air fan : c) At the suction of each Supply air fan d) At the suction of each Air washer and UAF (water repellent nylon type).
6.04.02	**Fine Filters (Microvee type)**			
	1)	Type	:	Flange / Cassette
	2)	Fine filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.		
	3)	Other requirements	:	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing. c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
	4)	Efficiency	:	Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE–52-76 / EN-779.
	5)	Minimum thickness	:	150 mm or 300 mm.
	6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
	7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.
	8)	Location	:	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air fan. iii) At the discharge of each supply air fan having static pressure 30mm wc or more.

6.04.03 **Absolute Filter / Hepa Filter**

1)	Media	:	100% sub-microscopic glass fibers.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
4)	Efficiency	:	99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B.
5)	Minimum thickness	:	300 mm
6)	Face Velocity	:	Not more than 1.2 m/sec.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 25 mm WC at rated flow; Final pressure drop - Up to 75 mm WC.
8)	Location	:	At the discharge of each individual AHUs with static pressure of 125mmwc or more.

~~6.05.00~~ ~~**LOW PRESSURE AIR DISTRIBUTION SYSTEM**~~

~~6.05.01~~ ~~Material of air distribution system shall be through galvanized steel sheet (Conforming to Class 275 of IS :277) or Aluminium alloy (grade 19000 / SIC or 3100 / NS3 of IS:737)~~

~~6.05.02~~ ~~**Thickness of rectangular ducts shall be as follows :**~~

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

6.05.03 **Thickness of round ducts shall be as follows :**

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

6.05.04 **Duct Fabrication and Supports:**

a) Duct fabrication shall be as per the latest relevant BIS/SMACNA standard.

b) Ducts for A/C system may be site fabricated or factory fabricated and installed at site. However, in case of partly used factory fabricated ducts, vendor shall take back the unused ducts.

c) The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns as provided by the Employer with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder.

d) Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass.

e) All curves, bends, off-sets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.

f) Wherever duct passes through a wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space.

g) Wherever pipe hangers or rods pass through the ducts, light and streamline easement around the same shall be provided to maintain smooth flow of air.

h) Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.

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

6.06.00 **Factory fabricated ducts:**

i) All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I.

ii) Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

iii) All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply:

a. Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

b. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

c. All edges to be machine treated using lock formers, flangers and roll-bending for turning up edges.

d. Sealant dispensing equipment should be used for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for the ducts over 2" w.g. static pressure

iv) All transverse connectors shall be 4-bolt slip-on flange system with built-in sealant, if any. To avoid any leakage additional sealant shall be used.

6.07.00	**Diffusers, Grills & Dampers :**
6.07.01	Supply air diffusers/grills with factory fitted volume control dampers be provided for all air-conditioned areas.
6.07.02	Return air diffusers of air conditioned areas shall be without volume control dampers.
6.07.03	The diffusers/grills shall be of extruded Aluminum of minimum 2 mm thick with powder coating. The colour of power coating shall be as per the interior Décor.
6.07.04	Supply air grills shall be of double deflection type and return air grills shall be of single deflection type.
6.07.05	The nozzle type diffusers shall be fabricated from minimum 1.5mm aluminium sheet. The base shall be fixed type. The nozzle shall be of volute design with the spout diameter being half the base dia. and designed for low noise and long throw. The nozzle shall be able to rotate to any angle within the base. The whole assembly shall be powder coated as per interior decor.
6.07.06	All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.
6.07.07	The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.
6.07.08	Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of Baffles wherever required shall also be provided.
6.07.09	Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.
6.07.10	All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames,
6.07.11	All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.
6.08.00	**Thermal and Acoustic Insulation**
6.08.01	**Application**
	(a.) All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products or Equivalent) be applied @ 1.5 Kg /Sqm on the surface.
	(b.) Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber or Equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen.
	(c.) Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.

(d.) Insulation Finish of types specified under shall be provided thereafter.

6.08.02 **Type of Insulation & Finish**

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
1.	Supply & return air duct of A/C System	Resin bonded glass wool or Closed Cell Elastomeric Nitrile Rubber	Roll /Slab sheet	50 19	F-3 As per manufacturer std.
2.	Refrigerant (Suction and liquid lines)	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
3.	AHU drain pipe	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
4.	AHU condensate pan (insulation if required)	Mineral wool or resin bonded glass wool	Slab	25	As per manufacturer std.
5.	Chilled water piping, valves & specialties	Resin bonded Mineral wool or resin bonded glass wool	Pipe section	75	F-1
6.	Chiller (insulation if required)	---------- As per manufacturer std. ----------			
7.	Chilled water pumps	Resin bonded Mineral wool or resin bonded glass wool	Slab	50	F-1
8.	Expansion tank with associated piping	Resin bonded Mineral wool or resin bonded glass wool	Slab/ Pipe section	50	F-1
9.	Acoustic insulation of duct	Resin bonded Glass wool	Slab	25	As per specifications

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
10.	Exposed air duct	Resin bonded Glass wool	Roll	50	F-4

6.08.03 Specification for insulation shall be as follows: -

Insulation Material	Code	Thermal conductivity (w/m/^{o}C)	Density Kg/m^3
Resin bonded glass wool	IS:8183	0.049 at 50^{o}C	i) 24 (For thermal insulation) ii) 48(For acoustic insulation)
Mineral wool pipe sectic Min.Gr.2	IS:9842	0.043 at 50^{o}C	144
Closed Cell Elastomeric Nitrile Rubber		0.036 at 20^{o}C	60-70

Note : Insulation used for HVAC application shall be CFC/HCFC free

6.08.04 The specification for various finishes shall be as follows

a) **Finish F-1**

Step-1 Wrapping of Poly-Bonded Hessain (PBH – to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.

Step-2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.

Step-3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.

b) **Finish F-2**

Step-1 Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.

Step-2 Same as Step-2 of Finish F-1 above.

Step-3 Same as Step-3 of Finish F-1 above.

c) **Finish F-3**

Step-1 Same as Step-1 of Finish F-2 above

Step-2 The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.

d) **Finish F-4**

Step-1 Same as Step-1 of Finish F-1 above.

Step-2 Same as Step-2 of Finish F-1 above.

Step-3 Same as Step-3 of Finish F-1 above.

Step-4 Application of 3 mm thick coat of water proofing compound "SHALIKOTE 30" or Equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound "SHALIKOTE 30" or Equivalent over the RP tissue.

Step-5 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface.

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

6.08.06 **ACOUSTIC INSULATION**

a) All ducts up to a distance of 5 meters from AHU shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M. density and 30 gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre-to-centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.

b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be inline with the requirements specified above.

7.00.00	**PLANT CONTROL**
7.01.00	Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from employer. The descriptions in the sub-sections of the control & instrument sections shall also be referred to
7.02.00	**Control Scheme for Air-Conditioning System**
7.02.01	All the functional requirements specified below and general control logic specified under this section shall be implemented in the respective control system.
7.02.02	The basic function of the system shall be to closely control and monitor temperature and humidity conditions inside the air-conditioned spaces, to optimize / minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour /day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating /deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and inside room temperature and humidity of CR, CER, ESP control room, UPS and Battery Charger room shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For Service building & Administrative building inside room temperature and humidity shall be maintained by varying the chilled water flow of secondary chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For sequential operation/duty cycling, Programmed startup/stop of individual AHU's, pumps and cooling towers as per operating requirements and inside room temperature and humidity.
7.02.03	The operation of each Air Conditioning system shall be possible through Microprocessor based dedicated controllers to be provided by Contractor for each Screw /centrifugal Chiller units with local start / stop & indication for main plant A/C system in addition to Main DDCMIS based Control system of A/C plant (provided by contractor) for Main plant area, ESP control room and water system control room. Further these microprocessor based control panels of Chiller units shall be suitably interfaced with DDCMIS based Control panels.
7.03.00	**Water Chilling Plant Control**
7.03.01	Microprocessor based controls shall be provided as per manufacturer's standard practice along with facilities to interface with control system and to meet the requirement of all system operations and controls. Water chilling unit control system shall be designed to have a constant chilled water outlet temperature from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve

	and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high water temperature set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically through cylinder "load-unload" mechanism activated through the suction pressure or return chilled water temperature.
7.03.02	Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve which gets its impulse from temperature element connected with suction line after chiller outlet.
7.03.03	High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.
7.03.04	Facility toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).
7.03.05	Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.
7.03.06	Provision shall also be made for the manual restarting of the compressor.
7.03.07	On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to simultaneously trip the compressor.
7.03.08	Compressor starting/running shall be interlocked with the low / adequate flow at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition, closure or open status of various valves shall be used for interlock, alarm and control of Air Conditioning System.
7.03.09	Condenser water pumps shall be interlocked with the low - level switch in each cooling tower sump and operation of cooling tower fans. High level in the cooling tower shall be annunciated in the panel by means of a separate level switch.
7.03.10	The standby condenser water pumps, standby chilled water pumps, standby fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/ Manual selecting and working/ standby selecting facility for the pumps/ AHU/ fresh air fan shall be provided.
7.03.11	Closure of fire dampers shall raise an alarm in the system.
7.03.12	There shall be provision for temperature and flow measurement in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.
7.03.13	Operation of air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling tower at inlet to the condenser. Status

indication of condenser water pumps and associated cooling towers shall be provided in the control panel of air conditioning plant.

7.04.00 **Air Handling Unit**

a) Inside room temperature and humidity shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve and by varying the flow by means of VFD driven AHU's which shall get its signal from the Control system for main plant A/C system. For Service building & Administrative building inside room temperature and humidity shall be controlled by varying the chilled water flow of secondary chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor.

b) Humidy sensor and gyserstat located in the return air duct shall actuate the PAN humidifier to obtain the desired degree of humidification.

c) Humidity and temp. sensor shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

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

e) AHU shall be started either locally or from the main control room of AC system by means of Remote / Manual selection facility.

f) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Fire Detection System.

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

7.05.00 **D-X Air-Conditioning System**

a) The control and interlocks described above for water chilling plants are applicable for this system also.

b) Further the compressor starting/running shall be interlocked with the flow switches in condenser water circuit and as well as with AHU motors.

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

7.06.00 **Cassette /Hi-wall Split Air Conditioners**

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

7.07.00	**General** a) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of A/C system. b) Status shall be provided of each pump, compressor, fans etc. of A/C system and Ventilation system on HMI system at control room. c) All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC, AWU etc.. d) The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally. e) Relative humidity and temperature measurement of all control rooms and CERs, ESP control room and all major air-conditioned areas shall be available in DDCMIS. Relative humidity and temp. measurement for main plant control room and CERs to be available in multiple numbers. f) Vibration and Noise level of screw chillers, condensing units, pumps with motor, AHU fans with motor, cooling tower fans with motor shall be measured during PG Test. Permissible limit of vibration for pumps shall be 75 micron peak to peak. For fans / screw chillers/condensing units, the same shall be in line with VDI-2056 Group T machines (maximum vibration level 7.1 mm/sec r.m.s). The maximum noise level shall be 85 dBA at 1.5 meter elevation and at a horizontal distance of 1 meter from the equipment.
8.00.00	**PAINTING:**
8.01.00	All the Equipments shall be protected against external corrosion by providing suitable painting.
8.02.00	The surfaces of stainless steel, Galvanized steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting, etc. as per the agreed procedure.
8.03.00	For all the steel surfaces (external) exposed to atmosphere (outdoor installation), one(1) coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied.
8.04.00	For all the steel surfaces inside the building (indoor installation), One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat shall be applied.

8.05.00	For centrifugal fans - Casing shall have hot dip/ spray galvanization (**minimum** 60 micron DFT).
9.00.00	**CODES & STANDARDS**
9.01.00	The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.
9.02.00	Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

Annexure –I

GENERAL SPECIFICATION FOR HORIZONTAL PUMPS

1) **SCOPE**

This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2) **CODES AND STANDARDS**

The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

3) List of Applicable Standards.

IS : 1520	: Horizontal Centrifugal Pumps for clear cold fresh water
IS : 5120	: Technical requirements of rotodynamic special purpose pumps
API : 610	: Centrifugal pumps for general refinery service.
IS : 5639	: Pumps Handling Chemicals & corrosion liquids
IS : 5659	: Pumps for process water
HIS	: Hydraulic Institute Standards, USA
ASTM-1-165-65	Standards Methods for Liquid Penetration Inspection.

In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

4) **DESIGN REQUIREMENTS**

a) The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve. The operating range of the pump shall be 40% to 120% of the duty point unless otherwise mentioned elsewhere. The maximum efficiency of pump shall preferably be within ± 10% of the rated design flow as indicated in data sheets.

Annexure –I

b) The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of about 15% more than the design head.

c) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

d) Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

Speed	Antifriction Bearing	Sleeve Bearing
1500 rpm and below	75.0 micron	75.0 micron
3000 rpm	50.0 micron	65.0 micron

The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment surface.

e) The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

f) The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

g) Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

h) The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

5) **DESIGN CONSTRUCTION**

a) Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.

Annexure –I

b) **Pump Casing**

Pump casing shall have axially or radially split type construction as specified. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

c) **Impeller**

Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled.

The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

d) **Impeller/Casing Wearing Rings**

Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

e) **Shaft**

The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

f) **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

Annexure –I

g) **Bearings**

Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 20,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

h) **Stuffing Boxes**

Stuffing box design should permit replacement of packing without removing any part other than the gland.

Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

i) **Mechanical Seals**

Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

j) The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

Annexure –I

k) **Pump Shaft Motor Shaft Coupling**

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

l) **Base Plate**

A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

m) **Assembly and Dismantling**

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

n) **Drive Motor (Prime Mover)**

The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

ANNEXURE-II

PIPING THICKNESS: Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The final thickness shall not be less then that specified as per IS: 3589 as indicated below.

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

SECTION-3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.0 GENERAL

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

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

3.1 PROJECT DETAILS

Sl. No.	Particular	Details
a)	Customer	NTPC Ltd.
b)	Engineer/Consultant/ Inspector	NTPC Ltd.
c)	Project Title	North Karanpura Super Thermal Power Project (3x660 MW) : 400/220kV Switchyard at NKSTPP end & 220kV Sub-station at Mine end
d)	Project Location	Place: Near Tandwa town District: Hazaribagh & Chatra State: Jharkhand
e)	Latitude & Longitude	**400/220kV S/s at NKSTPP:** North: 23°50' to 23°52' and East: 84°59' to 85°2' **220kV S/s at Chatti Bariatu & Kerandari-A mine:** North: 23°52'35" and East: 85°05'25"
f)	Nearest Railway Station	Khalari Railway Station Ranchi - Garhwa section of Eastern Railways
g)	Distance of project location from the Railway station	40 Km (approx.)
h)	Nearest Major Town	Hazaribagh city
i)	Distance of the town from the project site	50 Km.

j)	Nearest commercial airport	Ranchi
k)	Distance of airport from the project site	150 Km
	SITE CONDITIONS (for design purposes)	
a)	Design ambient temperature	50°C
b)	Maximum Relative humidity	95 %
c)	Height above mean sea level	Less than 1000 meters
d)	Pollution Severity	Heavily polluted (With Coal dust & Fly ash) and Highly Corrosive environment.
e)	Criteria for Wind Resistant design of structures and equipment	Standard Applicable - IS 875 (Part 3) 1987
f)	Basic Wind speed "Vb" at ten meters above the mean ground level.	39 m/ sec
g)	Category of terrain	Cat –2
h)	Risk Coefficient "K1"	1.06

3.1.1 **AUXILIARY POWER:**

Sl.No.	Nominal Connection Voltage	Variations in Voltage	Frequency	Phase	Neutral
1	415V	±10%	50 (+3% -5%)	3Phase , 4 Wire	Solidly Earthed
2	240V	±10%	50 (+3% -5%)	1 phase	Solidly Earthed

Combined variation of voltage and frequency shall be + 10%. Design fault level of 415V system shall be restricted to 50kA rms for 1 second.

The operational limits for variation of DC voltage are (+) 10% to (-) 15%.

3.2 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 recognized that the bidders may have standardized 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. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Except for lighting fixtures, wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition. For lighting fixtures, makes shall be as defined in Section-Lighting System.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

3.3 CODES AND STANDARDS

The supplier is required to follow local statutory regulations stipulated in the latest amended Electricity Supply Act 1948 and Indian Electricity Rules 1956 (latest), and other local rules and regulations.

The equipment to be furnished under this specification shall conform to latest issue with all amendments of standards and/ or codes specified under respective section heads. The standards mentioned in the specification are not mutually exclusive or complete in them, but intended to complement each other. The supplier shall also note that list of standards presented in this specification is not complete. Whenever necessary the list standards shall be considered in conjunction with specific IS/IEC. When the specified requirements stipulated in

the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards which ensure equivalent or better performance that specified in the standards referred under section shall also be acceptable.

In case governing standards for the equivalent for the equipment is different from IS/ IEC, the salient points of difference shall be clearly brought out in additional information schedule along with English language version of standard of relevant extract of the same. The equipment conforming to standards other than IS/ IEC shall be subject to Purchaser's approval.

The full names of the codes and standards mentioned in abbreviations under various equipment heads are as follows:

BS	British Standards
IEC/ CISPR	International Electro-technical Commission
IS	Bureau of Indian Standards
ISO	International Organization for Standards
NEMA	National Electric Manufacturers Association

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions. All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (not applicable for this project) short circuit etc for the equipment .

The equipment shall also comply with the following:

a) All equipments shall be suitable for hot line washing.
b) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
c) Piping, if any, between equipment control cabinet or operating mechanism to marshalling box of the equipment shall bear proper identification to facilitate the connection at site.
d) All equipment shall be supplied with necessary inter-pole cabling, and its cost shall be included in the cost of equipment.

3.5 ENGINEERING DATA

3.5.1 Drawings

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

Each drawing submitted by the Contractor (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

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

The review of these data by the purchaser will cover only general conformance of the data to the specification and documents, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect plan layout. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the purchaser shall not be considered by the contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

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

All engineering data submitted by the contractor after final process including review and approval by the purchaser shall form part of the contract document and the entire work performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the purchaser in writing.

3.5.2 Approval Procedure

The following procedure for submission and review/approval of the drawings, data, reports, information, etc. shall be followed by Contractor:

a. All data/information furnished by Vendor in the form of drawings, documents, Catalogues or in any other form for NTPC's information/interface and/or review and approval are referred by the general term "drawings".

b. The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

c. All drawings (including those of sub vendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his sub vendor along with his purchase order for sub vendor's compliance.

d. Contractor shall submit all the drawings in five (5) copies for review of Employer. Employer shall forward their comments within four (4) weeks of receipt of drawings.

e. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	pproved
CATEGORY II	Approved subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

f. Contractor shall resubmit the drawings approved under Category II, III within one (1) week of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g. 1.2.3. etc.).

g. In case Contractor does not agree with any specific comment, he shall furnish the explanation for the same to Employer consideration. In all such cases Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

h. It is the responsibility of the Contractor to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

i. Contractor shall not make any changes in the portion of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawings identifying the changes (along with reasons for changes) for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

j. Approval of drawings will not in any way relieve the Contractor of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

3.5.3 Erection Drawings.

a. Contractor shall furnish erection drawings for the guidance or commencement of erection or the first shipment, whichever is earlier. These shall generally comprise of fabrication/assembly drawings, various component/part details drawing, assembly, clearance data requirements, etc. The drawings shall contain details of components/ equipment with identification number, match marks, bill of materials, assembly procedures etc.

b. For all major equipment apart from above details, assembly sequence and instructions with check-lists shall be furnished in the form of erection manuals.

3.5.4 Instruction Manual

a. The Contractor shall submit to the Employer preliminary instruction manuals for all the equipment for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least sixty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipments, the transportation, storage, installation, testing, operation and maintenance procedures, etc. separately for each component/equipment along with log record format. These instruction manuals shall be submitted in five (5) copies for approval.

b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall being corporate and the updated final instruction manuals shall be submitted.

c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.

d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together will all relevant pamphlets.

e. The manuals shall include the following

   a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.

   b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

f. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.

g. A collection of the manufacturer's standard leaflets will not accepted to be taken as a compliance of this clause. The manual shall be specifically compiled for the concerned project.

3.5.5 Final Submission of drawings and documents:

The Contractor shall furnish the following after approval of all drawings /documents and test reports:

a. List of drawings bearing the Employer's and Contractor's drawing number.
b. Two (2) bound sets along with 4 CD-ROMs of all drawing.
c. All documents/designs in two (2) copies as noted above.
d. Contractor shall also furnish six (6) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Contractor shall also furnish two (2) sets of CD-ROMs/ DVD/Portable hard disk of all as-built drawings as decided by the Employer.
e. The Contractor shall also furnish four (4) copies of instruction/ operations & maintenance manuals (after approval) for all the equipment.

3.5.6 TEST REPORTS

Two (2) copies of all test reports shall be supplied for approval before shipment of Equipment. The report shall indicate clearly the standard value specified for each test to

facilitate checking of the reports. After final approval six (6) bound copies of all type and routine test reports shall be submitted to Employer.

3.5.7 MATERIAL /WORKMANSHIP

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential 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 purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

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. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the 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 also be interchangeable 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.
The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

3.6 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment

favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

Ventilation opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

Degree of Protection

The enclosure of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a. Installed outdoor: IP- 55
b. Installed indoor in air conditioned area: IP-31
c. Installed in covered area: IP-52
d. Installed indoor in non air -conditioned area where possibility of entry of water is limited: IP-41.
e. For LT Switchgear (AC & DC distribution Boards) : IP-52

The degree of protection shall be in accordance with IS: 13947 (Part –I) / IEC-947 (Part-I) / IS 12063/IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

PRESERVATIVE SHOP COATING

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification.

Transformers and other electrical equipment, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.
Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature

primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.

3.7 RATING PLATES, NAME PLATES AND LABELS

3.7.1 Each equipment shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.

3.7.2 Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.

3.7.3 The rated current, extended current rating and rated thermal current shall be clearly indicated in the name plate in case of current transformer.

3.7.4 Rated voltage, voltage factor and intermediate voltage shall be clearly indicated on the nameplate in case of capacitor voltage transformer.

3.7.5 Each switch shall a clear inscription identifying its function. Switches shall also have a clear inscription of each position indication.

3.7.6 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

3.7.7 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

3.8 GALVANISING:

3.8.1 The galvanised surface shall consist of a continuous film adhering to the steel. The finished surface shall be clean and smooth, and shall be free from defects like dissolved patches, base, spot, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects shall render the material liable to rejection.

3.8.2 All exposed ferrous parts shall be hot dip galvanised as per IS:2629 & IS:2633, Galvanising shall be uniform, smooth continuous and free from acid spots. Should the galvanising of the sample be found defective, the entire batch of steel shall have to be re-galvanised at Contractor's cost. The amount of zinc deposit shall be not less than 610 gms. per sq.m. of

surface area and in addition, the thickness of zinc at any spot shall not be less than 85 microns. The Employer reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument acceptable to Employer and reject any component which shows thickness of zinc at any location less than 85 microns. The testing on the galvanised materials shall be carried out as per IS: 2633.

3.8.3 The amount of zinc deposit over threaded portion of the bolts, nuts and screws shall not be less than 300 gms. per sq. meter of surface area. The amount of zinc deposit on washers shall not be less than 340 gms. per sq. meter of surface area. The threads having extra deposit of zinc shall be removed by die cutting after the completion of galvanising. The removal of extra zinc shall be carefully done so that threads shall have minimum deposits of zinc on them as specified.

3.9 PAINTING

Unless explicitly stated in relevant chapters of the specification, the painting of all electrical equipment shall be as follows:
Epoxy based with suitable additives. The thickness of finish coat shall be minimum 50 microns (minimum total DFT shall be 100 microns). However in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 50 microns shall be acceptable for finish coat. Paint shade shall be as per technical specification.

3.10 QUALITY ASSURANCE PROGRAMME

3.10.1 The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS- 14001.

A quality assurance programme of the contractor shall generally cover the following:

i. His organisation structure for the management and implementation of the proposed quality assurance programme
ii. Quality System Manual
iii. Design Control System
iv. Documentation Data Control System
v. Qualification data for Bidder's key Personnel.
vi. The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

vii. System for shop manufacturing and site erection controls including process, fabrication and assembly.
viii. Control of non-conforming items and system for corrective actions and resolution of deviations.
ix. Inspection and test procedure both for manufacture and field activities.
x. Control of calibration and testing of measuring testing equipments.
xi. System for Quality Audits.
xii. System for identification and appraisal of inspection status.
xiii. System for authorising release of manufactured product to the Employer.
xiv. System for handling storage and delivery.
xv. System for maintenance of records, and
xvi. Furnishing quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed as Annexure-I.

3.11 GENERAL REQUIREMENTS - QUALITY ASSURANCE

3.11.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.

3.11.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.

3.11.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control Organisation, during various stages of site activities starting from receipt of materials/equipment at site.

3.11.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.

3.11.5 These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

3.11.6 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of MDCC.

3.11.7 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

3.11.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.

3.11.9 All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.

3.11.10 All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.

3.11.11 Test results or qualification tests and specimen testing shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

3.11.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/ systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.

3.11.13 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

3.11.14 No welding shall be carried out on cast iron components for repair.

3.11.15 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

3.11.16 All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 50mm shall be ultrasonically tested.

The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the subcontractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified subcontractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

3.11.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the

suppliers. The quality plans called for from the subcontractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc.

3.11.18 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub vendor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

3.11.19 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractors and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

3.11.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

3.11.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

3.11.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

3.11.23 Environmental Stress Screening

1. All solid state electronic system / equipment / sub assembly shall be free from infant motile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following.

2. The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

Or

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

Burn In Test Cycle

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

3.12 QUALITY ASSURANCE DOCUMENTS

The Contractor shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identified in respective quality plan with tick (√) mark.

Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-ROM may be issued not later than three weeks.

3.12.1 Typical contents of Quality Assurance Document are as below:-

i) Quality Plan,
ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
iv) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
v) Heat Treatment Certificate/Record (Time- temperature Chart)
vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.
viii) Certificate of Conformance (COC) whoever applicable.
ix) MDCC

3.12.2 Similarly, the contractor shall be required to submit two hard copies and two sets on CD ROM of Quality Assurance Documents (in line with above) pertaining to field

activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

3.12.3 Before dispatch/ commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory. The Inspector shall stamp the quality document (or applicable section) for release.
ii) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing finalizing the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
i) If a decision is made for dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

3.13 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer after the delivery date for the corresponding equipment. One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site.
For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 1 month after the date of the last delivery similarly as stated above.

3.14 INSPECTION, TESTING & INSPECTION CERTIFICATE

3.14.1 The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

3.14.2 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

3.14.3 The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

3.14.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

3.14.5 When the factory tests have been completed at the Contractor's or subcontractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

3.14.6 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give

facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

3.14.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

3.14.8 To facilitate advance planning of inspection in addition to giving inspection notice, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

3.14.9 All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.

3.15 PACKAGING & TRANSPORTATION

Items shall be packed & dispatched separately to respective sites i.e. to 400/220kV S/s at NKSTPP end & to 220kV S/s at Chatti Bariatu & Kerandari-A mine end.

3.15.1 Packing, Marking and shipping

The packing and shipping shall be carried out in accordance with the standard practice of Contractor and with the following additional requirements:

a) The equipment shall be prepared in such a manner as to protect the equipment from damage or deterioration during shipping or storage. The shipments can be exposed to heavy rains, hot sun, high humidity and sudden extreme changes of temperature. The equipment shall be packed and shipped so as to protect it from all such conditions and any other abnormal conditions, generally expected during shipping & storage.

b) The metallic containers, if any, shall be considered as the property of the Contractor and he will be allowed to remove them from site once the contents are unpacked, inspected, documented and placed in temporary storage or in final position.

c) The equipment shall be shipped in such a manner as to facilitate unloading, handling and storage enroute and at the site. The Contractor shall provide lifting

lugs and special lifting devices for proper handling and erection.

d) The Contractor shall be liable for any damage or loss resulting due to careless, improper, poor or insufficient packing and handling.

e) Spare parts and spare equipment shall be packed separately in containers adequate for long term storage, plainly marked “Spare Parts Only”. They shall be crated individually or in kits to be used in one single renewal or overhaul operation. Other spare part kits shall not be disturbed when using one set or kit.

f) The Contractor shall at all times protect and preserve from damage, loss, corrosion and all other forms of damage, all parts of the works.

3.15.2 Transportation

a) The Contractor shall make a careful examination of access rail/roadways to the site in order to confirm the practical maximum transport weight and dimensions as well as a careful examination of the ports of disembarkation particularly with respect to the capacity of the cranes installed and access roads.

b) All instruments and computer/microprocessor based equipment imported into India from overseas for the purpose of this contract shall be air freighted to the nearest possible point and further by rail/road taking due precautions as per manufacturer’s recommendations. Employer shall have the right to decide the items that should be air freighted and Employer’s decision shall be binding on Contractor.

3.15.3 Insurance

a) The Contractor shall insure all shipments and works at his own expense for not less than the full replacement cost plus any additional cost for accelerated manufacturing of the replacement parts.

b) Loss or the damage to equipment during shipping or transportation to the site(s) or otherwise shall not constitute groups for claims for extension in time or for extra payment.

3.16 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

3.16.1 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS: 617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.

3.16.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

3.16.3 Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

3.16.4 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

3.16.5 They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

3.16.6 Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

3.16.7 Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.

3.17 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS

3.17.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS: / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.
Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

3.17.2 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.

3.17.3 Glazing of the porcelain shall be uniform brown in colour, free form blisters, burns and other similar defects.

3.17.4 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.

3.17.5 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

3.17.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

3.17.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.17.8 Insulator shall also meet requirement of IEC - 815 as applicable, having alternate long & short sheds.

3.18 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT.

3.18.1 All types of control cabinets, junction boxes, marshalling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC:439 as applicable.

3.18.2 **Mechanism Box/ Control Cabinet/ Kiosks:** A sheet steel (atleast 2.5 mm thick), dust and vermin proof M.Box/CCC/CMB shall be provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber.

Painting of boxes shall be as follows,

- External surface : Chemical resistant epoxy zinc phosphate primer, MIO (Miscellaneous iron oxide) as intermediate paint followed by polyurethane finish paint **(RAL 5012 Blue)**

- Internal surface : Chemical resistant epoxy zinc phosphate primer followed by chemical & heat resistant **epoxy enamel white paint**.

3.18.3 **Junction Boxes:** The junction boxes shall be made of minimum 2 mm thick sheet steel. Gland plates shall be removable type and made of 3 mm thick sheet steel. The boxes shall be provided with detachable cover or hinged door with captive screws. Top of the box shall be arranged to slope towards the rear of the box. The box shall be **hot dip galvanised** and shall be provided with suitable neoprene gaskets to achieve requisite degree of protection. Adequate spacing shall be provided to terminate the external cables. The boxes shall be suitable for mounting on various types of steel structures. The terminal blocks provided shall be of 650 V grade, rated for 10 A for control cables. Suitable numbering for terminal blocks shall be done. In case of junction box for power cable, the box shall be rated for maximum current carrying capacity. Terminal blocks shall be of one piece, Klippon RSF-1 or ELMEX CSLT-1 type with insulating barriers.

3.18.4 The cabinets/boxes/kiosks/panels shall be free standing or wall mounting or pedestal mounting type. They shall have hinged doors with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets.

3.18.5 The degree of protection of all the outdoor boxes shall not be less than IP 55 as per IS 2147.

3.18.6 The cable entry shall be from bottom, for which removable gasketed cable gland plates shall be provided.

3.18.7 Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.

3.18.8 The size of enclosure and the layout of equipment inside shall provide generous clearances. Each cabinet/box/kiosk/panel shall be provided with a 15A, 240V ac, 2 pole, 3 pin industrial grade receptacle with switch. For incoming supply, MCB of suitable rating shall be provided. Illumination of each compartment shall be with door operated incandescent lamp. All control switches shall be of rotary switch type.

3.18.9 Each cabinet/box/kiosk/panel shall be provided with two earthing pads to receive 75mm x 12mm GS flat. The connection shall be bolted type with two bolts per pad. The hinged door shall be connected to body using flexible wire. The cabinets/boxes/kiosks/panels shall also be provided with danger plate, and internal

wiring diagram pasted on inside of the door. The front label shall be on a 3mm thick plastic plate with white letters engraved on black background

3.19 Wiring

3.19.1 All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:

a) All circuits except CT circuits 2.5 sq.mm

b) CT circuits 4 sq. mm (minimum number of strands shall be 3 per conductor).

3.19.2 All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

3.19.3 Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.

3.19.4 All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

3.19.5 All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Interpol cabling for all equipment's shall be carried out by the Contractor.

3.20 CABLE GLANDS AND LUGS

3.20.1 Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.

3.20.2 The cable glands shall be tested as per BS: 6121. The cable glands shall also be duly tested for dust proof and weather proof termination.

3.20.3 Cables lugs for power cables shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminium or copper conductor (as

applicable). Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipment. The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

3.4 CONDUITS, PIPES AND ACCESSORIES

3.4.1 The bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.

3.4.2 Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/ pipes shall be of a reputed make.

3.4.3 Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

3.5 TYPE, ROUTINE & ACCEPTANCE TESTS:

All equipment to be supplied shall be of type tested design. During contract stage, bidder shall submit for Owner's approval the reports of all the type tests listed in this specification and carried out within last ten years from the date **28.11.2013**. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have be witnessed by a client.

However if contractor is not able to submit report of the type tests conducted within ten years from the date **28.11.2013** or in the case of type test reports are not found to be meeting the specification requirements, the bidder shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

SECTION-4

ENGINEERING DRAWINGS & DOCUMENTS

DOCUMENT SCHEDULE – TO BE SUBMITTED DURING DETAILED ENGG.

S N	DRAWING/ DATA SHEET DESCRIPTION	NTPC DRAWING / DATA SHEET NO.	SUBMISSION DATE	BHEL ACCEPTED SUBMISSION DATE
A	**TECHNICAL DATA SHEET**			
1	D.S. For Cassette AC units			
2	D.S. For Pre-filter & Fine filter			
3	D.S. For Supply Air Fans			
4	D.S. For Exhaust Fans			
5	Ventilation Fans Calculation			
6	BOQ - HVAC System			
7	PG Test Procedure			
B	**DRAWINGS**			
1	Cassette AC Layout for Control building			
C	**OTHER DOCUMENTS**			
1	Cable Schedule (with cable lengths)			
2	Electrical Load List			

Drawing/ Data sheet nos. will be provided to the vendor shall be provided during detailed engg. stage.

Signature of the authorized representative of Bidder

Name _____

Designation_____

Place_____

Date _____

Company Seal

SECTION-5

SCHEDULES TO BE FILLED BY THE BIDDER

Schedule 1 Certificate of No deviation

Schedule 2 Schedule of unpriced quote

Schedule 3 Details of contact person both technical and commercial

Schedule 4 Enclosures to Specification

SCHEDULE-1

CERTIFICATE OF NO DEVIATION

We confirm that there are no deviations whatsoever and our offer is in full compliance with the specification. We also confirm that there are no deviations in any other form such as comments, variations/ GTP and/ or exceptions.

Signature of the authorized representative of Bidder

Name :

Designation :

Place :

Date :

Company Seal

SCHEDULE-2

Bidders shall attach signed and stamped **unpriced** copy of this BOQ with their technical offer:

Sl. No.	Item Description	Unit	Qty	Whether Unit rates have been furnished in price bid	
				Supply	ETC
1.	Cassette AC unit of 4 TR capacity along with copper refrigerant piping as per clause ref 2. Sec-1 of Technical Specification.	Nos.	19	YES	YES
2.	8000 CMH @ 30 mm WC Axial flow supply air fan complete with pre-filters, fine filter, bird screen, rain protection cowl, gravity louver and mounting accessories etc. for LT Switchgear room.	Nos.	6		
3.	8000 CMH @ 10 mm WC Axial flow Exhaust fan with flame proof motor complete with bird screen, rain protection cowl, intake louver and mounting accessories etc. for Battery room.	Nos.	3		

✓ Prices of following shall be deemed to be inclusive in unit's rates of above items :

a. PVC drain piping from IDU, Copper refrigerant pipe & cable between IDU/ODU.

b. MS brackets and M.S. frame for indoor & outdoor units respectively and fixing hardware like anchor bolts, nuts, fittings etc. as would be necessary for installation of above equipment 1 lot for each AC unit and each capacity.

c. Any other item required for operation of the system inline with technical specification requirement.

Signature of the authorized representative of Bidder

Name :

Designation :

Place :

Date :

Company Seal

SCHEDULE-3

DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL

Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

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

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

SCHEDULE-4

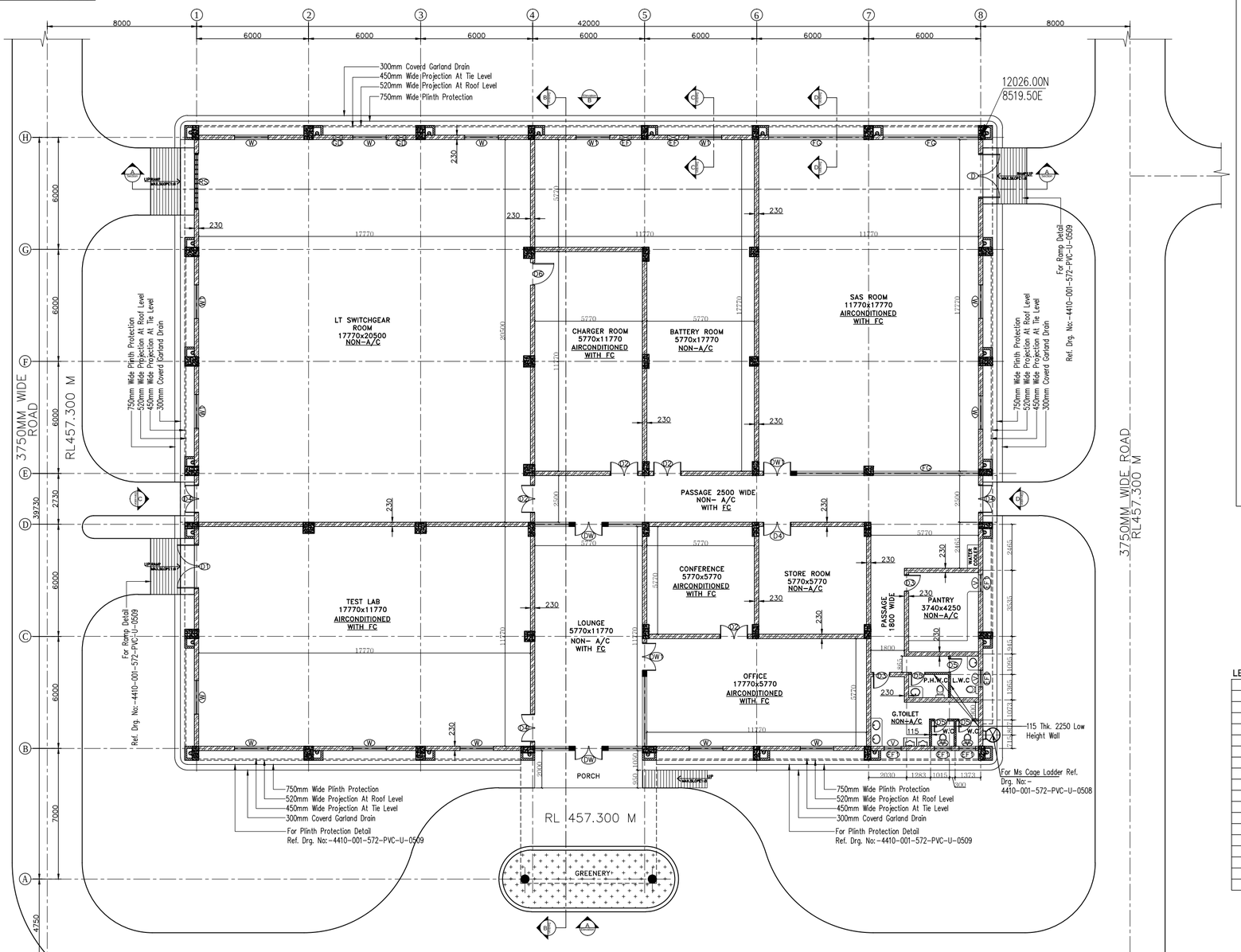
DRAWINGS

1) Architectural layout of Control Room Building drawing no. TB-0-369-607-626-1, Rev.1.

DRAWING NO TB-X-369-607-626-1

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM



GROUND FLOOR PLAN AT RL 457.500 M
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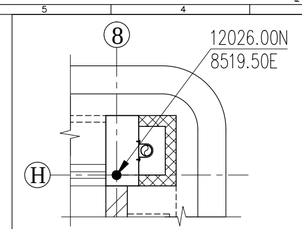

CORNER CO-ORDINATE DETAIL
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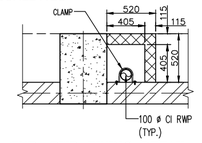

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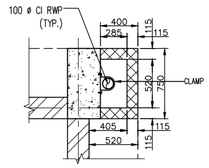

TYP. RWP CORNER FIXING DETAIL
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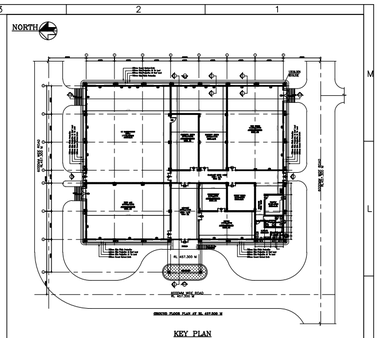


GENERAL NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRE AND ELEVATIONS ARE IN METRE.
2. RL 457.500 CORRESPONDS TO FFL OF CONTROL ROOM BUILDING & RL 457.00 IS FGL OF SWITCHYARD.
3. SIZE OF COLUMNS ARE TENTATIVE AND SUBJECTED TO CHANGE AS PER STRUCTURAL DWG.
4. THE DRAWING SHOULD NOT BE SCALED. ONLY THE WRITTEN DIMENSIONS SHALL BE FOLLOWED.
5. DOOR WIDTHS ARE CLEAR MASONRY OPENINGS AND DOOR HEIGHTS ARE FROM FFL TO BOTTOM OF LINTEL.
6. WALL GLAZING WORK SHALL BE CONFORM TO IS:1083 AND IS:3548.
7. ALL DIMENSIONS ARE READ AS UNPLASTERED MASONRY AND CONCRETE, UNLESS NOTED OTHERWISE.
8. READ THIS DWG. IN CONJUNCTION WITH TECHNICAL SPEC. AND TENDER DRAWINGS.

LEGEND :-

RL	REDUCED LEVEL
FGL	FINISHED GROUND LEVEL
TRL	TOP OF ROAD
FFL	FINISHED FLOOR LEVEL
BOB	BOTTOM OF BEAM
TOC	TOP OF CONCRETE
TOP	TOP OF PARAPET WALL
PCC	PLAIN CEMENT CONCRETE
TOB	TOP OF BEAM
FC	FALSE CEILING
DPC	DAMP PROOF COURSE
WPC	WATER PROOF COURSE
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
V	VENTILATOR
EF	EXHAUST FAN
FG	FIX GLAZING
GD	GRAVITY DAMPER

SCHEDULE OF DOORS & WINDOWS

S.NO.	TYPE.	SIZE	SILL LVL.	UN. LVL.	NOS.	DETAIL
1.	RS	3000x3000	–	3000	01	ROLLING SHUTTER AS/SPEC
2.	D1	2400x2400	–	2400	02	ALUMINUM GLAZED SHUTTER DOOR AS/SPEC
3.	D2	1500x2400	–	2400	04	STEEL FRAME WITH DOUBLE PLATE FLASH SHUTTER DOOR AS/SPEC
4.	D3	900x2100	–	2100	03	STEEL FRAME WITH WOODEN FLASH DOOR AS/SPEC
5.	D4	1500x2400	–	2400	05	ALUMINUM GLAZED SHUTTER DOOR (HERMETICALLY SEALED DOUBLE GLAZING) AS/SPEC
6.	D5	750x2100	–	2100	04	STEEL FRAME WITH WOODEN FLASH DOOR AS/SPEC
7.	D6	1200x2400	–	2400	01	STEEL FRAME WITH WOODEN FLASH DOOR AS/SPEC
8.	DW	1500x2400	–	2400	02	ALUMINUM GLAZED SHUTTER DOOR AND FIXED GLAZING AS/SPEC
9.	DW1	1500x2400	–	2400	02	ALUMINUM GLAZED SHUTTER DOOR AND FIXED GLAZING AS/ SPEC (HERMETICALLY SEALED DOUBLE GLAZING)
10.	W	1800x1500	900	2400	16	ALUMINUM FRAMED GLAZED SHUTTER WINDOW (HERMETICALLY SEALED DOUBLE GLAZING) AS/SPEC
11.	W1	1800x1500	900	2400	06	ALUMINUM FRAMED GLAZED SHUTTER WINDOW AS/SPEC
12.	FG	AS/PLAN	150	2400	03	ALUMINUM FRAMED GLAZED AS/SPEC (HERMETICALLY SEALED DOUBLE GLAZING)
13.	V	900x600	1800	2400	06	ALUMINUM FRAMED GLAZED SHUTTER VENTILATOR AS/SPEC
14.	GD	500x500	3300	3800	02	(GRAVITY DAMPER)WALL OPENING
15.	EF	600x600	3300	3900	02	EXHAUST FAN

230 THK. BRICK WALL

115 THK. BRICK WALL

NTPC REF. DWGS.

1. LAYOUT PLAN & SECTION OF 400/220 kV SWITHYARD AT NKSTPP END NTPC DRG. NO. 4410-001-PVE-F-0013
2. SWITHYARD CONTROL ROOM BUILDING LAYOUT AND DETAILS OF FOUNDATION AND COLUMN 4410-001-572-PVC-C-0497
3. SWITHYARD CONTROL ROOM BUILDING DETAILS OF DOOR & WINDOW 4410-001-572-PVC-C-0501
4. SWITHYARD CONTROL ROOM BUILDING FINISHING SCHEDULE 4410-001-572-PVC-U-0506
5. SWITHYARD CONTROL ROOM BUILDING DETAILS OF TOILET AND PLUMBING 4410-001-572-PVC-U-0507
6. SWITHYARD CONTROL ROOM BUILDING DETAILS OF CAGE LADDER 4410-001-572-PVC-U-0508
7. SWITCHYARD CONTROL ROOM BUILDING MISCELLANEOUS DETAIL 4410-001-572-PVC-U-0509

REV.	DATE	REASONS FOR REVISION	PREPARED BY	CHECKED BY	APPROVED BY
01	08.11.15	REV. AS PER NTPC COMMENTS OF 08.10.15	RK	BS	AA
0	24.09.15	FIRST SUBMISSION	RK	BS	AA

REFERENCE DRG.

NTPC DRG. No. 4410-001-572-PVC-C-0497

PROJECT: NORTH KARANPURA SUPER THERMAL POWER PROJECT (3x660MW)

EPC CONSULTANTS: DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS NEW DELHI

OWNER: NTPC Limited (A GOVERNMENT OF INDIA ENTERPRISE)

TBEM: BHARAT HEAVY ELECTRICALS LTD — TRANSMISSION BUSINESS GROUP NOIDA

DEPT CODE		NAME	SIGN	DATE
C	DRN	RK		31.08.15
	DESN	BS		
	CHD	BS		
	APPD	AS		

TITLE: SWITCHYARD CONTROL ROOM BLD : ARCHIECTURAL PLANS AND ELEVATIONS (GROUND FLOOR PLAN)

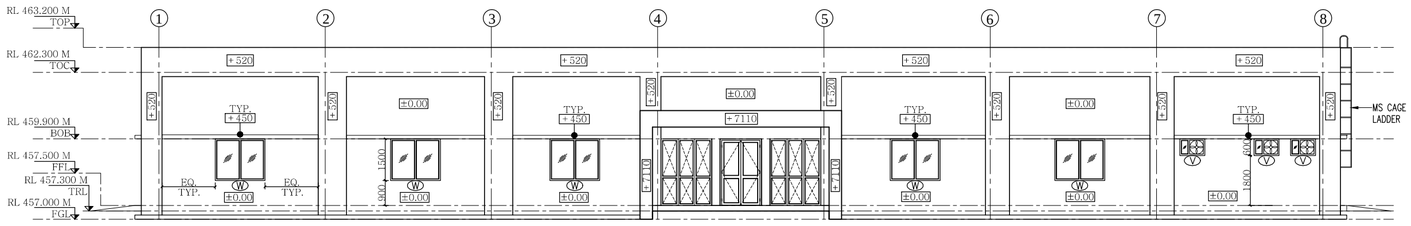
DEPT. | SCALE 1:20 | BHEL TB-0-369-607-626-1
SIGN | DCPL 14X06-DWG-A-626-1
DATE | SHEET 01 OF 04 | REV. 01

FORMAT SIZE A0

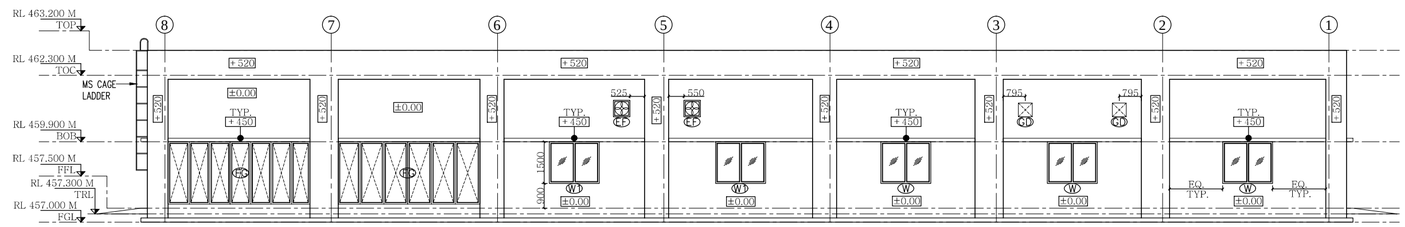
ELECTRONIC FILE NAME:

DRAWING NO. TB-X-369-607-626-2

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM



ELEVATION - A
SCALE1:100



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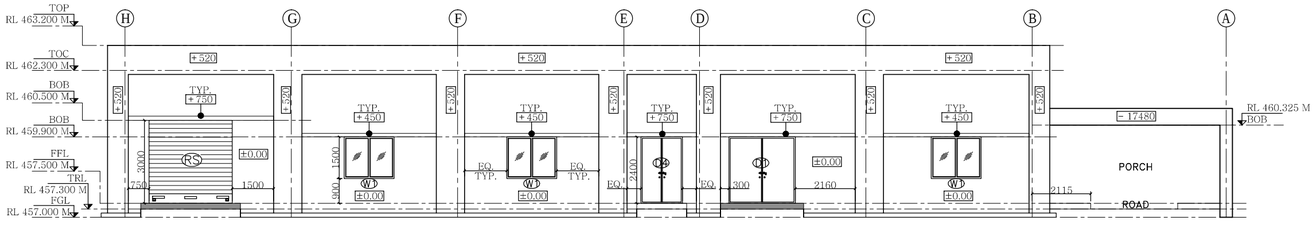

ELEVATION - C
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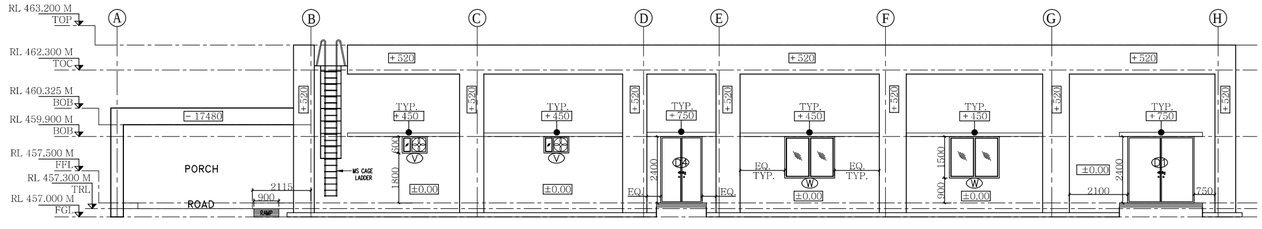

ELEVATION - D
SCALE1:100

GENERAL NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRE AND ELEVATIONS ARE IN METRE.
2. RL 457.500 CORRESPONDS TO FFL OF CONTROL ROOM BUILDING & RL 457.00 IS FGL OF SWITCHYARD.
3. SIZE OF COLUMNS ARE TENTATIVE AND SUBJECTED TO CHANGE AS PER STRUCTURAL DWG.
4. THE DRAWING SHOULD NOT BE SCALED. ONLY THE WRITTEN DIMENSIONS SHALL BE FOLLOWED.
5. DOOR WIDTHS ARE CLEAR MASONRY OPENINGS AND DOOR HEIGHTS ARE FROM FFL TO BOTTOM OF LINTEL.
6. WALL GLAZING WORK SHALL BE CONFORM TO IS:1083 AND IS:3548.
7. ALL DIMENSIONS ARE READ AS UNPLASTERED MASONRY AND CONCRETE, UNLESS NOTED OTHERWISE.
8. READ THIS DWG. IN CONJUNCTION WITH TECHNICAL SPEC. AND TENDER DRAWINGS.

NTPC REF. DWGS.

1. LAYOUT PLAN & SECTION OF 400/220 kV SWITHYARD AT NKSTPP END NTPC DRG. NO. 4410-001-PVE-F-0013
2. SWITHYARD CONTROL ROOM BUILDING LAYOUT AND DETAILS OF FOUNDATION AND COLUMN 4410-001-572-PVC-C-0497
3. SWITHYARD CONTROL ROOM BUILDING DETAILS OF DOOR & WINDOW 4410-001-572-PVC-C-0501
4. SWITHYARD CONTROL ROOM BUILDING FINISHING SCHEDULE 4410-001-572-PVC-U-0506
5. SWITHYARD CONTROL ROOM BUILDING DETAILS OF TOILET AND PLUMBING 4410-001-572-PVC-U-0507
6. SWITHYARD CONTROL ROOM BUILDING DETAILS OF CAGE LADDER 4410-001-572-PVC-U-0508
7. SWITCHYARD CONTROL ROOM BUILDING MISCELLANEOUS DETAIL 4410-001-572-PVC-U-0509

LEGEND :-

RL	REDUCED LEVEL
FGL	FINISHED GROUND LEVEL
TRL	TOP OF ROAD
FFL	FINISHED FLOOR LEVEL
BOB	BOTTOM OF BEAM
TOC	TOP OF CONCRETE
TOP	TOP OF PARAPET WALL
PCC	PLAIN CEMENT CONCRETE
TOB	TOP OF BEAM
FC	FALSE CEILING
DPC	DAMP PROOF COURSE
WPC	WATER PROOF COURSE
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
V	VENTILATOR
EF	EXHAUST FAN
FG	FIX GLAZING
GD	GRAVITY DAMPER

REV.	DATE	REASONS FOR REVISION	PREPARED BY	CHECKED BY	APPROVED BY
01	08.11.15	REV. AS PER NTPC COMMENTS OF 08.10.15	RK	BS	AA
0	24.09.15	FIRST SUBMISSION	RK	BS	AA

REFERENCE DRG.

NTPC DRG. No. 4410-001-572-PVC-C-0497

PROJECT: NORTH KARANPURA
SUPER THERMAL POWER PROJECT (3x660MW)

NTPC CONSULTANTS: DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
NEW DELHI

OWNER: NTPC Limited (A GOVERNMENT OF INDIA ENTERPRISE)

TBEM: BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
NOIDA

DEPT CODE		NAME	SIGN	DATE
C	DRN	RK		21.08.15
	DESN	BS		
	CHD	BS		
	APPD	AS		

TITLE: SWITCHYARD CONTROL ROOM BLD : ARCHIECTURAL PLANS AND ELEVATIONS (ELEVATIONS DETAILS)

DEPT. | SCALE 1:100 | BHEL TB-1-369-607-626-2
SIGN | DCPL 14X06-DWG-A-626-2
DATE | SHEET 02 OF 04 | REV. 01

FORMAT SIZE A1

ELECTRONIC FILE NAME:

DRAWING NO. TB-X-369-607-626-3

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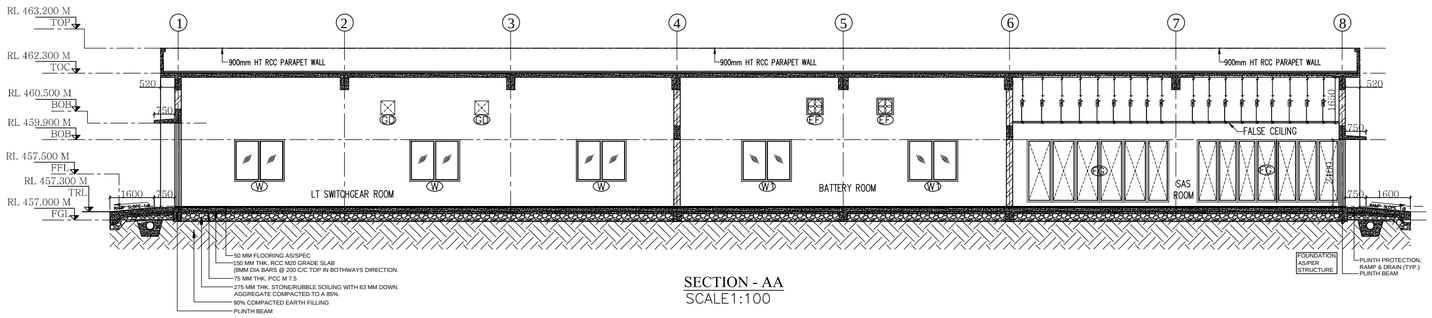
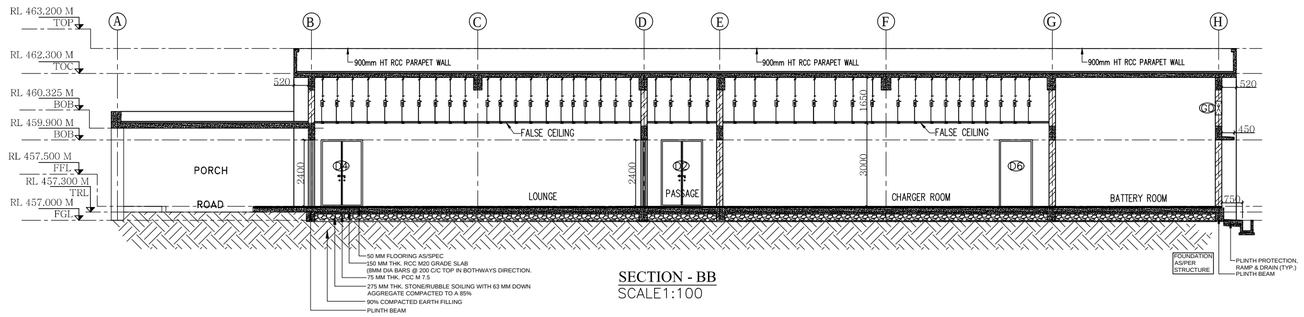


SECTION - AA
SCALE1:100



SECTION - BB
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GENERAL NOTES :-

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NTPC REF. DWGS.

1. LAYOUT PLAN & SECTION OF 400/220 kV SWITHYARD AT NKSTPP END NTPC DRG. NO. 4410-001-PVE-F-0013
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3. SWITHYARD CONTROL ROOM BUILDING DETAILS OF DOOR & WINDOW 4410-001-572-PVC-C-0501
4. SWITHYARD CONTROL ROOM BUILDING FINISHING SCHEDULE 4410-001-572-PVC-U-0506
5. SWITHYARD CONTROL ROOM BUILDING DETAILS OF TOILET AND PLUMBING 4410-001-572-PVC-U-0507
6. SWITHYARD CONTROL ROOM BUILDING DETAILS OF CAGE LADDER 4410-001-572-PVC-U-0508
7. SWITCHYARD CONTROL ROOM BUILDING MISCELLANEOUS DETAIL 4410-001-572-PVC-U-0509

LEGEND :-

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TRL	TOP OF ROAD
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BOB	BOTTOM OF BEAM
TOC	TOP OF CONCRETE
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PCC	PLAIN CEMENT CONCRETE
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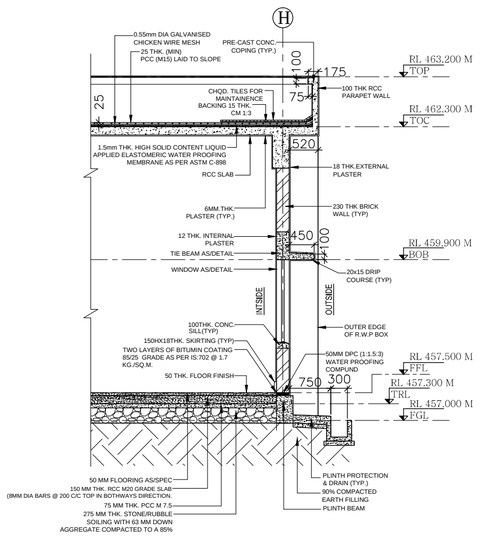
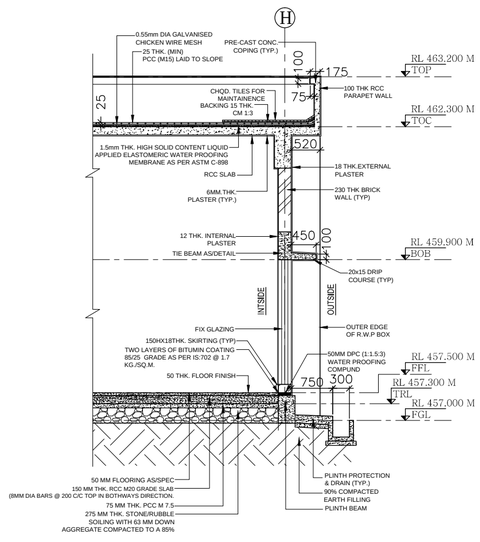
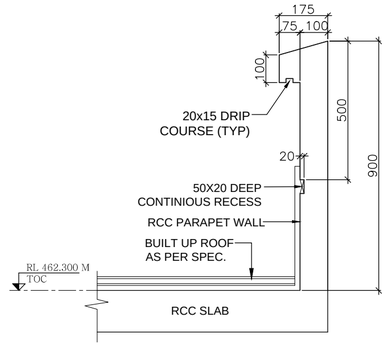


EXTERNAL WALL SECTION
SECTION - C-C
SCALE1:50



EXTERNAL WALL SECTION
SECTION - D-D
SCALE1:50



TYP. RCC DETAIL OF PARAPET WALL
SCALE1:10

REV.	DATE	REASONS FOR REVISION	PREPARED BY	CHECKED BY	APPROVED BY
01	08.11.15	REV. AS PER NTPC COMMENTS OF 08.10.15	RK	BS	AA
0	24.09.15	FIRST SUBMISSION	RK	BS	AA

REFERENCE DRG.

NTPC DRG. No. 4410-001-572-PVC-C-0497

PROJECT: NORTH KARANPURA
SUPER THERMAL POWER PROJECT (3x660MW)

EPC CONSULTANTS: DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
NEW DELHI

OWNER: NTPC Limited (A GOVERNMENT OF INDIA ENTERPRISE)

TBEM: BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP NOIDA

DEPT CODE		NAME	SIGN	DATE
C	DRN	RK		21.08.15
	DESN	RS		
	CHD	RS		
	APPD	AS		

TITLE: SWITCHYARD CONTROL ROOM BLD : ARCHIECTURAL PLANS AND ELEVATIONS (SECTIONS DETAIL)

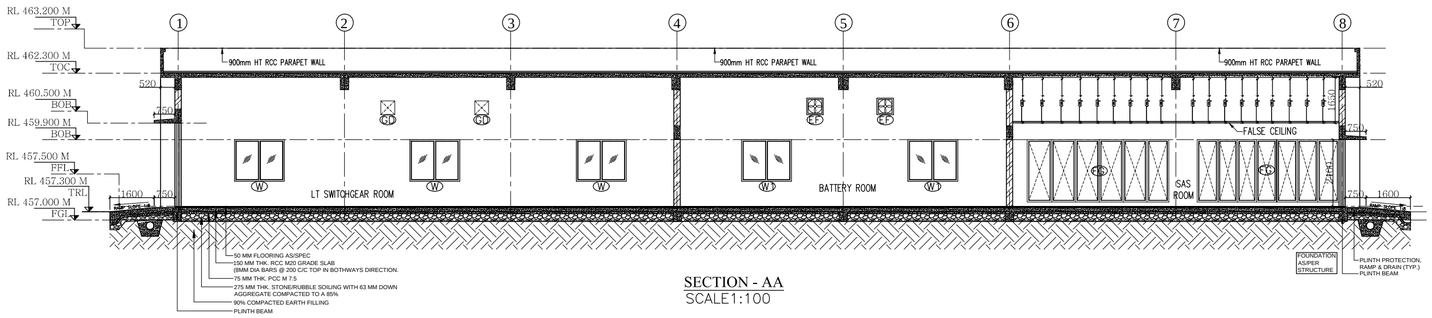
DEPT. | SCALE 1:100 | BHEL TB-1-369-607-626-3
SIGN | DCPL 14X06-DWG-A-626-3
DATE | SHEET 03 OF 04 | REV. 01

FORMAT SIZE A1

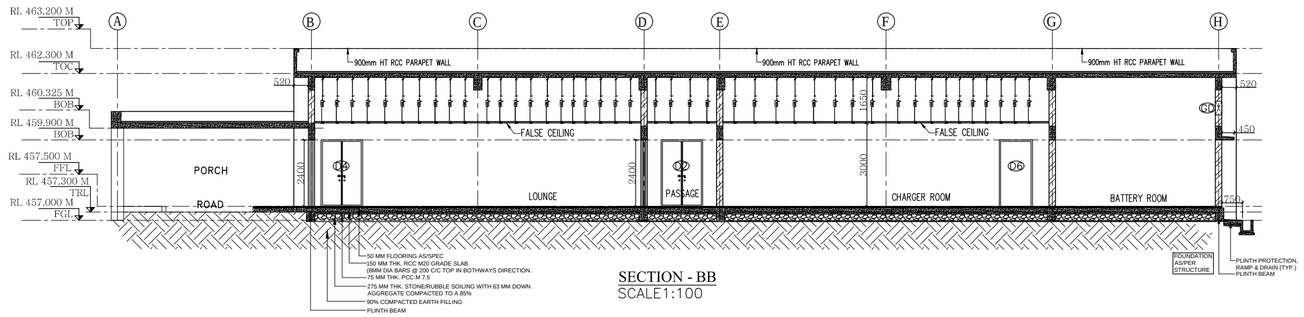
ELECTRONIC FILE NAME:

DRAWING NO. TB-X-369-607-626-3

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM



SECTION - AA
SCALE1:100



SECTION - BB
SCALE1:100

GENERAL NOTES :-

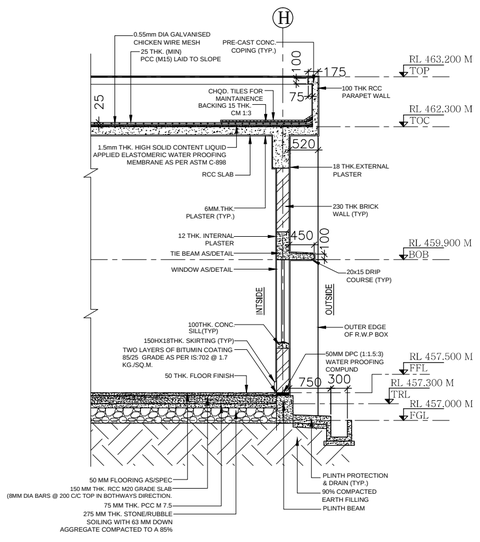
1. ALL DIMENSIONS ARE IN MILIMETRE AND ELEVATIONS ARE IN METRE.
2. RL 457.500 CORRESPONDS TO FFL OF CONTROL ROOM BUILDING & RL 457.00 IS FGL OF SWITCHYARD.
3. SIZE OF COLUMNS ARE TENTATIVE AND SUBJECTED TO CHANGE AS PER STRUCTURAL DWG.
4. THE DRAWING SHOULD NOT BE SCALED. ONLY THE WRITTEN DIMENSIONS SHALL BE FOLLOWED.
5. DOOR WIDTHS ARE CLEAR MASONRY OPENINGS AND DOOR HEIGHTS ARE FROM FFL TO BOTTOM OF LINTEL.
6. WALL GLAZING WORK SHALL BE CONFORM TO IS:1083 AND IS:3548.
7. ALL DIMENSIONS ARE READ AS UNPLASTERED MASONRY AND CONCRETE, UNLESS NOTED OTHERWISE.
8. READ THIS DWG. IN CONJUNCTION WITH TECHNICAL SPEC. AND TENDER DRAWINGS.

NTPC REF. DWGS.

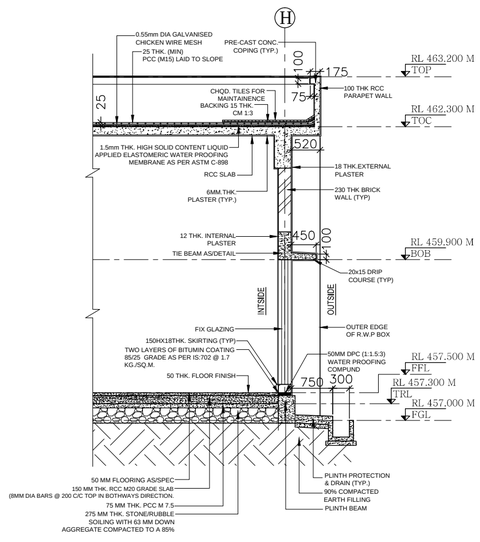
1. LAYOUT PLAN & SECTION OF 400/220 kV SWITHYARD AT NKSTPP END NTPC DRG. NO. 4410-001-PVE-F-0013
2. SWITHYARD CONTROL ROOM BUILDING LAYOUT AND DETAILS OF FOUNDATION AND COLUMN 4410-001-572-PVC-C-0497
3. SWITHYARD CONTROL ROOM BUILDING DETAILS OF DOOR & WINDOW 4410-001-572-PVC-C-0501
4. SWITHYARD CONTROL ROOM BUILDING FINISHING SCHEDULE 4410-001-572-PVC-U-0506
5. SWITHYARD CONTROL ROOM BUILDING DETAILS OF TOILET AND PLUMBING 4410-001-572-PVC-U-0507
6. SWITHYARD CONTROL ROOM BUILDING DETAILS OF CAGE LADDER 4410-001-572-PVC-U-0508
7. SWITCHYARD CONTROL ROOM BUILDING MISCELLANEOUS DETAIL 4410-001-572-PVC-U-0509

LEGEND :-

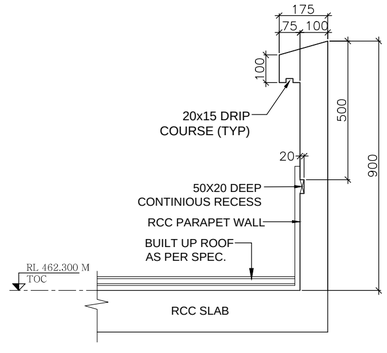
RL	REDUCED LEVEL
FGL	FINISHED GROUND LEVEL
TRL	TOP OF ROAD
FFL	FINISHED FLOOR LEVEL
BOB	BOTTOM OF BEAM
TOC	TOP OF CONCRETE
TOP	TOP OF PARAPET WALL
PCC	PLAIN CEMENT CONCRETE
TOB	TOP OF BEAM
FC	FALSE CEILING
DPC	DAMP PROOF COURSE
WPC	WATER PROOF COURSE
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
V	VENTILATOR
EF	EXHAUST FAN
FG	FIX GLAZING
GD	GRAVITY DAMPER



EXTERNAL WALL SECTION
SECTION - C-C
SCALE1:50



EXTERNAL WALL SECTION
SECTION - D-D
SCALE1:50



TYP. RCC DETAIL OF PARAPET WALL
SCALE1:10

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REFERENCE DRG.

NTPC DRG. No. 4410-001-572-PVC-C-0497

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ELECTRONIC FILE NAME: