BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
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VENTILATION SYSTEM (GIS & CONTROL BUILDING)				**DATE**	**23.12.20**	**23.12.20**	**23.12.20**
				GROUP	**TBEM**	W.O. No	**87005A UDG**
CUSTOMER	**TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD.**						
CONSULTANT	**TATA CONSULTING ENGINEERS LMITED BENGALURU**						
PROJECT	**2X660MW UDANGUDI STPP (STATE-1)**						

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SECTION-1
INTENT, SYSTEM REQUIREMENT, DESIGN CRITERIA & SCOPE

1.0 INTENT OF SPECIFICATION

1.1 This specification covers the design, manufacture, inspection and testing at bidder's and/ or his sub vendor's work(s), proper packing, transportation & delivery, storage and handling at site, erection, testing and commissioning, final painting and carrying out acceptance tests at site of **Ventilation System** as detailed in this section and in various other sections of this specification for different rooms located inside the 400KV Gas Insulated switchyard (GIS) control Building and GIS Hall of **2X660MW UDANGUDI STPP – (Stage-1).**

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

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Purchaser/ Owner, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance herewith.

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

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

1.6 *Deviation:* In case of any deviation, the bidder shall indicate separately the deviations clause-wise with respect to the specification in the 'Schedule of Deviation' given in schedule 1 of section-5. Deviations in any other form including clarifications / assumptions / etc. will not be considered and it will be construed that the bid conforms strictly to the specification.

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

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

2.0 VENTILATION SYSTEM

This system shall be designed with the objective of providing Ventilation in different rooms located inside the 400KV Gas Insulated switchyard (GIS) Control Building and GIS Hall of **2X660MW UDANGUDI SUPERCRITICAL THERMAL POWER PROJECT STAGE-1.**

2.1. CODES AND STANDARDS

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

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

IS: 659	- Safety Code for Air-Conditioning
IS: 655	- Specification of metal Air-Ducts
IS: 4999 (Part-51)	- Noise Level
IS: 3588	- Specifications of Electrical Axial Flow Fans
IS: 2312	- Propeller type Ventilation fans
BS: 6540 Part I	- Air Filters used in Air-Conditioning & General Ventilation
IS: 4671	- Expanded polystyrene for Thermal Insulation purpose
IS: 8183	- Bonded Mineral wool

2.2. SYSTEM DESCRIPTION

Design and Technical Requirement

Sl. No.	Area	Basis of Airflow rate: Air changes per hour	Equipment heat dissipation Load (kW)	Illumination Heat load
01	Cable Vault	15	10	2 Watt per sq. ft. or actual whichever is higher
02	LV Switchgear Room	15	15	
03	Transformer Room	15	12	
04	GIS Hall	15	171	
05	Battery Room	30	7	
06	Stores	06		
07	Pantry and Toilet	15		

Summary- Supply Air Ventilation System

Area to be ventilated	Supply air system	Exhaust air system
Cable Vault	Wall mounted supply fans with pre filters	Gravity dampers
LV Switchgear Room	Wall mounted supply fans with pre filters	Gravity dampers
Transformer Room	Wall mounted supply fans with pre filters	Gravity dampers
GIS Hall	Centrifugal fan with pre filter and fine filters along with ducting for supply air system, exhaust by gravity dampers will be provided for GIS building to maintain	Gravity dampers. Exhaust fan (2x50% capacity) inter linked with SF6 gas detector shall be provided for emergency purpose.

	positive pressure and to prevent ingress of dust particles inside GIS building.	**Capacity of exhaust fan shall be arrived based on 1ACPH of GIS Hall.**

Summary-Simple Exhaust Ventilation System

Area to be ventilated	Supply air system	Exhaust air system
Battery Room (2x50% capacity axial flow belt driven)	Fresh air through intake louvers	Wall mounted exhaust fans
Stores	Through door undercuts/door louvers	Wall mounted Propeller type exhaust fans
Pantry and Toilet	Through door undercuts/door louvers	Wall mounted Propeller type exhaust fans

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

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

b) All the areas served by means of dry mechanical ventilation shall be designed for a maximum inside temperature of 5 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.

c) All the ventilation fans shall operate on 100% fresh air considering **15 air changes per hour (ACPH)** for LV Switchgear, cable vault, transformer rooms, **06 ACPH** for store rooms, **15 ACPH** for toilet & pantry rooms and **30 ACPH** for battery room of 400KV GIS control building.

d) All the equipments of ventilation system shall be designed for generally continuous duty for continuous operation of 24 hours a day.

e) ***Heat dissipation from GIS bays shall also be considered for sizing of ventilation system of GIS hall during detailed engineering stage.***

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

g) Wall mounted supply air fans of suitable capacity (CMH) & required static head (WC) shall be provided for positive pressurization of the following rooms:

i. Cable Vault (In Control building of GIS)
ii. Transformer Room (In Control building of GIS)
iii. LV Switchgear Room (In Control building of GIS)

Directly driven axial flow fans with die cast aluminium impeller dynamically balanced, fitted with three-phase induction motor.
The fan casing shall be of galvanized steel material. Fan shall be provided with rain protection inlet cowl, filters, bird-screen, back-draft damper, (where necessary) grouting frame and cadmium plated fixing bolts.

The pre filter section shall comprise of 50 mm thick washable filter panel suitably arranged in holding frames. The pre filter shall have a minimum efficiency of 90% down to 10 microns size. Maximum Velocity across pre filter shall be 2.5 m/s.

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

i) Wall mounted Exhaust fans of suitable capacity (CMH) each having rain protection cowl, bird screen and mounting arrangement shall be envisaged for the Battery rooms of control building of GIS as per following design criteria:

Battery rooms - The wall mounted axial flow fan shall be of FRP coated cast aluminium impeller with blades of aerofoil design. The fan motor shall be externally mounted (outside the air path) on a bracket fixed to the casing with necessary V-belt drive. The motor shall be of explosion proof type. Redundancy for battery room exhaust fans shall be 2X50%.

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

j) **Store, Toilet & pantry shall be provided with propeller type exhaust fans of suitable capacity (CMH) with rain protection cowl, bird screen and mounting arrangement along with back draft damper.** Single phase power supply points to these ventilation fans will be provided by BHEL. Further wiring from the power supply point to the fans with necessary switch control shall be under contractor scope.

2.3. Ventilation system for 400 kV GIS Hall

Ventilation system shall be provided to maintain positive pressure inside GIS building. The system shall comprise of supply air fan assemblies with Pre & Fine filters, Gravity louvers, exhaust air fans, gravity dampers or a suitable combination of these along with necessary filters, ducting, grilles etc. Fans and accessories for this ventilation system shall be placed in separate ventilation room provided adjacent to the GIS Hall. This dry mechanical ventilation system shall be designed for a maximum inside temperature of 5 deg. Celsius above the design ambient (DBT) condition during summer or according to suitable air changes per hour (**minimum 15 ACPH**). The criterion that gives the highest flow rate will be considered for design & selection of the equipment. Ventilation system for GIS hall shall operate on 100% fresh air.

Plant shall mainly consist Supply air fans of DIDW type with pre and fine filters, Supply air ducting and grills. Two (2) nos. DIDW supply air centrifugal fans on 2x50 % (all working) basis shall be provided for the collective requirement of GIS Hall. It shall also have GSS intake louvers with wire mesh, frame and bird protection screen and HDPE filters of min. 99% arrestance down to 5 micron. The vibration level of fans shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans).

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

These filters shall be arranged in a panel formation with filter module mounting frame on the downstream side. Wall cut outs for mounting of intake louvers shall be made available in ventilation room. Two Supply air duct shall be taken from plenum chamber which shall run on the both walls along the length of the GIS Hall with necessary grilles/ diffusers to make proper ventilation arrangement inside the hall to facilitate proper mixing and avoid any hot spot.

Exhaust fan inter linked with SF6 gas detector shall be provided for emergency purpose. The control of switching on this exhaust fan under emergency condition shall be done through GIS supplier equipments (through PFC or any other contacts). However local control (push buttons) shall also be provided. The contractor shall make all necessary provision including cabling between fan switch board to GIS output contacts (under leakage condition) to enable automatic switch control (on/off) of this exhaust fan from remote under SF6 leakage condition. GIS supplier shall provide one free contact of SF6 stage 2 collective alarm for remote connection.

Gravity dampers (self-acting dampers) are provided to ensure pressurization of above areas. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet. Spring actuated counter weight operated Pressure relief dampers with frame & bird screen shall be provided of suitable size and quantities on both walls of GIS hall at elevation above supply air ducts to release hot air & excessive pressure inside the hall beyond design over pressure.

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

For fans and blowers, AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation. All the motors shall be rated for S1 duty for continuous operation. The motors shall be suitable for direct on-line starting on full load and shall be energy efficient type. Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

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

✓ **Notes:**

Ventilation fan calculation sheet for different areas mentioned above of GIS control building & GIS Hall shall be submitted for customer/ consultant approval during detailed engineering stage.

No monitoring and control of the ventilation system for switchyard area shall be done through remote PLC/DDCMIS in main plant.

GENERAL

a. Centrifugal Fans:

Centrifugal fans for Ventilation System shall be DIDW non-overloading type designed. Fan shall be driven with V-belt by a totally enclosed motor and the fan outlet velocity shall not exceed 11 m/sec.

Impeller shall be die formed aerofoil or laminar type of self-cleaning and non-overloading characteristics. The impeller shall be statically and dynamically balanced according to ISO standard.
The fan casing shall be of welded construction and provided with flanges on inlet & outlet side for duct connection.
The fan impeller & casing etc. shall be protected by a suitable corrosion resistant.
Accessories like common base frame, anchor bolts, vibration isolators, V-belt guard, inlet guard and outlet damper, canvas etc., shall be provided. Centrifugal fans and drive motors mounted on common base frame to be mounted on spring type vibration isolators to prevent vibration transfer to floors as well as to the downstream side of duct.

b. Air Distribution System

The ductwork inside the building shall be manufactured form hot-dip galvanized sheet metal, complying with IS-277 Gr 275 or better.

All ductwork support ties to the structure shall be made resilient with the use of 12mm thick non-intercellular neoprene strip, gaskets or washers. All ductwork connections to air handling equipment shall be made via 15 cm long connections of rubber impregnated canvass material.

Maximum velocity in the duct shall be 11 m/s and velocity of air through supply air grilles shall be maximum 5 m/s for ventilation system.

Supports for Ductwork: Supports shall generally comprise hot-dipped galvanized mild steel sections and drop rods assembled in a suitable manner to permit adjustment for height and alignment of the ducts, and to prevent the transmission of vibration and/or noise. Ducts shall be supported by the stiffening angles or angle flanges but where this is impractical, supporting angles shall be fixed to the ducts.

Supply and Exhaust Air Grilles: In conventional attractive design, lamellas adjustable, aerofoil shape, broad front frame to allow airtight mounting. Frame and lamella made from steel with agreed stove enamel finish, conserved in nature color. Covered screw mounting with use of mounting frame shall be provided. Air-flow control shall be by means of counter-moving, coupled lamellas, with sets of adjustable air deflection blades and an opposed blade damper located at the rear, adjustable from the front side.

Fire Dampers: The main duct of ventilation system shall be provided with automatic motor-operated fire dampers with fire rating of 120 minutes, at locations where ducts pass through wall/floors/ceiling slabs for isolation/ maintenance/ fire-protection purpose. The operation of these automatic dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of A/C plant for further wiring up to fire alarm panels.
Fusible link fire dampers of 60 minutes fire rating shall be provided for all other areas excluding electrical rooms where ducts pass through wall/floors/ceiling slabs for isolation/maintenance/ fire-protection purpose.

Isolating Dampers: Consisting of frames of galvanized sheet metal, air foiled lamellas, adjustable from the outside by a lever and positioning device.

Weather Louvers: Weather louvers shall be of hot-dipped galvanized angle-iron frame with built-in rain-rejecting galvanised iron or aluminium lamellas as well as bird protection screen of galvanized iron, Mounting frame of galvanized profile steel.

2.4. CONTROL & POWER SUPPLY REQUIREMENT

a. Four (4) nos. wall mounted fuse boards each for extending power supplies to 3 phase supply/exhaust fans in Cable vault, LV Switchgear, Transformer Room & Battery rooms, shall be located in their respective rooms. These fuse boards shall be supplied by contractor. Also necessary cabling shall be done further from the fuse board to each fan's 3-phase DOL local starter & motors by contractor. BHEL shall provide 4 nos. incomer feeders (through MPCB) one no. of 32 A rating for fuse board of cable vault and 3 nos. of 16A rating for fuse board of LV Switchgear, Transformer Room & Battery rooms. These feeders shall be made available by BHEL from MCC cum PDB of Air Conditioning System in AHU/AC Plant room (other's scope) of control room building area.

b. One (1) no. dedicated MCC cum Power distribution board in ventilation room of 400 kV GIS Hall shall be provided. This shall extend power supplies to centrifugal fan and other equipments of ventilation system of GIS Hall including exhaust fans under emergency conditions as described in clause 2.3. BHEL shall provide two incomers each of rating 200A from main ACDB board to feed this MCC cum PDB. Contractor shall provide necessary arrangements accordingly. Two nos. incomers of 200A rating (through MCCB) of cable size 3.5CX300 sqmm. (Al/XLPE) shall be provided from the main ACDB by BHEL and the same will be terminated in MCC cum PDB. Lamps shall be provided for indicating the status of each fan etc. in the panel. All annunciations related to failure of equipments, tripping of equipments and source of failure/reason due to which the equipment is stopped/tripped, low & high limits of parameters such as level, temp., pressure drop etc. as applicable details of which shall be finalized during engineering stage shall be provided for each fan in the panel. Fully wired, 20% spare annunciation windows shall be provided in the panel. Start/stop push buttons etc. shall also be provided.

c. MCC shall be drawout type. Bidder shall refer the detailed panel specification annexed to section-2.

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

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

f. Single phase power supply points to ventilation fans of Store, Toilet and pantry will be provided by BHEL.

Note: MCC cum PDB shall be of reputed make such as C&S Electric, L&T, BCH Electric, Schneider Electric, Pyrotech Electronics etc. that will be finalized during detailed engineering. Make finalized by customer shall be binding to contractor and there shall not be any price implication on account of make considered by bidder at tender stage and during detailed engineering. Hence bidder may prepare their estimate and quote accordingly to full fill above requirement.

3.0 Inspection & Testing requirement

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

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

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

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

4.0 List of Mandatory Spares

Ventilation system		
SL. NO.	**ITEM DESCRIPTION**	**QUANTITY**
A.	**Centrifugal Fans**	
1	V-Belts	2 sets of each type
2	Blower Bearing Sets	2 sets of each type
3	Blower Motor Bearings	2 sets of each type
4	Seal Gasket and other wear out parts in sets	2 sets of each type
5	Vibration Isolators	2 sets of each type
B.	**Axial Fans**	
1	Fan Bearings	2 sets of each type
2	Fan Motor Bearing	2 sets of each type
3	Dry Filters	2 sets of each type & size

4.0.1. Special Tools

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

	For Ventilation System	
1	RING SPANNER - 6 MM TO 32 MM (12 Pcs)	1 Set
2	OFFSET SCREW DRIVER	1 No.
3	LOCK WITH KEY FOR TOOL BOX	1 No.
4	MS TOOL BOX	1 No.
5	BOX WRENCHES - 6 MM TO 22 MM (14 Pcs)	1 Set
6	FLAT D WRENCH - 6 MM TO 32 MM (12 Pcs)	1 Set
7	ALLEN KEYS - 2 MM TO 10 MM	1 No.
8	CRESCENT SCREW SPANNER	1 No.
9	SCREW DRIVER	1 No.

10	INSULATED PLIER	1 No.
11	TORCH LIGHT (SUITABLE FOR 2 CELL)	1 No.
12	HAMMER 1 LB	1 No.
13	OIL CAN	1 No.
14	RATCHET 1/4"	1 No.

References:

i. ***Arch drawing- Control room building****-TB-1-400-607-620-1 (Plan), TB-1-400-607-620-2 (Elevation), TB-1-400-607-620-3 (Section) for 400kV (GIS) Switchyard at Udangudi.*

ii. ***Arch drawing- GIS building****- TB-1-400-607-640-1 (Plan), TB-1-400-607-640-2 (Elevation), TB-1-400-607-640-3 (Section) for 400kV (GIS) Switchyard at Udangudi.*

Notes:

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

5.0 SCOPE OF SUPPLY & SERVICES

Exact requirements shall be worked out during detailed engineering after award of contract. The scope of the work under the contract shall be deemed to include all such items, which although not specifically mentioned in the bid documents and/or in the bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation, unless the same is specifically excluded from the Bidder's scope of work under clause 6.0 of this section.

5.0.1. Bidder shall also consider the following while quoting for the system:

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

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

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

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

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

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

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

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

5.1.0. Scope of services

A. Erection, Testing & Commissioning (ETC) requirements

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

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

B. Electrical System

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

b. Providing necessary guidance to / coordination with civil contractor so that appropriate sized / correctly located cut outs are made (by civil contractor).
However, in case wall openings / cut outs have not been provided for either duct laying, louver fixing, ventilation fan(s), the same shall have to be made by the Contractor.

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

6.0 Exclusions

a) **Supply of power & control cables, Instrumentation and FO cable are excluded. However, laying and termination of these cables shall be in contractor's scope.** The bidder shall furnish quantity and type of cables required for complete system in their respective bids. Laying & termination is in contractor scope.

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

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

d) **Major civil works such as room & foundations for various Ventilation equipments.**

7.0 Utilities Available

Construction water and electricity shall be available at one point each. Contractor shall be required to make own arrangement for taking supplies from there.
However the final terms & conditions mentioned in work order shall prevail and contractual obligation to successful bidder.

8.0 Engineering Drawings/ Documents

Engineering shall start immediately after the award of the contract.
Submission & approval of all drg. / data sheet – as per tender requirement.

8.1 OPERATION & MAINTENANCE (O&M) MANUAL

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

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

9.0 Handing & Taking Over

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

10.0 Various Heads to be quoted for

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

Sl. No.	Item Description	Unit	Quantity	Unit Rate	Tota Ex-Works	Unit ETC	Total ETC	Remarks
1	CENTRIFUGAL FAN - 200000 CMH	Nos.	2					Supply air type Centrifugal fan with motor with pulley, casing alongwith fixing hardware.
2	Pre Filter	Nos.	20					Each filter of size 600X600 sqmm. for GIS ventilation system through centrifugal fans
3	Fine Filter	Nos.	20					Each filter of size 600X600 sqmm. for GIS ventilation system through centrifugal fans
4	AXIAL FLOW EXHAUST FANS - 15000 CMH	Nos.	2					Exhaust type axial flow fan with 20mmwc static pressure to exhaust SF6 Gas in case of emergency along with the connection to the alarm alongwith fixing hardware.
5	AXIAL FLOW SUPPLY FANS - 15000 CMH	Nos.	2					Supply Air type Axial flow fan with 10mmwc static

								pressure with rail protection cowl, filters, bird screen & gravity back draft damper alongwith fixing hardware - Cable Vault
6	AXIAL FLOW SUPPLY FANS - 6000 CMH	Nos.	2					Supply Air type Axial flow fan with 10mmwc static pressure with rail protection cowl, filters, bird screen & gravity back draft damper alongwith fixing hardware- LV Switchgear room
7	AXIAL FLOW SUPPLY FANS - 5000 CMH	Nos.	2					Supply Air type Axial flow fan with 10mmwc static pressure with rail protection cowl, filters, bird screen & gravity back draft damper alongwith fixing hardware - Transformer room
8	AXIAL FLOW EXHAUST FANS WITH FLP MOTOR - 6000 CMH	Nos.	2					Axial flow Exhaust fan with 20mmwc static pressure with belt driven flame proof motor with fresh air intake louver alongwith fixing hardware - Battery Room
9	PROPELLER EXHAUST AIR FANS - 1200 CMH	No.	3					Wall mounted propeller exhaust fan alongwith fixing hardware for store room, ladies toilets
10	PROPELLER EXHAUST AIR FANS - 2000 CMH	Nos.	3					Wall mounted propeller exhaust fan alongwith fixing hardware for pantry / dining hall, gents toilets
11	GSS DUCT SHEET - 24 G - VENTILATION SYSTEM	Sq.Mtr	250					As per IS-277 Gr 275 alongwith supporting structure and fixing hardware.
12	GSS DUCT SHEET - 22 G - VENTILATION SYSTEM	Sq.Mtr	1000					As per IS-277 Gr 275 alongwith supporting structure and fixing hardware.
13	GSS DUCT SHEET - 20 G - VENTILATION SYSTEM	Sq.Mtr	400					As per IS-277 Gr 275 alongwith supporting structure and fixing hardware.
14	GSS DUCT SHEET - 18 G - VENTILATION SYSTEM	Sq.Mtr	150					As per IS-277 Gr 275 alongwith supporting structure and fixing hardware.
15	VOLUME CONTROL DAMPER	SqMtr	20					
16	BACK DRAFT DAMPERS	SqMtr	16					
17	FUSIBLE LINK FIRE DAMPER	SqMtr	12					Fusible Link Fire Damper with fire rating of 60 minutes

18	MOTORIZED FIRE DAMPER	SqMtr	4					Motorized Fire Damper excluding Actuator with fire rating of 120 minutes
19	MOTORISED ACTUATOR FOR FIRE DAMPER	Nos.	2					Actuators for Fire Dampers with control panels
20	GRILLS/ DIFFUSERS	Sq.Mtr	57					
21	PRESSURE RELIEF DAMPER	Sq.Mtr	12					
22	AIR INTAKE LOUVER	Sq.Mtr	57					
23	MCC CUM POWER DISTRIBUTION BOARD	No.	1					
24	WALL MOUNTED FUSE BOARD 32A	No.	1					For Cable vault ROOM
25	WALL MOUNTED FUSE BOARD 16A	Nos.	3					For LV SWGR room, Transformer room & Battery room
26	LOCAL STARTER / PUSH BUTTON STATIONS (3-PHASE DOL STARTER)	Nos.	10					8 Nos. for all ventilation fans in cable vault, LV SWGR room, Transformer room & Battery room. 2 Nos. for Exhaust fans in GIS hall under emergency condition of SF6 leakage With sufficient contact multiplier and other necessary items required to it's automatic operation as eloborated in the technical specification
27	MAINTENANCE TOOLS & TACKLES	Set	1			NA		As per clause 4.0.1 of Section-1 of Technical Specification
28	**Mandatory spares**							
i.	V-Belts of each type for Centrifugal fans	Sets	2					One set = one no. of each type
ii.	Blower Bearing Sets of each type for Centrifugal fans	Sets	2					One set = one no. of each type
iii.	Blower Motor Bearings of each type for Centrifugal fans	Sets	2					One set = one no. of each type
iv.	Seal Gasket and other wear out parts in sets of each type for Centrifugal fans	Sets	2					One set = one no. of each type
v.	Vibration Isolators of each type for Centrifugal fans	Sets	2					One set = one no. of each type
vi.	Fan Bearings of each type for axial fans	Sets	2					One set = one no. of each type

vii.	Fan Motor Bearing of each type for axial fans	Sets	2					One set = one no. of each type
viii.	Dry Filters of each type & size for axial fans	Sets	2					One set = one no. of each type and size
	For ETC Scope							
29	Cable Laying along with accessories	Meter	40	NA				ETC scope only

***** Remarks: Bidder should go through the technical specification TB-400-553-124 for detailing of all equipments.***

a) The equipments and services to be furnished under this contract are detailed here under Cl. No. 10.0 of this section is for reference. Bidders shall work out the actual requirement based on the building & switchyard layout enclosed with this specification during detailed engineering stage.

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

c) 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.

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

e) 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.

f) 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.

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

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

i) Bidders shall consider makes for various equipments as per Annexure A, which shall be subjected to Owner's approval during design engineering stage. Price implication to BHEL later on account of non-acceptance of proposed vendors by Owner shall not be considered.

ANNEXURE-'B'

Cable Sizes being procured by BHEL for Sub-Station

2C x 2.5 sq mm PVC/Copper, Armoured Control Cable
5C x 4 sq mm PVC/Copper, Armoured Control Cable
5C x 2.5 sq mm PVC/Copper, Armoured Control Cable
7C x 2.5 sq mm PVC/Copper, Armoured Control Cable
10C x 2.5sqmm PVC/Copper, Armoured Control Cable
14C x 2.5 sq mm PVC/Copper, Armoured Control Cable
19C x 2.5 sq mm PVC/Copper, Armoured Control Cable
2C x 6 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable
4C x 16 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable
4C x 6 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable
3.5C x 70 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable
3.5C x 150 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable
3.5C x 300 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable
1C x 630 sq.mm XLPE/Aluminium, Armoured Auxiliary Power Cable

Annexure-A

VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

SL No	ITEM	VENDOR
~~1~~	~~AIR WASHER & UAF*~~	~~HYDERABAD POLUTION CONTROL~~
		~~SK SYSTEM~~
		~~ADVANCE VENTILATION~~
		~~DRAFT AIR~~
		~~BLUE STAR~~
		~~VOLTAS~~
		~~STERLING WILSON~~
		~~ROOTS COOLING SYSTEM~~
		~~C DOCTOR~~
		~~TAP~~
		~~Pack Plast~~
		~~Industrial projects and products~~
2	CENTRIFUGAL FAN	FLAKT
		KRUGER
		DRAFT AIR
		HYDERABAD POLUTION CONTROL
		ADVANCE VENTILATION
		PATEL AIR
		NICOTRA
		SK SYSTEM
		MARATHON
		CB DOCTOR
		SARLA
		Comefri
3	FRESH AIR/ SUPPLY/ EXHAUST/ RE UNIT FANS / PROPELLAR	HYDERABAD POLUTION CONTROL
		SK SYSTEM
		ADVANCE VENTILATION
		KRUGER
		NICOTRA
		MARATHON
		FLAKT
		CB DOCTOR
		SARLA (SITAL)
		PATEL AIR
		KHAITAN
~~4~~	~~PUMPS~~	~~BEST & CROMPTON~~
		~~JYOTI~~
		~~SAM TURBO~~
		~~KBL~~
		~~KSB~~

VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

		~~M&P~~
		~~VOLTAS~~
		~~BEACON-WEIR~~
		~~WORTHINGTON~~
		~~Flowmore~~
		~~SULZER PUMPS INDIA LTD.~~
		~~BHARAT PUMPS & COMPRESSORS LTD~~
		~~FLOWSERVE INDIA CONTROL PVT LTD~~
		~~V-FLOW PUMPS & SYSTEMS CO~~
		~~Kishore pumps~~
5	LV MOTORS (FLAME PROOF)	SIEMENS
		ABB
		CGL
		MARATHON
		KEC
		BHARAT BIJLEE
		BHARAT ELECTRIC
		NGEF
		JYOTI
		LHP
6	LV MOTORS (NON FLAME PROOF)	SIEMENS
		ABB
		CGL
		MARATHON
		KEC
		BHARAT BIJLEE
		BHARAT ELECTRIC
		NGEF
		JYOTI
		LHP
7	AIR FILTER	PUROLATOR
		FMI
		ANFILCO
		TENACITY
		JOHN FOWLER
		SPECTRUM
		AIR TECH
		PUROMATIC
8	INSULTATION MATERIAL	BEARDSHEL
		K-FLEX
		PARAMONT
		ARMAFLEX
		SUPREME

		LLOYDS
		UP TWIGA
		AEROCELL
9	FIRE DAMPER	TSC
		CARRYAIRE
		RAVISTAR (SYSTEM AIR)
~~11~~	~~BUTTERFLY VALVES~~	~~Audco~~
		~~Fouress Engg~~
		~~INTER VALVE~~
		~~BDK~~
		~~WEIR BDK~~
		~~TYCO~~
		~~CRANE PROCESS~~
		~~KEYSTONE~~
		~~Fluidline~~
		~~INSTRUMENTATION LTD~~
		~~R and D MULTIPLES (METAL CAST) PVT LTD~~
		~~SURYA VALVES AND INSTRUMENTS MFG CO~~
		~~PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED~~
		~~UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED~~
		~~VENUS PUMPS AND ENGG. WORKS~~
~~12~~	~~NON RETURN VALVE~~	~~Leader Valves~~
		~~H SARKAR~~
		~~Fluidline~~
		~~HI-TECH~~
		~~CRESCENT VALVES~~
		~~A V VALVES~~
		~~Bankim~~
		~~SHIVADURGA~~
		~~SURYA VALVES AND INSTRUMENT MANUFACTURING~~
		~~ATAM VALVES~~
		~~GM DAULI & SONS~~
		~~KBL~~
		~~VENUS PUMPS AND ENGINEERING WORKS~~
~~13~~	~~STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)~~	~~CRESCENT VALVES~~
		~~BDK~~
		~~Audco~~
		~~Fouress Engg~~
		~~KIRLOSKAR BROTHERS LTD.~~
		~~SANT VALVES~~

		~~BOMBAY METAL & ALLOYS~~
		~~Bankim~~
		~~Leader Valves~~
		~~H SARKAR~~
		~~AV Valves~~
		~~VENUS PUMPS~~
~~14~~	~~STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)~~	~~Fluidline~~
		~~HI –TECH~~
		~~SHIVADURGA~~
		~~SURYA VALVES AND INSTRUMENT MANUFACTURING~~
		~~ATAM VALVES~~
		~~GM DAULI & SONS~~
		~~KBL~~
~~15~~	~~Pipes (MS/GI) - ERW~~	~~SURYA ROSHNI~~
		~~TISCO~~
		~~DADU PIPES~~
		~~INDUS TUBES~~
		~~WELSPUN~~
		~~TATA~~
		~~BST~~
		~~JINDAL~~
		~~SAIL~~
		~~PSL~~
		~~LALIT PROFILE~~
		~~SAMSHI PIPE INDUSTRIES~~
		~~S MUKUT PIPES~~
		~~MANN INDUSTRIES~~
		~~SURENDRA ENGINEERING~~
		~~PRATIBHA PIPES AND STRUCTURES PVT LTD~~
		~~JCO GAS PIPES~~
		~~NUKAT TANK AND VESSELS~~
		~~GOODLUCK TUBES~~
		~~ADVANCE STEEL TUBES~~
		~~BIHAR TUBES~~
		~~HITECH PIPES~~
		~~RATNAMANI~~
		~~MAHARASHTRA SEAMLESS~~
16	GI SHEETS FOR DUCTING	TISCO
		INDIAN IRON & STEEL CO
		RASHTRIYA ISPAT NIGAM LIMITED
		ESSAR
		ISPAT INDUSTRIES

VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

		JSW
		LLOYDS
		Bhushan steels
		TATA
		SAIL
		JINDAL
17	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW
		TSC
		AIR MASTER
		CARRYAIRE
		RAVISTAR (SYSTEM AIR)
~~18~~	~~HUMID STAT~~	~~JHONSON CONTROL~~
		~~HONEYWELL AUTOMATION~~
		~~PENN~~
~~19~~	~~Y / POT STRAINER~~	~~MULTITEX~~
		~~GREAVES COTTON~~
		~~JAYPEE~~
		~~SANT VALVES~~
		~~OTOKLIN~~
		~~GRAND PRIX~~
		~~GUJARAT OTOLIFT~~
		~~DS ENGG~~
		~~SAROJINI ENTERPRISE~~
		~~BHATIA ENGINEERING~~
		~~FILTERATION ENGINEERS INDIA PVT LTD~~
		~~SUNGOV ENGINEERING~~
20	LOCAL CONTROL PANEL	INDUSTRIAL CONTROL & APPLIANCE
		Pyrotech Electronics Pvt. Ltd.
		Positronics Pvt. Ltd.
		CONTROL & SWITCHGEAR
		SIEMENS
		L&T
		GE POWER
		RITTAL
		HOFFMAN

VENTILATION SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

NOTES:

~~1. *Designed by Hyderabad Pollution Control / SK SYSTEM/ ADVANCE VENTILATION / DRAFT AIR/BLUE STAR/ VOLTAS/ STERLING WILSON/ROOTS COOLING SYSTEM/ C DOCTOR/ TAP/ Pack Plast/ Industrial projects and products & fabricated by their approved fabricator.~~

2. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.

3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.

SECTION-2
CUSTOMER SPECIFICATION

Customer contract document is enclosed as part of this specification. Only equipment specification pertaining to Section-1 shall be referred. Regarding quantities and type of Ventilation System equipment, Section-1 shall be referred.

2.1. PANEL SPECIFICATION

Refer Annexure-1 to Section-2

2.2. MOTOR SPECIFICATION

2.2.1 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.

2.2.2 Design margin

Whenever the basis for motor rating are not specified in the corresponding mechanical specification section maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.
The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
Service shall be considered as 1.0 only.

2.2.3 Efficiency

All the duty motors shall be energy efficient type. For HT and LT motors, it shall be IE3 class as per IS 12615.

2.2.4 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of air cooled motors shall not exceed 70^0C over air temperature of 50^0C by resistance method, while delivering its maximum rated output.
- Temperature rise of water cooled motors shall not exceed 80^0C over inlet cooling water temperature by resistance method, while delivering its maximum rated output.

2.2.5 Enclosure

a) Motors shall have IP 55 degree of protection.
b) For hazardous location, the enclosure of motors shall following have flame proof construction conforming to applicable standard.
   - Fuel oil area Group – IIB
   - Hydrogen generation plant area: Group – IIC

2.2.6 Cooling

LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.

2.2.7 Winding

Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.

2.2.8 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for inservice positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided.
- All the motors rated <15 kW shall be provided with sealed ZZ bearings.

2.2.9 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.2 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.

2.2.10 Earthing Terminals

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

2.2.11 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

2.2.12 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.
In addition to the minimum information required by IEC/IS, the following information shall be shown on motor rating plate:
- Temperature rise in ºC under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

2.2.13 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).

SECTION-3.10: LOW VOLTAGE (LV) SWITCHGEAR

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of low voltage switchgear.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

a) 415 V, AC intelligent Power control centres (PCC) for units, station, auxiliary plant and non plant buildings.
b) 415 V, AC intelligent Motor control centres (MCC) for units, station, auxiliary plant and non plant buildings.
c) 415 V, AC distribution boards for units, station, auxiliary plant and non plant buildings.
d) 415 V, AC Emergency PCC and emergency MCC for each unit.
e) 220 V DC distribution boards for units, station and auxiliary plants.
f) 415 V heater control panels for electrical heat tracing of fuel pipe lines
g) Local starters for units, station and auxiliary plants.
h) Local panels for units, station and auxiliary plants.
i) Local push button stations for various units, station and auxiliary plants.
j) Commissioning spares and consumables
k) Mandatory spares
l) Tools & tackles
m) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS/IEC standards including amendments, if any, except where modified and/or supplemented by this specification. Some of the applicable standards are listed below:

a)	IS 8623	Specification for low voltage switchgear and control gear Assemblies
b)	IS 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
c)	IS/IEC 60715	Dimensions of low-voltage switchgear and control gear - standardized mounting on rails of mechanical support of electrical devices in switchgear and control gear installations
d)	IS 12021	Specification for control transformers for switchgear and control gear for voltages not exceeding 1000 V
e)	IS 13032	Miniature circuit breaker boards for voltages not exceeding 1000 V
f)	IS/IEC60947	Specification for low voltage switchgear and control gear
g)	IS 694	Specification for PVC insulated cables for working voltage up to and including 1100 V
h)	IS 5	Colour for ready mixed paints and enamels
i)	IS 14372	Specification for volt-ampere hour meters for full power factor range
j)	IS 14415	Specification for volt-ampere hour meters for restricted power factor range
k)	IS 1248	Direct acting indicating analogue electrical measuring instruments and their accessories

l)	IS 2705	Specification for current transformers
m)	IS 3156	Specification for voltage transformers
n)	IS 3231	Specification for electrical relays for power system protection
o)	IS 6005	Code of practice for phosphate of iron and steel
p)	IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
q)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
r)	IEC 60439	Low voltage switchgear and control gear assemblies
s)	IEC 60947	Low voltage switchgear and control gear
t)	IEC/TR 61641	Enclosed low-voltage switchgear and control gear assemblies – Guide for testing under conditions of arcing due to internal fault

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Power supply voltage shall be considered as follows:

- Motors rated > 0.2 kW and up to 200 kW : 415 V, 50 Hz, 3 Phase
- Motors rated up to 0.2 kW : 240 V, 50 Hz, Single Phase
- Panel lighting & Space Heater : 240 V, 50 Hz, Single Phase
- Control Supply : 220 V DC

4.2.0 Current Rating

4.2.1 Ambient temperature prevailing inside the switchgear while carrying rated current, when the outside air ambient temperature is 50˚C shall be considered as design ambient temperature for sizing the equipment/device/bus rating. Continuous current rating shall be such that the temperature does not exceed 90˚C. For silver plated joints the temperature shall not exceed 105˚C.

4.2.2 The continuous current rating of the feeders shall be based on the name plate current rating of the connected equipment with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.

4.2.3 The continuous current rating of the incomers/tie feeders/main bus bars of PCC shall be based on the name plate rating of the upstream transformer with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.

4.2.4 The continuous current rating of the incomers/tie feeders/main bus bars of other switchgear shall be based on the continuous current rating of the all the connected loads with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.

4.2.5 For switchgear having two bus sections, each bus section, bus coupler and incomer shall be rated for the combined load requirements of both the bus sections.

4.2.6 Similar equipment and components shall be of same make. Equipment / Module of same type and rating shall be interchangeable.

4.2.7 The design of the LV Switchgear shall include all devices required for remote control & monitoring from DCS. It shall be monitored from the EMS system also.

4.2.8 The power control centres and motor control centres shall be intelligent type.

4.3.0 **Protection**

4.3.1 The Contractor shall be responsible for selection of protective devices so as to provide optimum protection and discrimination of various circuits and equipment including the safety of the devices. For motor feeders, coordination of overload relay and MPCB/MCCB with the thermal characteristics of the motor shall be ensured.

4.3.2 MCCB / MPCB, contactor and Electronic overload relay for motor feeders shall meet type-2 coordination as per applicable standard.

4.3.3 The incomer modules shall be interlocked with their upstream breaker such that they can be closed only when upstream breaker is closed and trip automatically when upstream breaker is tripped.

4.3.4 Each breaker module shall be provided with multifunction numerical relay for protection. Relays shall have built in protection, control & metering and communication modules suitable for IEC-61850 protocol.

4.4.0 **Control**

4.4.1 Incomers and bus coupler of PCCs shall have air circuit breaker (ACB). PCC refers to LV switchgear connected to load center transformer which consists of outgoing power feeders and outgoing motors feeders.

4.4.2 Outgoing feeders of PCC shall be controlled by ACB / moulded case circuit breakers (MCCBs) depending on their ratings / applications.

4.4.3 Incomers and bus couplers of MCCs shall be breaker controlled. Outgoing feeders of MCCs shall be controlled by MCCBs / Motor protection circuit breakers (MPCBs) and contactors depending on their ratings / applications.

4.4.4 Feeders rated above 630 A shall be controlled by ACBs, unless specified otherwise. Feeders rated up to 630 A may be controlled by MCCBs. However ACB shall be used for 400 A and 630 A feeders where auto changeover is envisaged at incomer / bus coupler.

4.4.5 ACBs shall be used for motor feeders rated above 125 kW for direct-on-line (DOL) starting.

4.4.6 MCCB/MPCB Contactor starter units shall be used for motor feeders rated up to 125 kW for DOL starting.

4.4.7 Feeders of 415 V PCC/MCC shall be controlled from DCS or Respective control system and Local Push Button (LPB) Station as per scheme requirement.

4.4.8 Remote selection shall enable control from DCS/Respective control system.

4.4.9 The control/interlock schemes for various types of feeders shall be commensurate with their applications.

4.4.10 Local start push button shall be hardwired to DCS/Respective control system so as to check the process permissive for starting the drives, whereas local stop push button shall be directly hard wired to concerned switch gear for tripping.

4.5.0 **Changeover Scheme**

4.5.1 All PCCs and ACB operated MCCs shall be normally operated with the bus coupler breaker open. Auto-changeover facility shall be provided such that if there is a prolonged under voltage on any one of the bus sections, the respective incoming breaker shall trip and the bus coupler breaker shall close, provided on the other bus section is healthy. This auto-changeover shall be

blocked if the incoming breaker had tripped either on a bus fault or manually. Changeover back to the normal source of supply shall be done manually.

4.5.2 Planned changeover facility shall be provided for PCC and ACB operated MCC. When planned outage of one of the normal incoming supplies is required, the respective incomers shall be tripped automatically after the bus coupler breaker is closed manually through synchro-check relay. For this purpose, a trip selection shall be provided in DCS/Respective control system for selecting the incomer to be tripped. Thus, depending on the selection made incomer A or incomer B shall be tripped once bus coupler breaker is closed manually, thus maintaining continuity of supply. A timer for annunciation of the running breaker failing to trip within a pre-set time, (i.e. if the two sources remain paralleled for more than a pre-set time) shall be provided. When the normal supply is to be brought back into operation, the incomer breaker shall be closed through synchro-check relay whereupon the bus section breaker shall trip automatically. All hardware required for meeting the functional requirements stated above, shall be included.

4.6.0 Emergency MCC

4.6.1 Emergency MCC to supply power to important emergency loads/motors for safe shut-down of unit shall be provided for each unit. It shall have two bus sections (A&B) with a bus coupler. Bus section-A shall have two incomers, one from Unit PCC and the other from emergency PCC. Bus section-B shall have one incomer from station PCC. All the incomer breakers in the emergency MCC shall be 4 Pole. Bus coupler shall be normally closed.

4.6.2 In case of failure of unit supply to the Emergency MCC, the station supply shall be switched ON automatically and in case of total failure of AC supply of the power station, the supply from emergency PCC shall be switched ON automatically.

4.6.3 DG PCC shall have two incomers, one incomer fed from respective Unit DG set and second incomer fed from standby DG set. In case of failure of unit DG set, the stand-by DG set shall be switched ON.

4.6.4 All service like essential motors for safe shutdown of the unit, UPS incomers, battery charger AC supply, lighting, etc. shall be connected to this MCC. DG supply shall be extended to emergency MCC in less than 15 sec from loss of power.

4.6.5 On restoration of normal supply, the changeover of DG supply to normal supply at Emergency MCC shall be done with synchronizing facility to avoid interruption of supply.

4.6.6 For DG paralleling / load testing, separate breaker shall be provided in main plant AC MCC & Emergency MCC. Load test of DG set can be carried out using connected loads on the AC MCC switchgear.

4.7.0 Essential Service Modules

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

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

5.0.0 CONSTRUCTIONAL FEATURES

5.1.0 General

5.1.1 PCC/MCC/DB shall be metal enclosed, indoor, floor mounted and free standing type. Switchgear frames, load bearing members, doors and covers and gland plates shall be fabricated using CRCA sheet steel. The thickness of sheet shall be not less than 1.6 mm for non-load bearing members and 2.0 mm for load bearing members. Gland plate thickness shall be minimum 3.0 mm.

5.1.2 PCC / MCC shall be drawout type and distribution boards can be fixed type with compartmentalized construction.

5.1.3 Suitable synthetic rubber gaskets shall be provided to make switchgear completely dust-proof and vermin-proof with a degree of protection of IP 52 for all switchgear. However, degree of protection for bus bar chamber where the bus bar is rated above 1600 A can be IP 42.

5.1.4 All switchgear shall be compartmentalized (conforming to Form 4b of IEC 60439-1) with uniform height not exceeding 2450 mm. Module size of switchgear shall not be less than 200 mm.

5.1.5 The switchgear shall be arc proof tested. In the event of an internal fault in a functional unit, the damage shall be confined to that unit alone, so that the busbar system and all other functional units remain fit for further service. Switchgear assemblies shall comply with IEC 61641 with regard to internal arc testing.

5.1.6 The arrangement of feeders in the switchgear shall take into consideration the number and size of cables required for the feeders. Incomer and bus section ACB shall be limited to one per panel. ACB outgoing feeders shall be limited to two per panel for ratings up to 1000 A. For ratings 1250 A and above, the number of outgoing feeders shall be limited to one per panel.

5.1.7 Bus duct entry shall be from top and cable entry shall be from bottom for PCCs/MCCs/DBs. Switchgear shall be divided into distinct vertical sections (panels), each comprising of the following compartments:

- Main bus bar compartment
- Switchgear/feeder compartment
- Cable alley of at least 300 mm width
- Auxiliary bus bar compartment
- Control compartment for relays for ACB feeder

5.1.8 Switchgear shall be of modular design, consisting of modules, segregated into single or multi-tier compartments. Each module shall be placed in individual compartment. All module grouped together shall form the complete switchgear. Completed switchgear shall be of flush-fronted design having a neat appearance and shall be readily extensible.

Door shall be provided at the front of each compartment to give full access to all the components and the compartment.

Switchgear covers (including doors without interlock) shall be bolted type and shall be designed to give access to individual circuits without exposing other circuits, which may be live. Alternatively, circuits exposed by the removal of the cover shall be individually shrouded.

5.1.9 The switchgear shall be designed to prevent contact with live parts both within the modules and in the cable alley. Following are the minimum segregations to be provided amongst the different parts of the switchgear:

a) Main horizontal bus bar chamber and vertical bus bar chamber

b) Between different modules
c) Between modules and cable chamber
d) Between auxiliary bus bars and the rest of the switchgear
e) Between vertical bus bars and modules

All insulating materials used as partitions guards and shrouds shall be non-hygroscopic and flame retardant.

5.1.10 Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module. Defeat interlock shall be provided for the module comprising of MCCB/MPCB as a means of isolation, such that it is possible to open the door with device ON and the module in 'SERVICE' position. The following shall apply under these conditions:

a) It shall not be possible to close the door till the interlock has been reinstated
b) Attempted withdrawal of the module under such conditions shall be cautioned against by providing warning label affixed at an appropriate place

5.1.11 Switchgear shall be equipped with thermostatically controlled space heaters in each panel (separate for front and rear in case of double front panels having separate cable alleys) so as to maintain interior temperature 5˚C above the ambient. They shall have MCB for protection.

5.1.12 All LT switchgear modules shall be provided with lock and Key arrangement with key rack located in respective control room.

5.1.13 At least 20% of feeder modules covering the range of motors/ outgoing feeders used subject to minimum of one module in each bus section shall be provided as spare. Spare modules shall be completely wired up.

5.1.14 20% of control terminals in each module shall be provided as spare subject to a minimum of 2 terminals.

5.2.0 **Feeder Modules**

5.2.1 Drawout modules shall have the following features:

a) Withdrawal of module shall be possible without disconnecting wires.
b) Drawout units of similar type and rating shall be interchangeable.
c) Secondary connections to the drawout module shall be through self-aligning and self-isolating contacts. In case of circuit breakers, easily disconnecting type plug and socket shall be acceptable in place of self-aligning and self-isolating type contacts.
d) With the drawout module fully removed from its housing, live parts exposed shall either be finger proof or shall have means to shroud them totally to prevent contact. Suitable add-on type shrouds shall be provided where automatic shutters or in-built shrouds are not provided.

5.2.2 All single front switchgear shall be provided with single leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with 'DANGER' labels.

5.2.3 Drawout modules shall have distinct 'SERVICE' and 'TEST' positions. The equipment pertaining to a drawout type module shall be mounted on a fully withdrawable chassis, which can be drawn out without having to unscrew any wire or cable connection. Suitable arrangement with cradle/rollers and guides shall be provided for smooth movement of the chassis.

5.2.4 Each switchgear shall be provided with removable type gland plate, which shall cover the entire cable alley. For all single core cables, gland plate shall be of non-magnetic material.

5.2.5 The arrangement of the feeders shall ensure that operating handle of the switch/breaker shall be above 350 mm but below 1800 mm from finished floor level.

5.3.0 **Bus Bars and Insulators**

5.3.1 Each PCC/MCC/DB shall be provided with three phase bus bars and one neutral bus bar. DC distribution boards shall have two bus bars.

5.3.2 Bus bars (including neutral bus bar) shall be capable of carrying the short time current for the duration as specified, without any damage. Current carrying capacity of neutral bus bar shall be minimum half that of the phase bus bar.

5.3.3 For double front type of board, separate vertical bus bars for each front shall be used.

5.3.4 All bus bars shall be made of high conductivity copper/aluminium alloy. They shall be supported on insulators of material such as fiber reinforced polyester or epoxy cast resin.

5.3.5 Minimum air clearance for horizontal and vertical bus bar termination shall be 25 mm between phases and 20 mm between phase and earth. For all other components the clearance shall be 10 mm minimum.

5.3.6 All bus bars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength insulators. All bus bar joints shall be provided with high tensile steel bolts, belleville/spring washers and nuts. All bus bars and bus taps shall have HRPVC sleeves, colour coded as follows:

- Red, yellow & blue for R, Y & B phases respectively
- Black for neutral
- Grey & white for positive and negative respectively

5.3.7 All horizontal and vertical bus bars and joints shall be covered by insulating shrouds.

5.3.8 Contact surfaces at all joints shall be silver plated or properly cleaned and anti-oxide grease applied to ensure an efficient and trouble free connection. In case of dissimilar metal connections (copper to aluminium), proper treatment shall be given to minimize bimetallic effect. All such joints shall be silver/tin plated or suitable bimetallic washers shall be provided.

5.3.9 Auxiliary bus bars each of minimum 25 sq.mm thick electrolytic tough pitch copper shall be provided for the following applications.

- 240 V AC supply for panel space heater/motor space heater/panel illumination
- 220 V DC control supply for breaker tripping and closing, spring charging motors, indication circuits
- 110 V AC control supply for contactor operated motor starter control circuits as applicable

5.4.0 **Control Supply and Space Heater Supply**

5.4.1 PCC and ACB operated MCC shall have redundant 220 V DC control supply and shall have diode auctioneering. Each panel shall receive control supply through bus wires tapped off from auxiliary copper bus bar through MCBs provided in the respective panel. It shall be possible to isolate any panel without disturbing the power supply to other panels. Each sub-circuit shall have separate MCB.

5.4.2 An under voltage relay to monitor control supply shall be provided. A contact of the relay shall be wired to the terminal for external use. Control Supply Failed' indication shall be provided.

5.4.3 PCC/MCC shall derive 110 V AC control supply through 2X100% rated 415 /110 V transformer and shall be provided with changeover arrangement. Changeover shall be blocked for control

bus bar fault. The control transformers shall be of insulation class 'B' or better. The sizing of control transformers shall be carried out considering the load of power contactors, auxiliary contactors, indicating lamps and other equipment including remote auxiliary relays and lamps in the circuit with 20% design margin. One pole of secondary winding shall be earthed.

5.4.4 For PCC and MCC 240 V AC Space heater supply shall be derived from 415/230 V control supply transformer located one in each bus section. Necessary MCB to isolate and distribute the supply shall be provided. For DB, 240 V AC space heater supply can be derived from incoming supply itself.

5.4.5 All motors rated 30 kW and above shall be provided with power supply for space heater. Circuit for motor space heater shall be wired through auxiliary NC contact of breaker/contactor and MCB.

5.4.6 Each panel of PCC/MCC/DB shall be equipped with the following as required:

- Thermostatically controlled space heater(s).
- Illumination lamp with door switch
- 5 Amp 3 pin socket with MCB protection.

5.5.0 **Air Circuit Breakers**

5.5.1 Air circuit breakers shall be stored energy, trip free, air break and horizontal drawout type and shall have fault making and breaking capacities as specified. There shall be 'SERVICE', 'TEST' and 'ISOLATED' positions for the breakers. In 'TEST' position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the 'SERVICE', 'TEST' or 'ISOLATED' position. It shall be possible to close the door in 'TEST' position.

5.5.2 Breakers of different ratings shall not be interchangeable. Front fascia cut-outs for all ratings of breakers shall be identical.

5.5.3 The spring charging mechanism of the circuit breaker shall be motor operated. The close/trip control switch shall be interlocked to trip before close. The closing and tripping circuits shall be self-opening on completion of their respective functions irrespective of the position of the control switch. Manual closing devices shall also be provided. The circuit breaker shall be electrically and mechanically trip free. For all circuit breakers electrical anti-pumping device shall be provided.

5.5.4 The fixed portion of the circuit breaker shall have rail arrangement over which the chassis can move smoothly. Proper mechanical indication shall be provided for the three positions ('SERVICE', 'TEST' and 'ISOLATED') without opening the compartment door. It shall be possible to bring the circuit breaker to isolated position with the help of external lever without opening the compartment door. The circuit breaker can be padlocked in OFF position with door interlock defeat facility.

5.5.5 The following interlocks shall be provided on the circuit breaker:

- It shall not be possible to withdraw the circuit breaker from the service position with the contacts of the breaker closed
- It shall not be possible to close the circuit breaker unless any one of the three positions is located
- It shall not be possible to open the compartment door when the circuit breaker is ON

5.5.6 It shall not be possible to close the breaker under following conditions:

- Stored energy mechanism is not charged
- Shunt release is energized
- OFF push button is locked in OFF position

5.5.7 The circuit breaker shall be provided with mechanical ON/OFF, 'TRIP', 'SPRING CHARGED/DISCHARGED', 'READY TO CLOSE' and breaker position indications and mechanical trip push button. An operating handle shall also be provided to charge the spring manually.

5.5.8 The circuit breaker shall be provided with automatic safety shutters, so that before the breaker reaches 'ISOLATED' position the main isolating contacts are completely shrouded. In the drawout condition, it shall be possible to inspect the breaker fixed contacts condition by lifting the shutters.

5.5.9 When the circuit breaker compartment door is open, it shall not be possible to touch the live parts. All removable covers protecting live parts shall be clearly labeled with warning notices reading 'LIVE PARTS. ISOLATE ELSEWHERE BEFORE REMOVING COVER'. It shall be possible to readily remove the arc chutes for routine inspection of the contacts with the circuit breaker in the withdrawn position. Contact erosion indicator shall be provided on moving contacts of breaker for visual indication of contact life.

5.5.10 Each breaker feeder shall be provided with the following:

- An anti-pumping relay
- Motor charged spring operating mechanism
- Manual spring charging and manual closing mechanism
- Mechanical indication of spring charge
- Mechanical position indicator (to show whether the breaker is in the 'ON' or 'OFF' positions and in the 'SERVICE', 'TEST' or 'ISOLATED' positions)
- Closing coil
- Shunt trip coil
- CTs for protection
- Manual trip push button
- Phase barriers
- Shutter assembly
- Door interlock kit
- Operation counter
- Intelligent control unit

5.5.11 The closing coil and spring charging motor shall operate satisfactorily for all values of control supply voltage between 80% and 110% of the rated voltage. But, the shunt trip coil shall be designed such that it shall operate satisfactorily for all values of control supply voltage between 70% and 110% of the rated voltage. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to motor.

5.5.12 Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle. The trolley shall be such that the topmost breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. Also, it shall be such that all types, sizes and ratings of breakers can be withdrawn / inserted in the switchgear.

5.6.0 Contactor Starter Unit

5.6.1 All motors rated up to 125 kW shall be controlled by direct-on-line contactor starters. MPCB shall be used for motor feeders rated up to 15 kW. For feeders rated above 15 kW and up to 125 kW, MCCB shall be used. The starting circuit shall consist of the following:

- Isolating device (MCCB/MPCB)
- Contactor as main means of starting and stopping of motor
- A short circuit protective device (Inbuilt feature of MPCB/MCCB)
- Electronic overload protection relay with current display unit & built-in single phasing prevention feature
- CT operated numerical relay for motor feeders rated 75 kW and above
- Intelligent control unit

5.6.2 Withdrawable contactor starter units shall be provided with means for mechanically indicating the 'SERVICE' and other positions.

5.7.0 **Moulded case Circuit Breakers (MCCB) / Motor Protection Circuit Breakers (MPCB)**

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

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

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

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

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

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

5.7.7 MCCBs/MPCBs shall have following accessories and features:

a) Shunt trip release
b) Under voltage release
c) Auxiliary contact for ON/OFF/ trip position
d) Fault signaling contact
e) Insulation shields to isolate the connection between each pole
f) Finger protection plate to prevent accidental contact
g) The compartment door shall be interlocked with handle of MCCB/MPCB.

5.8.0 **Control and Selector Switches**

5.8.1 All circuit breaker operating switches shall be of the pistol grip type, spring return to neutral and lockable in that position. The trip, neutral and close positions shall be clearly indicated.

5.8.2 Ammeter and voltmeter selector switches shall have four stay put positions with adequate number of contacts for 3 phase 4 wire system. These shall have oval handles. Ammeter

selector switches shall have make before break type contacts to prevent open circuiting of CT secondary

5.8.3 Local/Remote selector switch shall be provided as per control requirement.

5.9.0 **Contactors**

5.9.1 Contactors shall be of air break, electromagnetic type rated for uninterrupted duty. Contactors shall be double-break, non-gravity type and their main contacts shall be silver faced copper. Direct-on-line contactors shall be of utilization category AC3. Full voltage reversing starters shall comprise of forward and reverse contactors mechanically and electrically interlocked with each other. These contactors shall be of utilization category AC4. DC contactor shall be of utilization category DC3. The contactor rating shall be chosen to provide type-2 discrimination. However, the minimum rating shall be 16 A.

5.9.2 Electronic over load relay shall have selectable setting, self-powered, ambient temperature compensated, sensitive to phase loss/unbalance, trip free mechanism, with trip indication, test and stop function, current display etc. Type-2 coordination shall be ensured between MCCB/MPCB, contactor and overload relay.

5.10.0 **Miniature Circuit Breaker (MCB)**

MCB shall be rated for atleast 10 kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCB shall have overcurrent protection, ON/OFF position indicators and auxiliary contact block for ON/OFF/Trip positions.

5.11.0 **Instrument Transformers**

All current and voltage transformers shall be completely encapsulated, cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchgear is operating at its rated condition and the specified ambient temperature. The class of insulation shall be ‘B’ or better.

Current Transformers shall be cast-resin type with 1 A secondary. Separate cores shall be used for metering and protection. Accuracy class of the current transformers shall be class 5P20 for relaying and Class 0.5 and ISF<5 for metering.

Voltage transformers shall be cast-resin drawout type and shall have an accuracy class of 0.5/3P for metering & protection. Voltage transformer mounted on breaker carriage is not acceptable. It shall have a continuous voltage factor of 1.2 with short time over voltage factor of 1.5 for 30 seconds. The VT shall be provided with MCCB on the primary side and MCBs on secondary side.

5.12.0 **Relays and Timers**

5.12.1 Relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent and dust tight covers removable from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay.

5.12.2 Relays shall have lock-out facility with manual reset. Each circuit breaker feeder shall be provided with separate latched lockout relay (86), trip circuit supervision relay, necessary auxiliary relays, timers, etc. to meet circuit requirements. In addition self-reset type lockout relay to be provided on Bus PT Panel for Under voltage tripping the motor feeders.

5.12.3 Lock out relay contacts shall only be provided for protection trip & reset status for use in close and trip interlocks of the circuit breaker.

5.12.4 Auxiliary supply voltage for relays and transducers shall be 220 V DC. Relays shall be capable of satisfactory continuous operation between 80-120% of the rated voltage.

5.12.5 Failure of a control or auxiliary supply and de-energisation of a relay shall not initiate any circuit breaker operation. All relays shall withstand a minimum test voltage of 2 KV AC Rms for one minute.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.12.20 Timer functions shall be programmable for on/off delays.

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

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

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

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

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

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

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

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

5.12.28 Ethernet switches shall be ‘substation hardened’ and shall comply with IEC61850-3 for communications and environment requirements. The Ethernet switches shall be of managed type with two (2) no. of fibre optic cable ports for ring network and Fourteen/Sixteen of Copper ports to achieve the LAN configuration. These switches shall be mounted inside the switchgear Panel.

5.12.29 The switchgear shall be provided with DC fail relay and DC fail indication lamp.

5.12.30 Breaker auxiliary contacts used for interlocking purposes shall be multiplied using electrically latched relay.

5.12.31 Protection relays shall include, protection functions but not limited to the following:

a) Incomer feeder from transformers:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Under voltage relay (27)

b) Normal Incomer feeder (Direct from Upstream switchgear):
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Under voltage relay (27)

c) Bus Coupler feeder:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Check Synchronizing relay (25C)

d) Outgoing ACB operated Motor feeder:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Over load (49)
- Negative sequence (46)
- Phase Reversal (46 R)
- Restart inhibit with startup counter (37)
- Locked rotor (48-LR)
- Under current (66)

e) Other Outgoing feeder:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)

f) Bus PT:
- 3 phase Under voltage relay

5.13.0 Indicating Instruments

5.13.1 All indicating instruments and meters shall be capable of carrying continuously their full load currents and full voltage across their coils. They shall not be damaged by the passage of fault currents or the existence of over voltage on the primary side of their instrument transformers for the maximum permitted duration of fault conditions which may occur during normal operation. All instruments and meters shall be back connected.

5.13.2 Meters and transducers for 415 Volts PCCs

For incomers feeders following Meters and transducers shall be provided:
- Current transducer on ‘Y’ phase
- Voltage transducer on ‘Y-B’ phase
- 1.0S class energy accounting and audit meter
- 1.0 class digital multi-function meter

For Bus Coupler following Meters and transducers shall be provided:
- Current transducer on ‘Y’ phase
- 1.0 class digital multi-function meter

For ACB outgoing feeders following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class digital multi-function meter

For ACB motor feeders following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase

For contactor motor feeders 15 kW & above following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase
- Electronic overload relay with current display in switchgear.

For contactor motor feeders less than 15 kW following Meters and transducers shall be provided:
- Electronic overload relay with current display in switchgear.

For Bus PT following Meters and transducers shall be provided:
- Digital Voltmeter measuring all three phases
- Voltage transducer on three phases
- Power factor transducer

5.13.3 Meters and Transducers for 415 Volts MCCs

For incomers feeders following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- Voltage transducer on 'Y-B' phase
- 1.0 class digital multi-function Meter.

For Bus Coupler following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class digital multi-function Meter.

For Bus PT following Meters and transducers shall be provided:
- Digital Voltmeter measuring all three phases
- Voltage transducer on three phases

For contactor motor feeders 15 kW & above following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase
- Electronic overload relay with current display in switchgear.

For contactor motor feeders less than 15 kW following Meters and transducers shall be provided:
- Electronic overload relay with current display in switchgear.

5.13.4 Meters and Transducers for 415 Volts DBs

For incomers feeders following Meters shall be provided:
- Digital voltmeter measuring all three phases
- Digital ammeter measuring all three phases

For Bus PT following Meters shall be provided:
- Digital Voltmeter measuring all three phases

5.13.5 Energy accounting and audit meters shall meet CEA regulation. It shall be integrated with integrated energy management system. The energy audit meters shall be suitable for measurement, recording and display of cumulative active energy with date and time. It shall

have data storage capacity for at least 35 days in a non-volatile memory. It shall have facility to download the parameters through meter reading instruments as well as remote transmission of data over communication network. It shall also have the facility to measure, record and display the following parameters. All parameters excluding instantaneous electrical parameters shall also be stored in memory.

(a) Apparent power
(b) Phase wise kilowatt at peak KVA
(c) Phase wise KVA(reactive) at peak KVA
(d) Phase wise voltage at peak KVA
(e) Power down time
(f) Average power factor
(g) Line currents
(h) Phase voltages
(i) Date and time
(j) Tamper events

5.13.6 Digital Multifunction Meters shall be provided with bright LED/LCD display for local indication and shall be provided with communication port suitable for communicating on MODBUS protocol to EMS/DCS. It shall display various parameters like 3 phase currents, voltages, PF, MD, KW, KVA, etc. for local indication and shall be provided with minimum 8 nos. of user programmable registers for communicating any of the displayed parameters to the remote.

5.13.7 For motor feeder, analog ammeter with accuracy class 1.0, of 96x96 sq.mm square with 240° scale. Shall be provided. It shall have cramped scale above 2 times to 8 times the rated current for indicating the starting current.

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

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

5.14.0 **Push Buttons**

5.14.1 Push buttons shall be of heavy duty, spring return and push-to-actuate type. Their contacts shall be rated to make, continuously carry and break 10 A at 240 V AC and 1 A (inductive) at 220 V DC.

5.14.2 All push buttons shall have two nos. NO and two nos. NC contacts, unless specified otherwise. The contact faces shall be of silver alloy. All push buttons shall be provided with integral escutcheon plates marked with their functions.

5.14.3 The colour of the button shall be as follows:

- Green for motor START and breaker CLOSE
- Red for motor STOP and breaker OPEN
- Black for valve/damper OPEN/CLOSE commands
- Black for all annunciation functions, overloads, reset and miscellaneous commands

5.14.4 All push buttons on panels shall be located in such a way that red push buttons shall always be to the left of green push buttons. All emergency push buttons shall have mushroom knobs.

5.15.0 **Indicating Lamps**

5.15.1 Indicating lamps shall be of the panel mounting clustered LED type. The lamps shall have escutcheon plates marked with their functions, wherever necessary. Bulbs and lamp covers shall be easily replaceable from the front of the cubicles. Low Voltage Glow Prevention (LVGP) feature shall be provided for indicating lamps. Lamps shall have translucent lamp covers of the following colour, as warranted by the application :

- Red for motor ON, valve/damper OPEN and breaker CLOSE
- Green for motor OFF, valve/damper CLOSE and breaker OPEN
- Amber for TRIP
- Blue for 'SERVICE' position indications
- White for all healthy conditions (e.g. control supply, lockout relay healthy, spring charged condition etc.)
- White for 'TEST' position indications
- Red, yellow, blue for R, Y and B phases respectively

5.15.2 Indicating lamps shall be located just above the associated push button/control switch. Red lamps shall invariably be located to the right of green lamps. When associated with push buttons, red lamps shall be directly above the green push button and green lamp shall be directly above the red push button.

5.15.3 All indicating lamps shall be suitable for continuous operation at 85% to 110% of their rated voltage.

5.15.4 For incomer and bus, indicating lamps for R, Y and B phases shall be provided.

5.16.0 **Wiring**

5.16.1 Wiring shall be by 1100 volt grade multi-stranded PVC insulated copper wire having a cross-sectional area of not less than 1.5 sq.mm. All connections from CT leads up to instruments, relays and terminal board shall be made by copper wires of minimum 2.5 sq.mm size. The cables shall be tested for flammability test as per applicable standards and shall also withstand service temperature without deterioration.

All wiring shall use the colour codes specified below:

- 3 phase AC connections Red, yellow & blue for R, Y & B phases respectively
- 1 phase AC connections Red and black for phase and neutral respectively
- DC connections Grey & white for positive and negative respectively
- Earth connection Yellow-Green

5.16.2 Wiring shall be run mostly clear of all metal parts in insulated cleats, properly routed and neatly bunched. However, PVC wire holders and channels shall be preferred for running of wiring. Where wiring passes from one compartment to another, the aperture shall be 'bushed' to prevent damage of wires against sheet metal edges. Bushes may comprise of good quality rubber grommets.

5.16.3 Where single phase conductors are associated with the 3 phase system from which they are derived, the phase conductor shall use the same colour as the phase from which it is derived.

5.16.4 Inter-module bus wires shall be kept separate from all other wiring. AC or DC terminations shall be grouped function-wise as far as possible and labels of the function shall be affixed.

5.16.5 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal. Terminal boards shall be mounted vertically at the side of the cubicle or in horizontal rows and properly spaced to have clean wiring

arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked on the panel.

5.16.6 Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped. All internal wiring terminations shall be made with solder less crimping type heavy duty tinned copper lugs. Insulation sleeves shall be provided over the exposed parts of lugs.

5.16.7 Engraved core identification plastic ferrules marked to correspond with panel wiring diagrams shall be fitted at both ends of each wire.

5.16.8 Control terminal blocks shall be of 650 V grade, rated for 10 A and in one piece molding. It shall be complete with insulating barriers, clip-on type terminals and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities.

5.16.9 In all the panels, at least 20% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks.

5.16.10 All interlocks shall be hardwired in the switchgear itself.

5.16.11 The wiring shall be complete in all aspects so as to ensure proper functioning of control, protection and interlocking scheme. All the wiring shall be complete up to terminal blocks on the side of each unit/module.

5.16.12 Adjacent rows of terminal blocks shall be spaced not less than 100 mm apart.

5.16.13 The terminal blocks shall be mounted inside the module (and not in cable way) in a manner so as to provide easy access to terminals and to enable ferrule numbers to be read without difficulty.

5.16.14 All inter-panel wiring shall be carried out within the switchgear before dispatching the panel.

5.16.15 A typed circuit directory, card holder and card with clear plastic covering shall be provided on the inside of each cabinet door. The directory card shall provide space to identify each circuit in the panel board. An electronic copy of the circuit directory shall be provided to the Owner.

5.17.0 **Cable/Busduct Termination**

a) PMCC/MCC/DB shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection. Add-on panels shall be considered for cables, if any.

b) Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminium conductor, XLPE insulated, armoured and FRLS PVC sheathed cables.

c) Sufficient space and support arrangement shall be provided in the cubicles to accommodate cables.

d) Cables shall be PVC insulated, armoured, extruded FRLS PVC overall sheathed with 2.5 sq.mm for control & current circuits and 1.5 sq.mm for voltage circuits and PVC insulated, armoured, extruded FRLS PVC overall sheathed with stranded copper / aluminium conductor for power circuits.

e) All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned copper lugs, brass compression glands with tapped washer and terminals blocks.

f) The gland plates and supporting arrangement for 1/C power cable shall be such as to minimize flow of eddy current.

g) For all DG sets & service transformers rated 1000 KVA and above shall be connected through bus ducts to the respective switchgear panel. Busduct entry shall be from the top.

5.18.0 **Name plates and labels**

5.18.1 Nameplates shall be of 3 ply laminate with black lettering on white background. The following shall be provided with nameplates/warning labels as described below:

- Main name plate for PCC/MCC/DB on front and back sides
- All incomers and outgoing feeders indicating description, rating, equipment no., feeder no., etc.
- All door mounted components
- Panel numbers on front and rear
- Warning labels for interlocks

All name plates shall be fastened by means of screws to the panel.

Danger labels shall be provided for the following:

- MCC as per statutory regulations
- Bus bar chamber
- Cable alley housing live terminals

5.18.2 Name plate or polyester adhesive stickers shall be provided inside the panel for all equipment (lamps, push buttons, switches, relays, auxiliary contactors etc.) mounted on the switchgear.

5.18.3 Special warning plates, one each on each front of a shipping section, shall be provided on removable covers of doors giving access to cable terminals and bus bars. Special warning labels shall be provided inside the switchgear also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

5.18.4 All major components such as breakers, switches, contactors, CTs etc. shall be provided with labels indicating their ratings.

5.18.5 For single front switchgears, similar panel and board identification labels shall be provided at the rear also.

5.19.0 **Earthing**

5.19.1 Two earth terminals shall be provided on each switch cubicle, at the rear side. An earth bar of at least 50 x 10 mm aluminium shall be fixed to these terminals. The earth bar shall be electrically continuous and shall run the full extent of each board. This earth bar shall be on the same side as the cable entry and shall be extended on both sides of the panel.

5.19.2 Each unit shall be constructed to ensure satisfactory electrical continuity between all metal parts not intended to be alive and earth terminals of the unit. Suitable holes with bolts and nuts shall be provided at each end of earth bar of switchgear for connection to a main earthing grid.

5.19.3 The earth bar shall be accessible in each cable entering compartment either directly or through a branch extension to earth the cable armour and shields. 10 mm diameter holes shall be drilled and hardware for connection provided through the earth bus.

5.19.4 The cores of transformer (bus voltage transformer, control transformer, heating transformer etc.) shall also be earthed through copper wire. Doors shall have a copper wire for earth

connection to fixed unit. VT and CT secondary neutral point earthing shall be at one place only on the terminal block.

5.19.5 All non-current carrying metal work of the switchgear/panel shall be effectively bonded to the earth bus. All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth bus by independent stranded copper wires of size not less than 2.5 sq.mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. All hinged doors shall be earthed through flexible earthing braid.

5.20.0 **Wall Mounted Distribution Boards**

5.20.1 Wall mounted distribution boards shall be metal enclosed, suitable for outdoor mounting on wall or steel structures with suitable hood on the top. The enclosure shall be cold rolled sheet steel of at least 1.6 mm thickness. Gland plate shall be of 2 mm thick. The board shall be dust and vermin-proof and shall have a degree of protection of IP-55. MCB/motor protection circuit breaker (MPCB) shall be rated for 10 kA short circuit rating. MPCB shall have adjustable overload setting and short circuit release.

5.20.2 Wall mounted distribution boards shall comprise the following as a minimum:

- Adequately rated TPN MCB isolator as incomer
- 3 phase & neutral bus bar
- Required number of TPN/SP MCBs or MPCBs with contactor and start/stop PBs for outgoing feeders
- R,Y, B indicating lamps (LED)

5.21.0 **Local Motor Starters**

5.21.1 Local motor starters shall be metal enclosed, suitable for outdoor mounting on wall or steel structures with suitable hood on top. The enclosure shall be cold rolled sheet steel of at least 1.6 mm thickness. The local motor starters shall be dust and vermin-proof and shall have a degree of protection of IP-55.

5.21.2 Local motor starters shall comprise of the following:

- A 3-pole contactor, mechanically latched type
- Start push button, coloured green
- Stop push button, coloured red
- ‘ON’ indicating lamp
- Electronic overload relay with single phasing protection

5.22.0 **Local Push Button (LPB) Stations**

5.22.1 The local push buttons station enclosure shall be with hood on top suitable for outdoor mounting on wall or steel structures. The enclosure shall be provided with a protective guard, to avoid inadvertent operation of push buttons. The local push button stations shall be dust and vermin-proof and shall have a degree of protection of IP-55 as per IS 13947.

5.22.2 LPB shall be of following types:

- Type-A: With Stop Push Button in FRP enclosure
- Type-B: With Start & Stop Push Buttons in FRP enclosure
- Type-C: With Forward, Reverse & Stop Push Buttons in FRP enclosure
- Type-D: With Stop Push Button in flame-proof enclosure
- Type-E: With Start & Stop Push Buttons in flame-proof enclosure
- Type-F: With Forward, Reverse & Stop Push Buttons in flame-proof enclosure

5.22.3 Push buttons shall be with two NO and two NC contacts. Emergency stop push buttons shall be mushroom, latched type. Start push button shall be self-reset type.

6.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on sheet steel shall not be less than 85 microns. Final shade shall be RAL-7035.

7.0.0 TESTS

7.1.0 All tests shall be conducted as per relevant IS/IEC standards and shall be performed in the presence of Owner's representative, if so desired by the Owner. All equipment/ components/materials shall be of type tested and proven type.

7.2.0 Type test reports shall be submitted for switchgear panel and breaker of each current rating as per applicable standard. The switchgear panel shall be subjected to routine tests in accordance with the relevant IS/IEC standards. Test reports shall be submitted to the Owner for approval.

7.3.0 Type Tests

7.3.1 Type test reports for the following shall be submitted for switchgear panel of each current rating:

- Power frequency withstand test on power circuit and auxiliary and control circuits
- Temperature rise test
- Measurement of resistance of the main circuit
- Short time withstand current and peak withstand current test
- Degree of protection test

7.3.2 Type test reports shall be submitted for circuit breaker as per applicable standard by the Bidder for Owner's review. The list of type tests shall include the following:

- Dielectric tests
- Measurement of the resistance of the main circuit
- Temperature rise tests
- Short time withstand current and peak withstand current tests
- Electromagnetic compatibility tests
- Mechanical and environmental tests including mechanical operation test
- Short circuit current making and breaking tests
- Mechanical endurance test
- Electrical endurance test

7.3.3 The contactors, relays, switches, breakers, local push buttons, local motor starters, instruments, VTs, CTs and control transformers shall be subjected to type tests in accordance with the relevant IS/IEC standards.

7.4.0 Routine Tests

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

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

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

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

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

7.5.0 **Site Tests**

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

a) General

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

b) Circuit Breaker/ Contactors

- Check alignment of trucks for free movement
- Check correct operation of shutters
- Check slow closing operation (if provided)
- Check control wiring for correctness of connections, continuity and IR values
- Manual operation of breakers completely assembled
- Power closing/ opening operation, manually and electrically at extreme condition of control supply voltage
- Closing and tripping time
- Trip free and anti-pumping operation
- IR values, resistance and minimum pick up voltage of coils
- Simultaneous closing of all the three phases
- Check electrical and mechanical interlocks provided
- Checks on spring charging motor, correct operation of limit switches and time of charging
- Check SF6 pressure/ vacuum (as applicable)
- All functional checks

c) Current Transformers

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

d) Voltage Transformers
- Insulation resistance test
- Ratio test on all cores
- Polarity test
- Line connections as per connection diagram

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

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

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

8.0.0 TECHNICAL PARAMETERS OF LV SWITCHGEAR

Sloe.	Description	Unit	Parameters
1.0	**LV Switchgear – General**		
a)	Type		Metal clad, Form 4b
b)	Type of cooling		Natural air cooled
c)	One minute power frequency withstand voltage • Main circuit • Auxiliary circuit	 kV kV	 2.5 2.0
d)	Rated voltage	V	415 ±10%, 3 phase, 4 wire
2.0	**PCC/MCC**		
a)	Short circuit withstand current rating for switchgear fed from 2500 kVA transformer		65 kA (rms) for 1 sec & 137 kA (peak)
b)	Short circuit withstand current rating for all other switchgear		50 kA (rms) for 1 sec & 105 kA (peak)
c)	Degree of protection of switchgear with modules in service and all doors closed		IP-52

Sloe.	Description	Unit	Parameters
d)	Degree of protection for bus bar chambers (above1600 A)		IP-42
3.0	**AC Distribution Board**		
a)	Short circuit withstand current rating	kA	50 kA (rms) for 1 sec 105 kA (peak)
b)	Degree of protection		IP-52
4.0	**Air Circuit Breaker**		
a)	Type		ACB
b)	No. of poles		TPN/TP/4P
c)	Short circuit performance category		P2
d)	Rated operating duty		O-3min-CO-3min-CO
e)	Short time current for 1 sec. for 2500 kVA transformer	kA(rms)	65
f)	Rated short circuit breaking current for 2500 kVA transformer	kA(rms)	65
g)	Rated short circuit making current for 2500 kVA transformer	kA(peak)	137
h)	Short time current for 1 sec. for all other breakers	kA(rms)	50
i)	Rated short circuit breaking current for all other breakers	kA(rms)	50
j)	Rated short circuit making current for all other breakers	kA(peak)	105
k)	Control supply voltage • Closing coil, spring charging motor • Tripping coil	V	 220 V DC, (80-110%) 220 V DC, (70-110%)
4.0	**Moulded Case Circuit Breaker (MCCB)**		
a)	No. of poles		TPN/TP
b)	Short time current for 1 sec.	kA(rms)	50/65
c)	Rated short circuit breaking current	kA(rms)	50/65
d)	Rated short circuit making current	kA(peak)	105/137
e)	Overload release setting		Yes
f)	Short circuit release setting		Yes
g)	Undervoltage release		Yes
h)	Shunt trip		Yes
4.0	**Motor Protection Circuit Breaker (MPCB)**		
a)	No. of poles		TP
b)	Rated short circuit breaking current	kA(rms)	50/65
c)	Overload release setting		Yes
d)	Short circuit release setting		Yes

Sloe.	Description	Unit	Parameters
e)	Undervoltage release		Yes
f)	Shunt trip		Yes
5.0	**Bus Bar**		
a)	Temperature rise over design ambient of 50°C (i) Bus bars (ii) Silver plated joints		40°C 55°C
b)	Short-time current for PCC with incomer from 2500 kVA transformer	kA	65 kA (rms) for 1 sec with 137 kA (peak) dynamic rating
c)	Short-time current for other PCC/MCC/DB	kA	50 kA (rms) for 1 sec with 105 kA (peak) dynamic rating
d)	Bus bar clearance in air (minimum) • Phase to phase • Phase to earth	 mm mm	 25 20

9.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Technical data sheet
- General arrangement and section drawing
- Single line diagram & Schematic wiring diagrams
- Sizing Calculation for busbar
- Short circuit withstand calculation for busbar (Thermal & dynamic)
- Component list & Bill of Quantities for all the boards
- Panel cutout details
- Foundation Plan & loading details
- Erection and commissioning procedures
- CT / VT sizing calculation
- Relay setting calculation
- Catalogues / drawings / leaflets for all items
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

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 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 hold good.

3.1 SITE INFORMATION

SL.NO.	DESCRIPTION	
3.1	PROJECT INFORMATION	
	a) Customer	Tamil Nadu Generation and Distribution Corporation (TANGEDCO)
	b) Project	400kV GIS at 2 x 660 MW Udangudi STPP (Stage-I)
	c) Project location	
	i) Country	India
	ii) State	Tamil Nadu
	iii) Administrative district	Thoothukudi
	iv)Next Big cities to site	Thoothukudi (approx.. 45 kms from site)
	v) Road access	East Coast Road- State high way (176)
	vi) Nearest Railway Station	Thiruchendur (approx.. 12 kms from site)
	vii) Nearest Airport	Vagaikulam (approx.. 60 kms from site)
	viii) Nearest Harbour	Tuticorin (approx.. 45 kms from site)

3.2	**SITE CONDITIONS**	
3.2.1	Ambient Air Temp.	
	a) Maximum dry bulb temp. (max.) °C	41^0C
	b) Minimum dry bulb temp. (min.) °C	17^0C
	Design ambient temperature	50^0C
3.2.2	**Relative humidity**	
	Mean Maximum humidity (Summer)	84 %
	Mean Minimum humidity (Summer)	62 %
	Maximum humidity (Monsoon)	97%
	Minimum humidity (Monsoon)	45%
3.2.3	**Rain fall**	
	Annual rainfall (Maximum)	718.2 mm
	Annual rainfall (Minimum)	384.1 mm
	Twenty four (24) Hour max	138.2 mm
3.2.4	**High Flood Level**	
	High Flood Level for site	RL 2.450 m
3.2.5	**Wind**	
	Mean Wind Speed (max)	39 m/sec (As per IS: 875)
	Wind direction	North, North east, North west, East
3.3	**Seismic intensity**	
	Seismic Intensity	As per IS:1893 Latest
	Zone	II

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 Manufacturer 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.

3.3 STANDARDS

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification.

The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.

When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.

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

The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

All equipment shall also perform satisfactorily under various other electrical, electro mechanical and meteorological conditions of the site of installation All equipment

shall be able to withstand all external and internal mechanical, thermal and electro mechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

3.5 ENGINEERING DATA

3.5.1 Drawings

The Supplier shall necessarily submit all the drawings/ documents unless anything is waived. The Supplier shall submit drawings/ design documents/ data/ test reports/manuals as may be required for the approval of the purchaser. All drawings submitted by the Manufacturer 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 Manufacturer shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. 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.

Further work by the Manufacturer 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 Owner will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. Owner may not indicate a thorough review of all 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 Owner shall not be considered by the Manufacturer, 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 Manufacturer's risk. The Manufacturer 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 Manufacturer's drawing or work by the Purchaser shall not relieve the manufacturer of any of his responsibilities and liabilities under the Contract.

All engineering data submitted by the Manufacturer after final process including review and approval by the Owner shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Owner in Writing.
The title block of drawings shall contain the following information incorporated in all contract drawings

Title block for project:

1. Customer : Tamil Nadu Generation and Distribution Corporation (TANGEDCO)
2. Consultant : DESEIN PRIVATE LIMITED, DESEIN HOUSE, NEW DELHI
3. Project : 400kV GIS at 2 x 660 MW Udangudi STPP (Stage-I)
4. Contract No./LOA No. : Lr.No.CE/Proj.II/SE/C/UTPP/EE/E/LOI/D.179/2017, dt.07.12.2017
5. Main Contractor : Bharat Heavy Electricals Limited
6. BHEL Order No. & Date :

3.5.2 Documentation

Document Distribution Schedule - After Placement of Order:

S. No.	Stage	No. of copies	
i)	Submission of Data sheets Datasheet, drawings, documents, write-ups, calculation, test reports, Preliminary	13	As per agreed schedule
ii)	Resubmission of above, if required	13	As per agreed schedule
iii)	Final approved documents	13	As per agreed schedule
iv)	Instruction manuals for erection and O&M	6	As per agreed schedule
v)	As built drawings including O &M manual		As per agreed schedule

	-Hard copy -Soft copy in CD/Pendrive	13 6	

NOTES:

a) The manufacturer may note that all re-submissions must incorporate all comments given in the prior submission by the Purchaser. Adequate justification for not incorporating the same must be submitted, failing which the submitted documents may be returned.

3.5.3 Format of Documentation

a) All engineering documents and drawings shall be of international "A" series sizes, that is, A0, A1, A2, A3 and A4.
b) Two set of CD/ pendrive containing all the drawings in Auto CAD shall also be supplied in addition to hard copies. Soft copy of all documents shall be supplied in a CD/pendrive in PDF format.
c) Grouped documents shall be provided by size A4, with the inclusion of bigger size drawings which, however, have to be folded as Size A4.

3.5.4 Instruction manuals and operating manuals

The Supplier shall provide Instruction & Maintenance Manuals for each part of the Plant and Equipment included in the Works and Operating Manuals for each Station.

The Instruction Manuals and Operating Manuals shall be arranged in an organized library adequately cross referenced to facilitate issuing clauses of the manuals as required by the work i.e. erection instructions shall be required before operating & maintenance instructions.

All Manuals provided by the Supplier shall be fully detailed and specifically prepared for the Works and equipment provided. General manuals not specifically required for the work shall not be acceptable.

The instruction manuals shall at least contain:

a) A general description of all components
b) Storage instructions
c) Erection instructions
d) Pre-commissioning Instruction:
e) Material and part list.
f) Design clearances and settings
g) Complete sets of drawings as finally issued

h) Operating Instructions:
i) Routine and Preventive Maintenance instructions with material requirement for each site
j) Preventive Maintenance Schedule.
k) Replacement instruction for all equipment

The operation manuals shall at least contain:
a) Operator oriented functional descriptions of the equipment.
b) Operator oriented description of the protection and control systems
c) Description of the equipment auxiliary systems
d) Fault finding and diagnostic tools
e) User software interface tools for modification/augmentation etc.

Notes:

The supplier may please note that all resubmissions must incorporate all comments given in the earlier submission by the Owner/Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Supplier to the Owner/Purchaser.

The Supplier shall furnish to the Owner/Purchaser, catalogues of spare parts also.

3.6 QUALITY ASSURANCE PROGRAMME

This section contains general requirements for inspection of material, parts, equipment and workmanship during manufacture, assembling to demonstrate compliance with specification, codes and standards to ensure overall reliability of product operation and performance.
The Owner and/or authorized Representatives shall, at any time, be allowed free and ready access to the Contractor's premises and those of his suppliers as well as to the site installation and the Contractor has to make the items available for the purpose of inspection of the specified equipment components and obtaining information as to the progress of the work. Failure on the part of the Owner, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Owner shall not prejudice the right to reject equipment if it does not give complete satisfaction in service.

To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Manufacturer's Works or at his Sub-manufacturer's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Manufacturer shall adopt a suitable quality assurance programme to control such activities at all points, as necessary.
Before manufacture commences and not later than 45 days after award of contract, the Contractor shall submit an outline of his proposed inspection program, which shall include all major stages during manufacturing. The inspection and test program shall include for the various items the designation No., name of equipment, part of equipment, the kind of test, test standard, company which carries out the test, place, date and witnesses by the Contractor, third party or Owner's Representative. The detailed manufacturer’s quality assurance plan shall be subject to approval after award of contract.
The Owner will return a copy of the Contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be by Fax or email in a format to be agreed and shall be sent prior to the intended test. If the Owner intends to be represented at the test he will provide at least 24 hours' notice and if his representative does not attend on the notified date, an alternative date has to be informed by the Owner.
A quality assurance programme of the manufacturer shall generally cover the following:

(a) Manufacturer's organisation structure for the management and implementation of the proposed quality assurance programme:
(b) Documentation control system;
(c) Qualification data of bidder's key personnel;
(d) The procedure for purchases of materials, parts components and selection of sub-Manufacturer's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
(f) Control of non-conforming items and system for corrective actions;
(g) Inspection and test procedure both for manufacture and field activities;
(h) Control of calibration and testing of measuring instruments and field activities;
(i) System for indication and appraisal of inspection status;
(j) System for quality audits;
(k) System for authorising release of manufactured product to the Purchaser
(1) System for maintenance of records;
(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and Procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered. The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and Procedure of the Manufacturer/his vendors quality management and control activities.

3.7 Quality Assurance Documents

The Manufacturer shall be required to submit all Quality Assurance Documents as stipulated in the quality plan at the time of purchaser's inspection of equipment/ material.

3.8 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

All equipment being supplied shall conform to type tests and shall be subject to routine and acceptance tests in accordance with requirements stipulated under respective sections. Purchaser reserves the right to witness any or all the tests. The Manufacturer shall intimate the Purchaser the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies. The Manufacturer shall also submit type test procedure for approval of the Purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the technical specification or any/all additional type tests not carried out, Such test shall be conducted fresh without any additional cost implication to the Purchaser.

The price of conducting all tests and additional type tests is deemed to be included in Bid price. In case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein, give notice in writing to the Manufacturer, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Manufacturer shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the

said objections or shall confirm in writing to the Purchaser/ inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

When the factory tests have been completed at the Manufacturer's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser/inspector, the certificate shall be issued within fifteen (15) days of receipt of the Manufacturer's Test certificate by the Engineer/ Inspector. Failure of the Purchaser/inspector to issue such a certificate shall not prevent the Manufacturer from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should it, on further tests/ after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Purchaser.

In all cases where the Contract provides for tests whether at the premises or at the works of the Manufacturer or of any Sub-Contractor, the Manufacturer except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser Inspector or to his authorised representative to accomplish testing.

The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Manufacturer in respect of the agreed quality assurance programme forming a part of the Contract.

The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Purchaser.

3.9 MATERIALS AND WORKMANSHIP

Equipment materials and components shall be new, of high grade and good quality and be to the latest engineering practice. The material and workmanship throughout shall be in accordance with the purpose for which they are intended. Each component shall be designed to be consistent with its duty.

All the information concerning materials or components to be used in manufacturing, machinery, equipment, materials and components supplied, installed or used shall be submitted for approval. Without such approval the supplier shall run risk of

subsequent rejection. The cost as well as time delay associated with such rejection shall be borne by the supplier.

3.10 COLOUR SCHEME

The Supplier shall propose a colour scheme for the equipment for the approval of the Employer. The decision of the Employer shall be final. However, the finishing colour shall be RAL 7035 for all Control panels/ MCC/ Switchgear panels. The scheme shall include:

- Finishing colour of Indoor equipment
- Finishing colour of Outdoor equipment
- Finishing colour of various auxiliary system equipment including piping
- Finishing colour of various building items.
- Finishing colour of all cubicles.

All steel structures, plates etc shall be painted with non-corrosive paint on a suitable primer. The galvanised structures in the switchyard shall not be painted. However galvanised structures in other areas may require painting for aesthetic reasons.

3.11 PACKING AND STORAGE

Packing specification shall be submitted for BHEL/customer approval after award of contract.
All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. On request of the purchaser, the manufacturer shall also submit packing details/associated drawing for any equipment/ material at a later ate, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The manufacturer shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc shall be to the account of the manufacturer. Purchaser takes no responsibility of the availability of the wagons.

All coated surfaces shall be protected against abrasions, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device.

Supplier shall ensure that equipment shall be properly packed, blocked, padded, coated and protected so that it is not damaged due to possible mishandling. Storage requirements shall be clearly defined by the supplier. Packing shall be such that if

required, long time storage (at least 1 year) at site should not deteriorate the performance of the equipment.

3.12 NAME PLATE

Name plates which are to be firmly fixed on all the equipment, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the piping or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.
The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them. Indoor installed equipments (e.g., panels, cabinets, switchgear, etc.) shall also be labelled by appropriate name plate.
The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Contractor and the Owner. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags.

The Equipment identification shall be finalized by vendor in consultation with BHEL/TANGEDCO and should be included in name plates.

3.13 CLAMPS & CONNECTORS

i) All power clamps and connectors shall conform to lS: 5561, and/or IEC standard and shall be made of materials listed below:

a)	For connecting ACSR conductors	Aluminium alloy casting, conforming to designation A6 of IS: 617 and shall be tested for all tests as per IS:617
b)	For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from aluminium alloy casting, conforming to designation A6 of IS 617 with 2 mm thick Bimetallic liner and shall be tested as per IS: 617.
c)	For connecting G.I. Shield wire	Galvanised mild steel
d).1	Bolts, nuts & Plain washers.	Electro galvanized for sizes below M12, for others hot dip galvanised
d).2	Spring washers for items 'a' to 'c'	Electro-galvanised mild steel suitable for at least service condition-3 as per lS: 1573

ii) Equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type. The requirements regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. In case the connector is not available then equivalent connector may be used. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of Work.

iii) Where copper to aluminium connections are required, bi-metallic clamps shall be used, which have been properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current t shall be furnished to the Employer.

iv) Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified are also included in the scope of Work.

v) No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2mm thickness shall be cast integral with aluminium body for Bi-metallic clamps. When copper alloy is not cast integral with aluminium body, a bimetallic washer or strip shall be used to meet the functional requirement.

vi) All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

vii) Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of IPS Aluminium tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

viii) Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance.

x) TESTS

The following is the list of type tests.

a) Temperature rise test (maximum temperature rise allowed is 35deg C over 50 deg C ambient)
b) Short time current test
c) Dry corona and RIV test as per annexure-A
d) Resistance test and tensile test

3.14 GALVANIZING

Galvanizing works shall conform in all respect to B.S. 729, B.S. 3083 and B.S.C.P. 2008 and to DIN 50976 whatever requires the higher quality and shall be performed by the hot dip process, unless otherwise specified. It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with B.S 4479.

Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably be blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with B.S. 4360. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants in accordance with DIN 55928, part 4 and DIN 50976. The weight of zinc coating per unit area has to be noted in the manufacturing documents in accordance with DIN 50976.

The minimum average coating weight shall be as specified in Table 1 of B.S. 729 or Table 2, DIN 50976, whatever requires higher quality.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 610 g/m2 (DFT = 85μ) .

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor (defined in B.S. 3294, part 1 and B.S. 4604,
part 1) is achieved. Care shall be taken to ensure that the roughening is confined to the area of the mating faces.
Bolts, nuts and washers, including general grade high-tensile friction grip bolts (referred to in B.S. 3139, and B.S.4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to B.S. 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is possible in accordance with DIN 50976.
Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with DIN 55928, part A and DIN 50976 by:

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.
- Application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with DIN1707, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface. Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with DIN 2444.
After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint.
Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner’s approval.

3.15 DEGREE OF PROTECTION

The enclosures of the control cabinets, Junction boxes and Marshalling boxes, panels etc. to be installed as detailed here under:

The minimum requirements for panels are as follows:

- Installed out door: IP- 55
- Installed indoors in air-conditioned area: IP-32
- Installed in covered area: IP-52
- Installed indoors in non air-conditioned area where possibility of entry of water is limited: IP-41.
- 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.

SECTION-4
LIST OF DRAWINGS & DOCUMENTS

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

DRAWING NO.	DRAWING NAME
TB-400-553-123-03	Ventilation equipment & Ducting layout for GIS building
TB-400-553-123-04	Schematic, GA & SLD for Ventilation PDB in GIS building
DATA SHEETS	**DATA SHEETS NAME**
TB-400-553-124-11	TDS For Duct/Fire Damper/Pre & fine filter/Instruments
TB-400-553-124-03	TDS For Supply Air Fans / Exhaust Fans
TB-400-553-124-04	TDS for Centrifugal Fan
TB-400-553-124-12	BOQ- Ventilation System
TB-400-553-124-09	Ventilation Fan Calculation
TB-400-553-124-13	O&M Manual for Ventilation System

SECTION-5
ENCLOSURES TO SPECIFICATION

SCHEDULES TO BE FILLED UP BY THE BIDDER

Schedule 1 **Schedules of Deviations**

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

Schedule 3 **Enclosures to Specification**

Annexure-A: Drawings

SCHEDULE-1

SCHEDULE OF TECHNICAL DEVIATION

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

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

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

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

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

Place

Date

Signature of the authorized representative of Bidder

Name ----------

Designation----------

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

SCHEDULE-2

DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL

Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

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

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

SCHEDULE –3

ENCLOSURES TO SPECIFICATION

(ANNEXURE-A)

DRAWINGS

1. Architecture drawing-GIS Building (Plan)
DRG. NO. **TB-1-400-607-640-1 Rev-01**

2. Architecture drawing-GIS Building (Elevation)
DRG. NO. **TB-1-400-607-640-2 Rev-01**

3. Architecture drawing-GIS Building (Section)
DRG. NO. **TB-1-400-607-640-3 Rev-01**

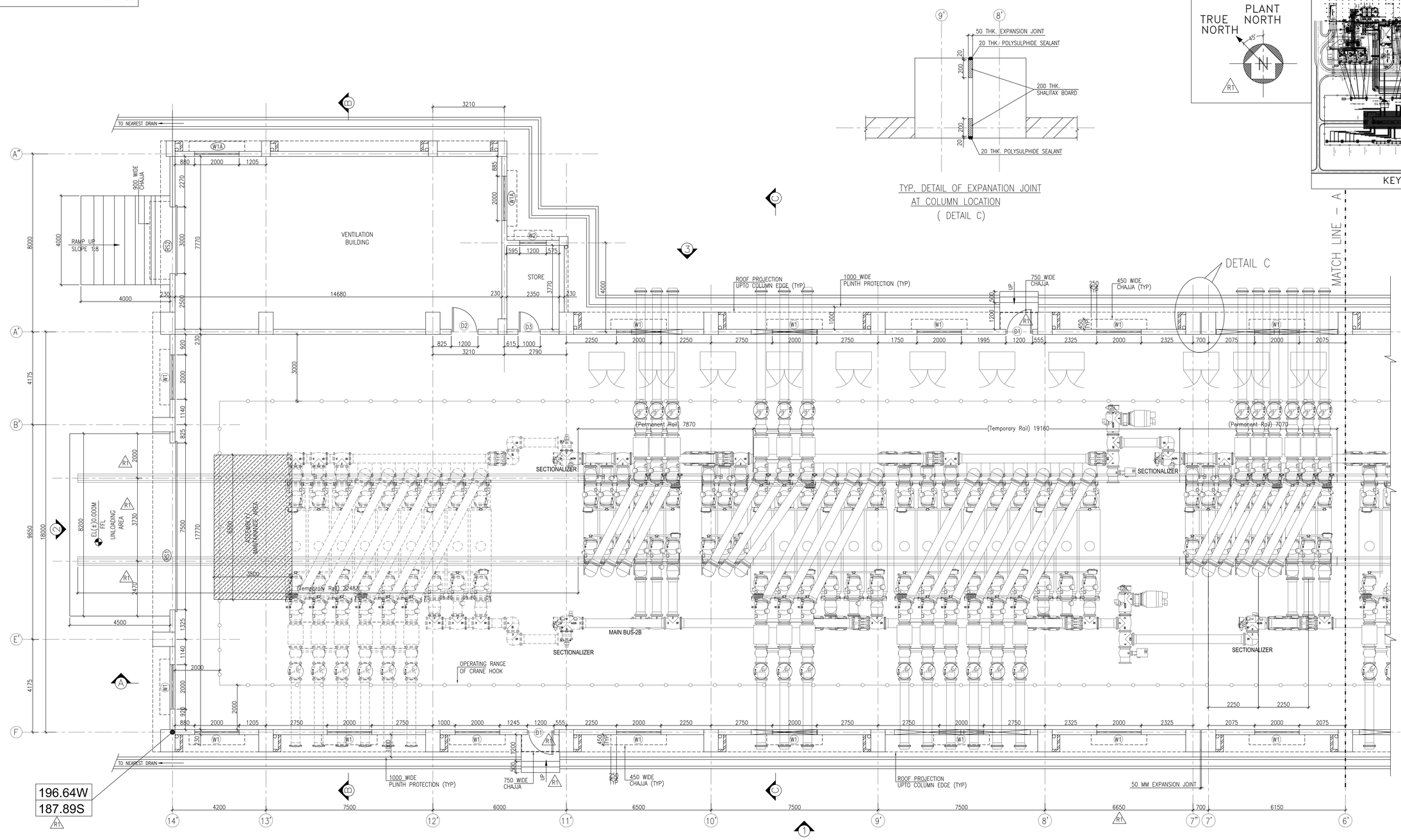
4. Architecture Drawing Control Room Building (Plan)
DRG. NO. **TB-1-400-607-620-1 Rev-01**

5. Architecture Drawing Control Room Building (Elevation)
DRG. NO. **TB-1-400-607-620-2 Rev-01**

6. Architecture Drawing Control Room Building (Section)
DRG. NO. **TB-1-400-607-620-3 Rev-01**

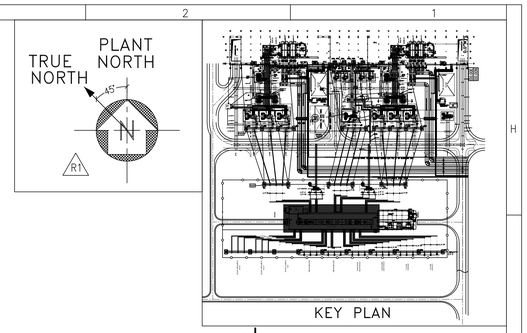
7. Indoor trench layout of control room building
DRG. NO. **TB-2-400-316-010 Rev-00**

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)



GROUND FLOOR PLAN

TYP. DETAIL OF EXPANATION JOINT AT COLUMN LOCATION (DETAIL C)



LEGEND :–	
FGL	FINISHED GROUND LEVEL
FFL	FINISHED FLOOR LEVEL
TOC	TOP OF CONCRETE
FC	FALSE CEILING
UDI	UNDER DECK INSULATION
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
V	VENTILATOR
EF	EXHAUST FAN
WB	WASH BASIN

REFFRENCE DRAWING:–

1 CONCEPTUAL GIS BUILDING LAYOUT – TB–1–400–316–005
2 GIS LAYOUT – 1HYG900056–2_REV 03

NOTES:–

1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2 ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
3. ALL DOOR–WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD
															01	19.04.20	TKR	DKU	SG
																REVISED AS PER COMMENTS			

JOB NO.
STATUS CONTRACT
DISTRIBUTION

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

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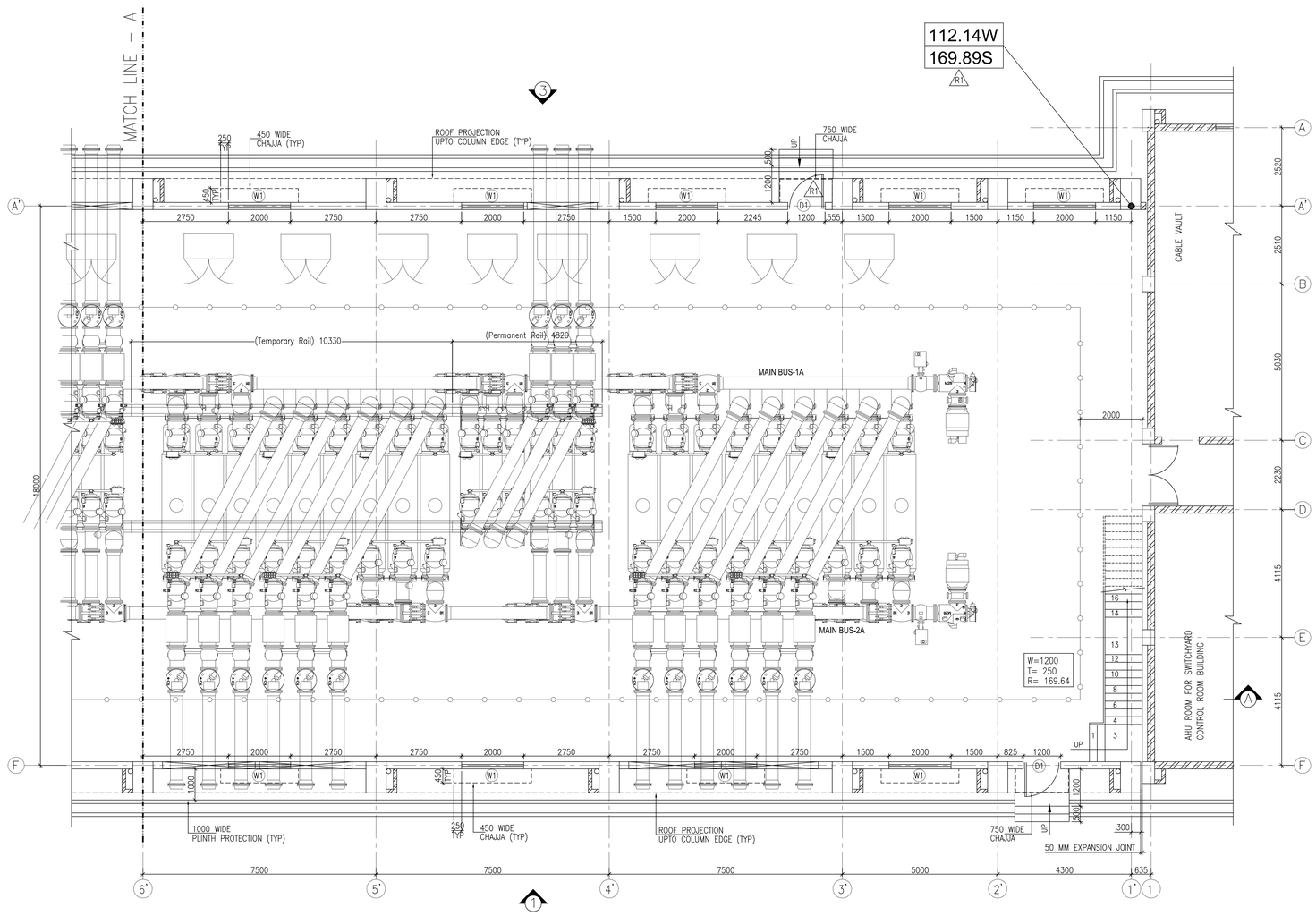
DEPT CODE		NAME	SIGN	DATE
E	DRN	TKR		20.01.20
	DESN	SS		20.01.20
	CHD	DKU		20.01.20
	APPD	AG		20.01.20

TITLE ARCHITECTURAL DRAWING GIS BUILDING (PLAN)

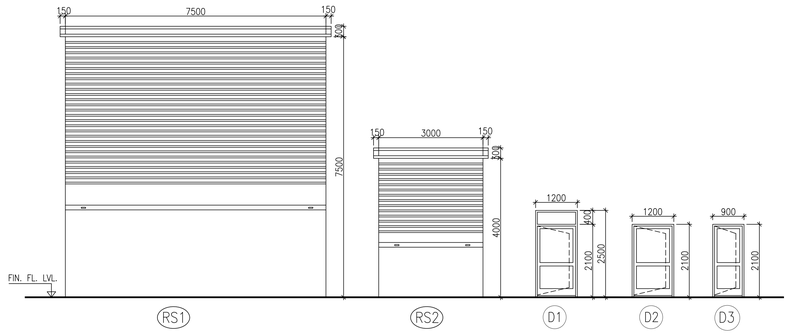
DEPT. SCALE 1:75
SIGN

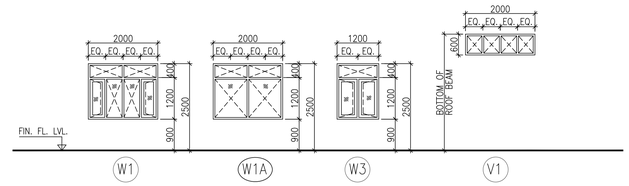
DRAWING NO. TB–1–400–607–640–1
SHEET 01 OF 06 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)



GROUND FLOOR PLAN





SCHEDULE OF DOORS & WINDOWS (AS PER TECHNICAL SPECIFICATION)

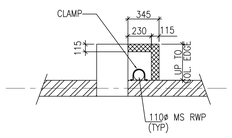
TYPE	OPENING SIZE	CILL LEVEL	LINTEL LEVEL	NOS.	DESCRIPTION
RS1	7500x7500	–	7500	1	STEEL ROLLING SHUTTER
RS2	3000x4000	–	4000	1	STEEL ROLLING SHUTTER
R1 D1	1200x2500		2500	4	SINGLE SHUTTER SHUTTER STEEL DOOR AS PER SPECS.
D2	1200x2100		2100	1	SINGLE SHUTTER SHUTTER STEEL DOOR AS PER SPECS.
D3	1000x2100		2100	1	SINGLE SHUTTER STEEL FRAME DOOR AS PER SPECS.
W1	2000x1600	900	2500	24	PARTLY FIXED & PARTLY OPENABLE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
W1A	2000x1600	900	2500	2	FIX TYPE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
W2	1200x1600	900	2500	1	PARTLY FIXED & PARTLY OPENABLE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
V1	2000x600	–	SOFFIT OF ROOF BEAM	29	FIXED ALUMINIUM VENTILATOR

FOR FINISHING SCHEDULE REFER DRG NO TB–1–400–607–632

R1

WATER PROOFING ON ROOF:

HIGH SOLID CONTENT LIQUID APPLIED ELASTOMERIC WATER PROOFING MEMBRANE WITH SEPARATE WEARING COURSE AS PER ASTM C –898. THICKNESS OF THE MEMBRANE SHALL BE 1.5 MM. THIS TREATMENT SHALL INCLUDE APPLICATION OF POLYMERISED MASTIC OVER THE ROOF TO ACHIEVE SMOOTH SURFACE AND PRIMER COAT. WEARING COURSE ON THE TOP OF MEMBRANE SHALL CONSIST OF 40MM. THICK PCC (1:2:4) CAST IN PANELS OF MAX. 1200x1200 SIZE AND REINFORCED WITH 0.56 MM. DIA. GALVANIZED CHICKEN WIRE MESH AND SEALING OF JOINTS USING SEALING COMPOUND/ ELASTOMETRIC WATER PROOFING MEMBRANE.



TYP. RWP FIXING DETAIL

INTERNAL:
12mm THK. PLASTER (1:6 CEMENT : SAND)
EXTERNAL:
18mm THK. PLAIN PLASTER (1:6 CEMENT : SAND)
12mm 1ST LAYER 1:6 C&S, 6MM 2ND LAYER 1:4 C&S
CEILING EXCEPT FOR WHERE FALSE CEILING WILL BE PROVIDED.
6mm THK. PLAIN PLASTER (1:4 CEMENT : SAND)

NOTES:–

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2 ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
3. ALL DOOR–WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD	
01	19.04.20	TKR	DKU	SG	REVISED AS PER COMMENTS

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

JOB NO.
STATUS CONTRACT
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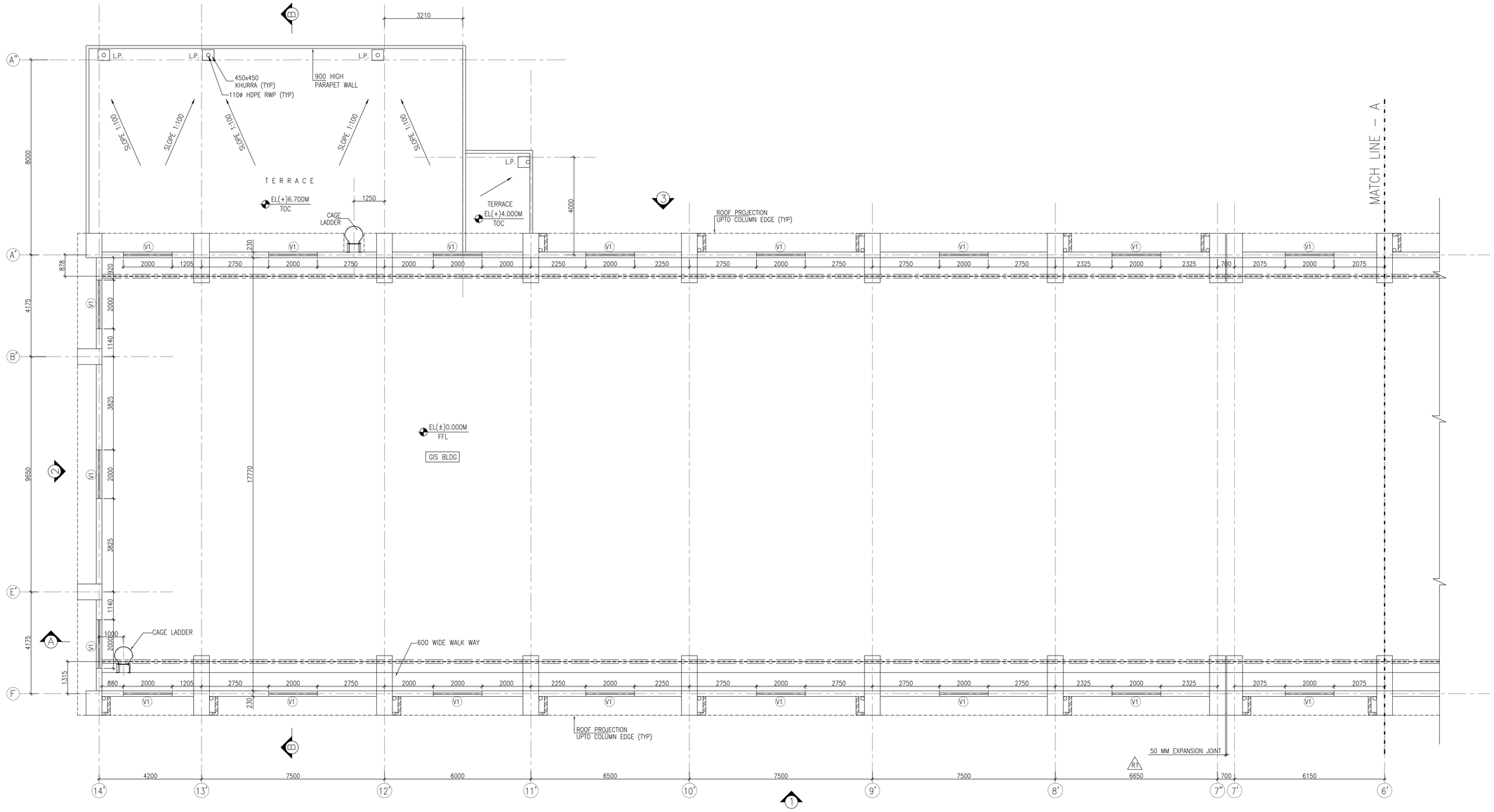
	DESN	SS		20.01.20
	CHD	DKU		20.01.20
	APPD	AG		20.01.20

TITLE ARCHITECTURAL DRAWING GIS BUILDING (PLAN)

DEPT. SCALE 1: 75
SIGN
DRAWING NO. TB–1–400–607–640–1
SHEET 02 OF 06 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No.



PLAN AT CRAIN GIRDER LEVEL@ EL(+)9.500M

NOTES:–

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CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
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DEPT. SCALE 1: 75

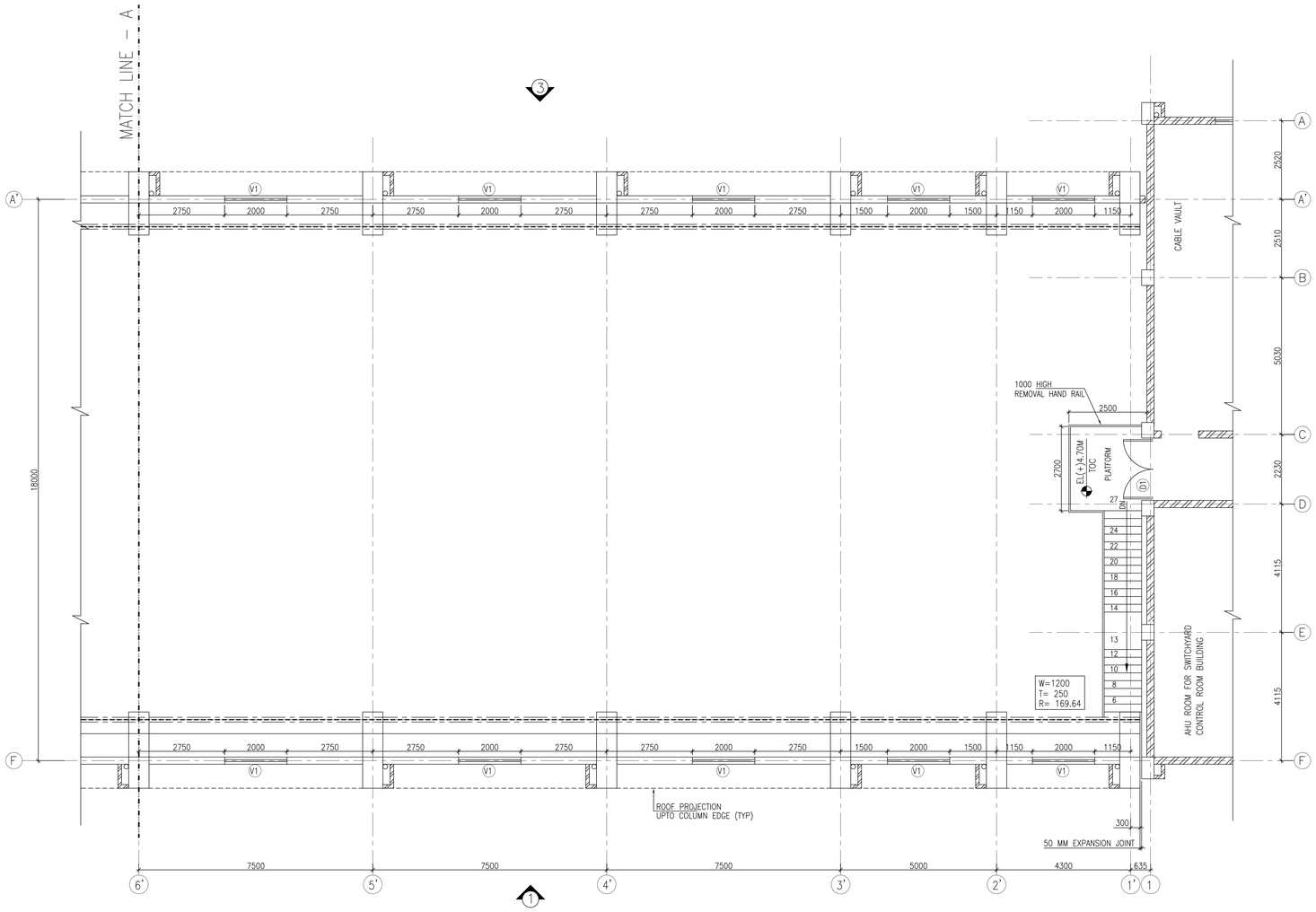
SIGN

DRAWING NO. TB–1–400–607–640–1

SHEET 03 OF 06 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No.



PLAN AT CRAIN GIRDER LEVEL@ EL(+)9.500M

NOTES:–

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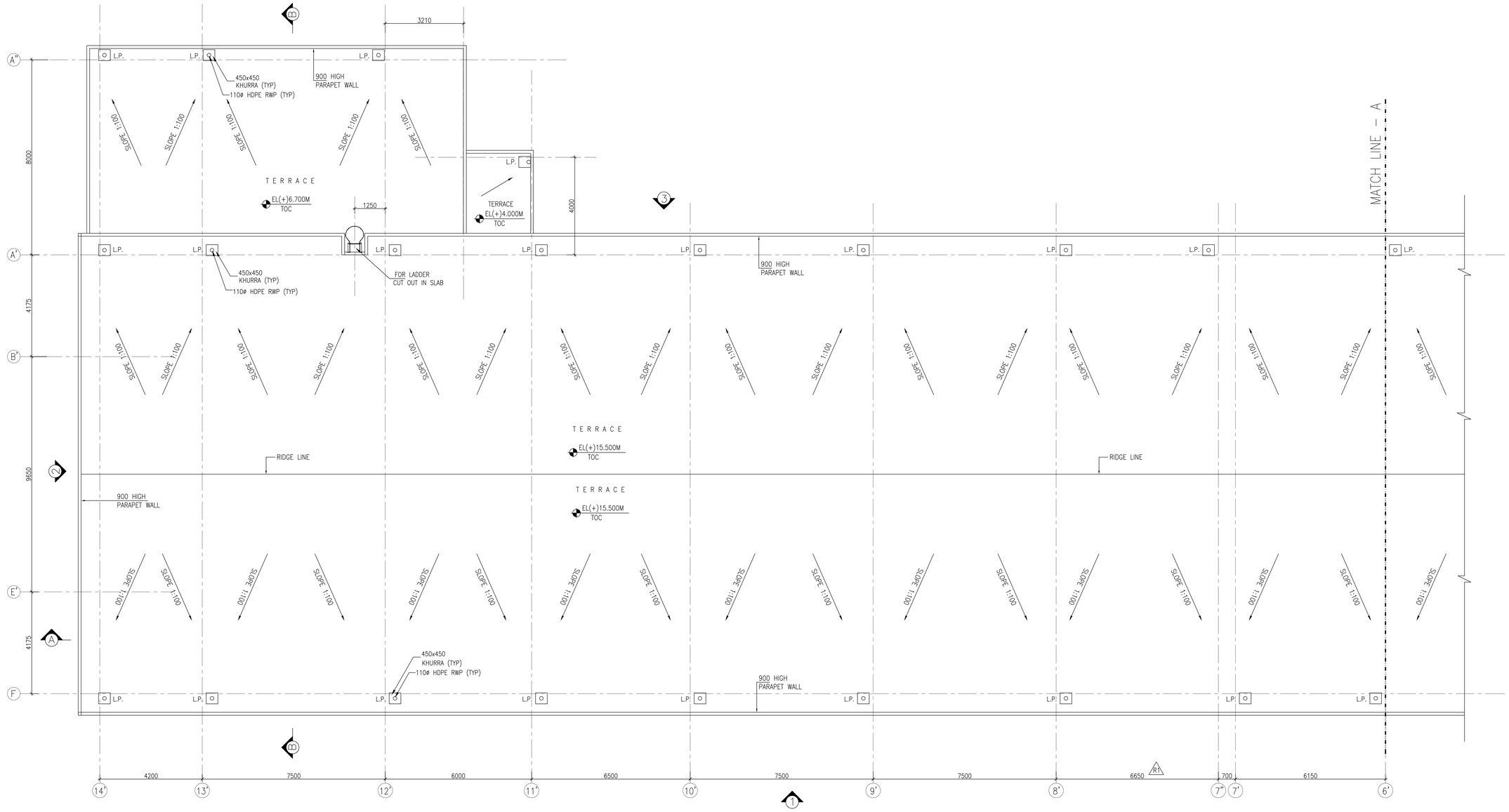
DEPT. SCALE 1: 75

SIGN

DRAWING NO. TB–1–400–607–640–1

SHEET 04 OF 06 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)



TERRACE PLAN

NOTES:–

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REVISED AS PER COMMENTS

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TITLE ARCHITECTURAL DRAWING GIS BUILDING (PLAN)

DEPT. SCALE 1: 75

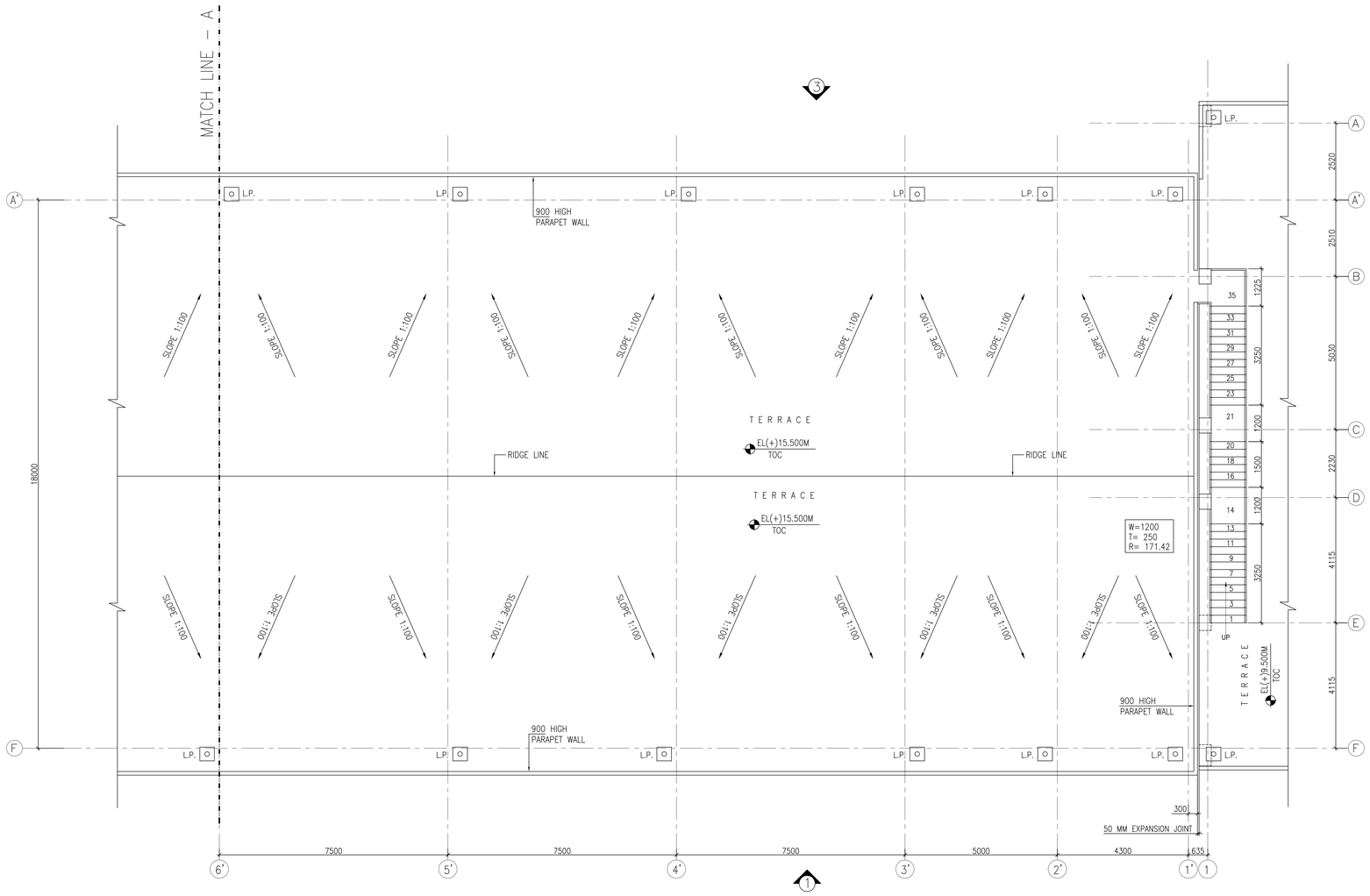
SIGN

DRAWING NO. TB–1–400–607–640–1

SHEET 05 OF 06 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No.



TERRACE PLAN

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TITLE ARCHITECTURAL DRAWING GIS BUILDING (PLAN)

DEPT. SCALE 1: 75

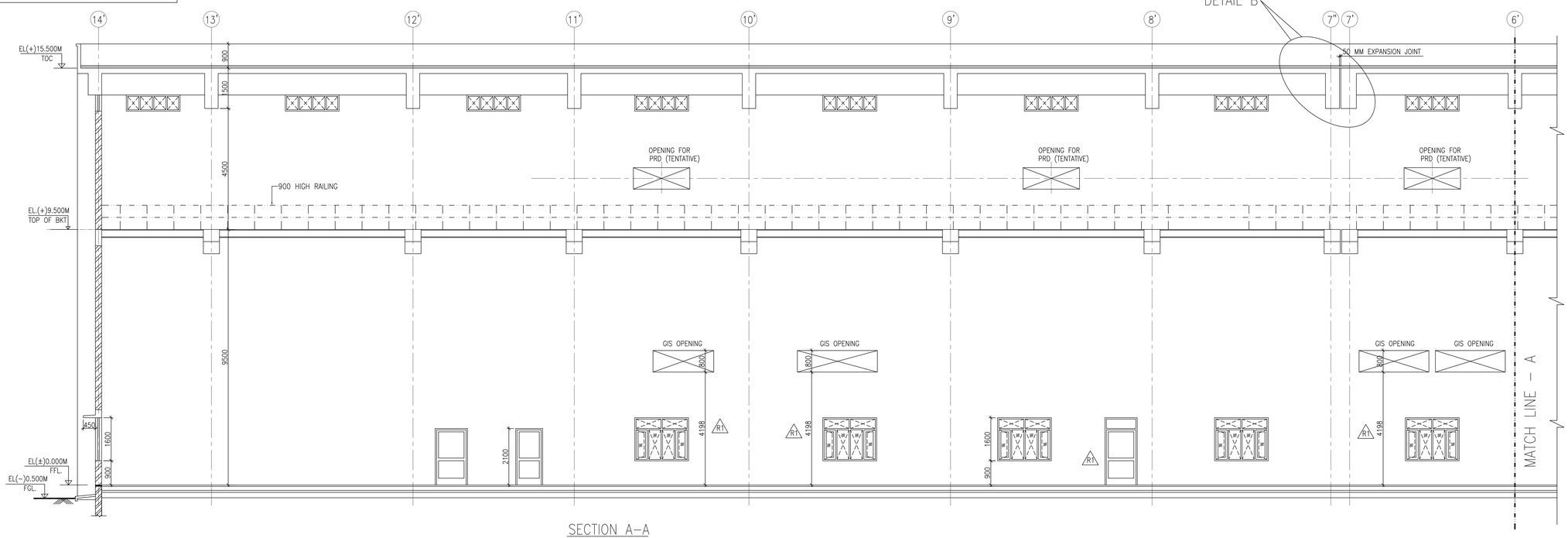
SIGN

DRAWING NO. TB–1–400–607–640–1

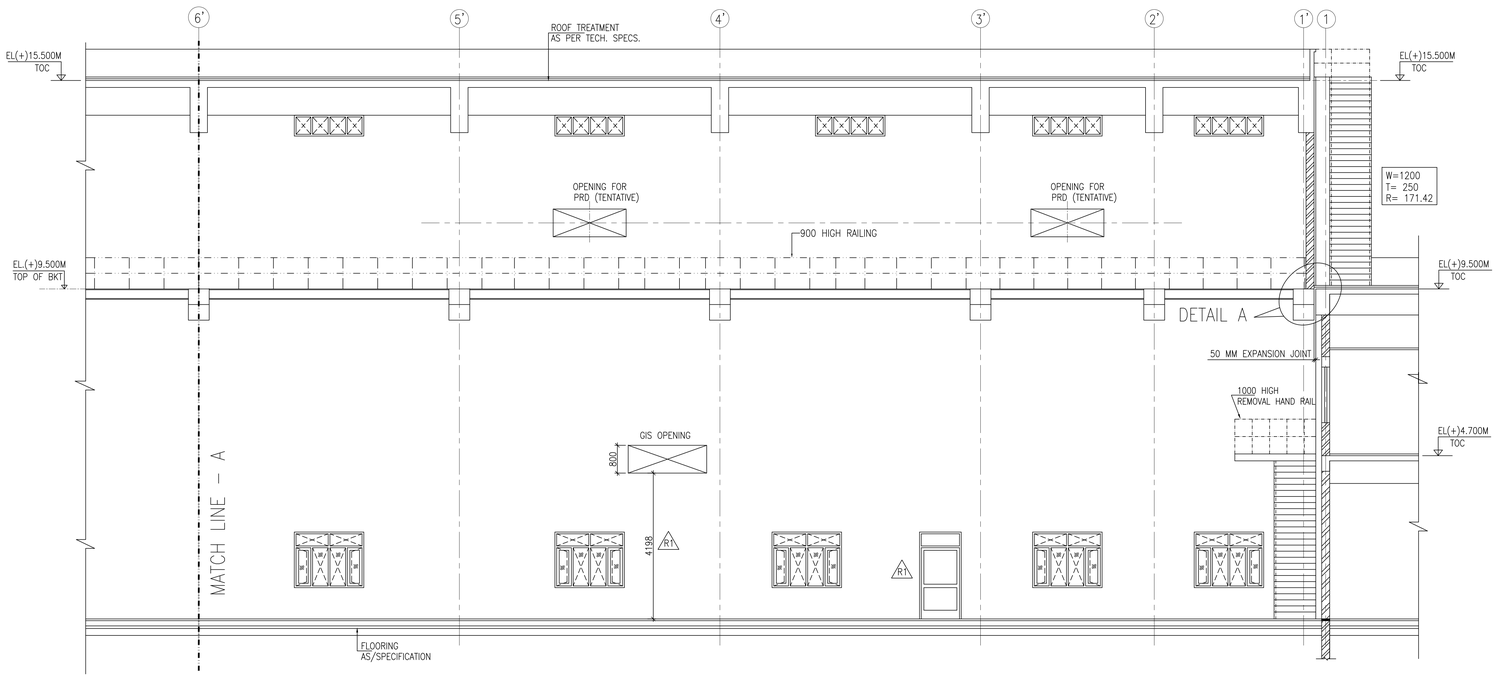
SHEET 06 OF 06 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

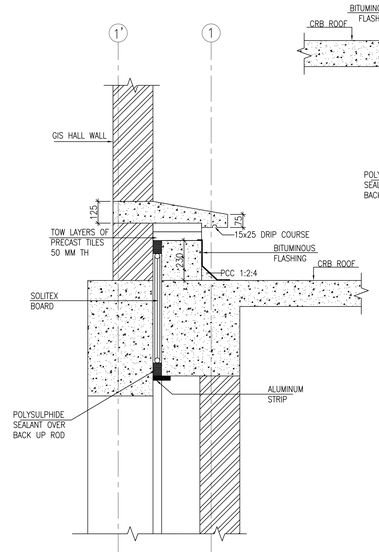
DRAWING No.



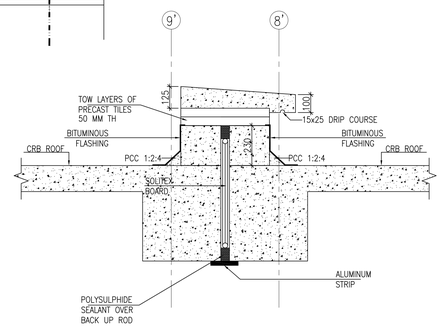
SECTION A–A



SECTION A–A



TYP. DETAIL OF EXPANATION JOINT
AT GIS & CRB LOCATION
(DETAIL A)



TYP. DETAIL OF EXPANATION JOINT
AT SAME LEVEL LOCATION
(DETAIL B)

NOTES:–

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															01	19.04.20	TKR	DKU	SG
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CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
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TITLE ARCHITECTURAL DRAWING GIS BUILDING (SECTION)

DEPT. SCALE 1: 75

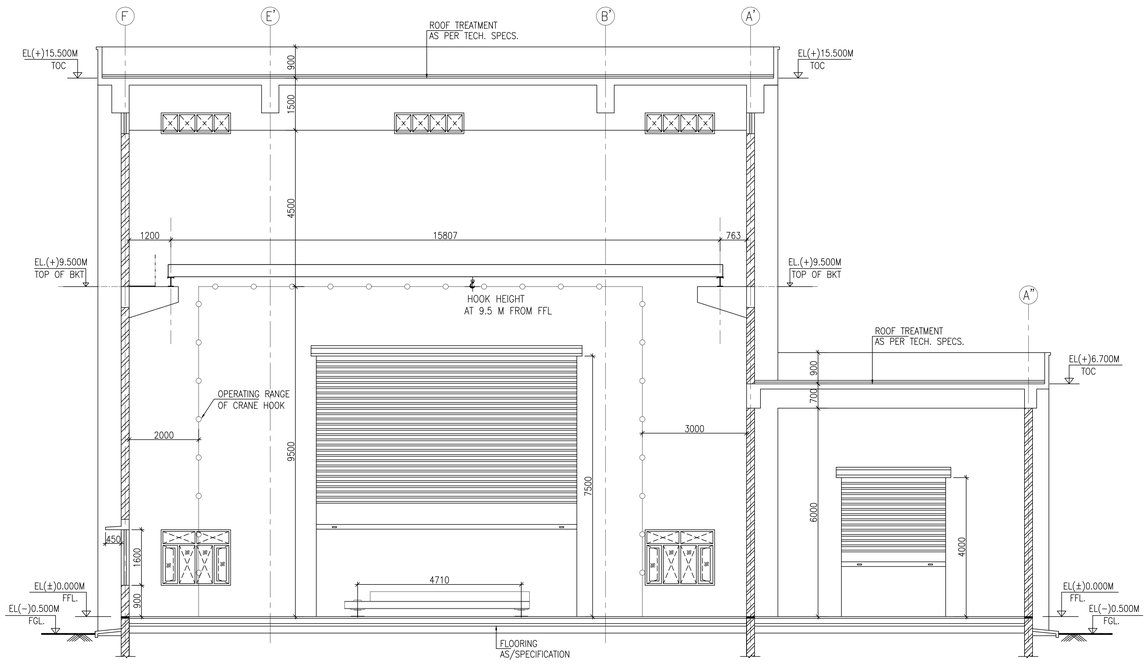
SIGN

DRAWING NO. TB–1–400–607–640–3

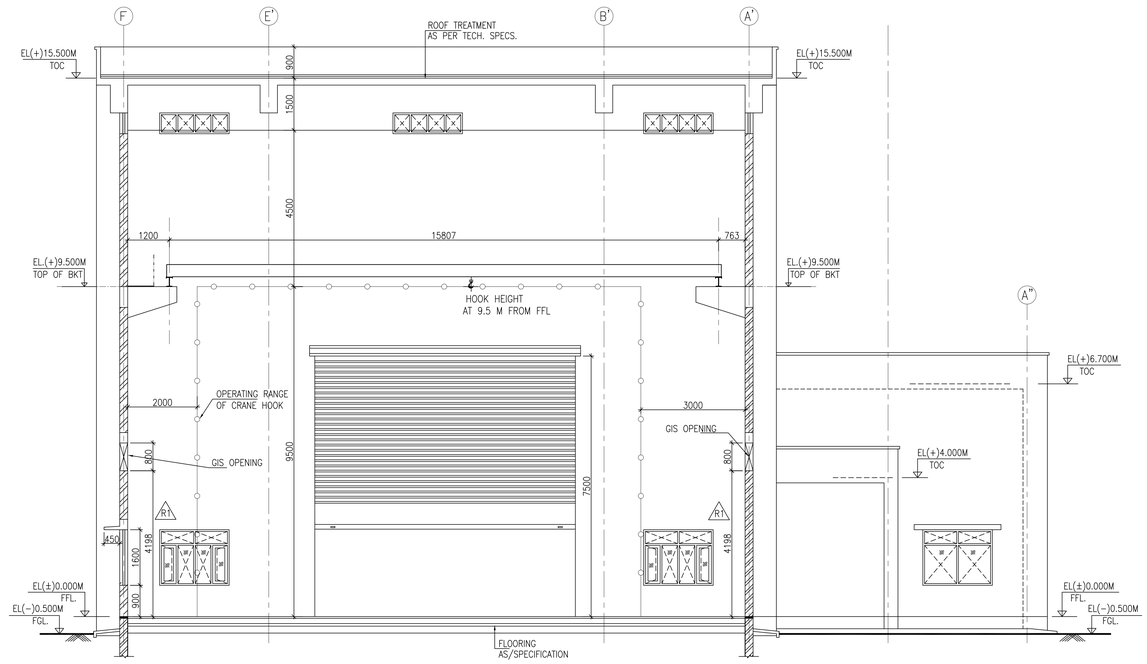
SHEET 01 OF 02 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

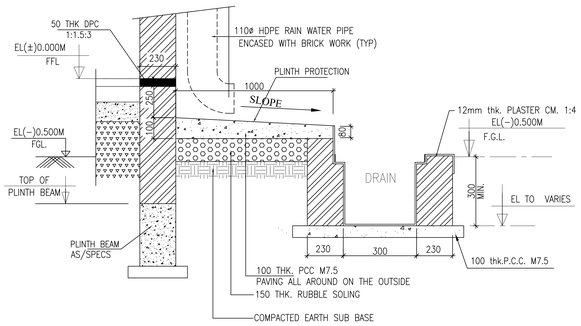
DRAWING No.



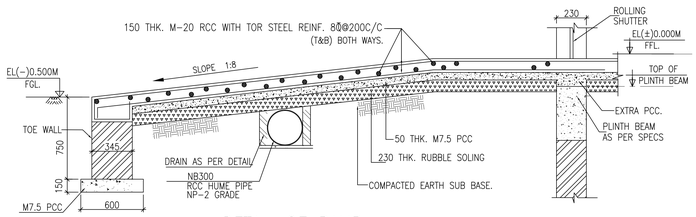
SECTION B–B



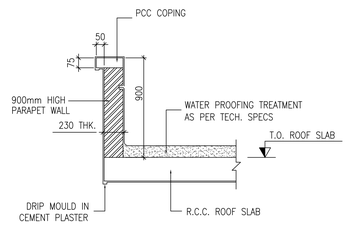
SECTION C–C



PLINTH PROTECTION ALONG BUILDING
WITH DRAIN–TYPICAL



DETAIL OF RAMP



TYP. DETAIL OF PARAPET

NOTES:–

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REV.	DATE	ALTD	CHD	APPD
01	19.04.20	TKR	DKU	SG

REVISED AS PER COMMENTS

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

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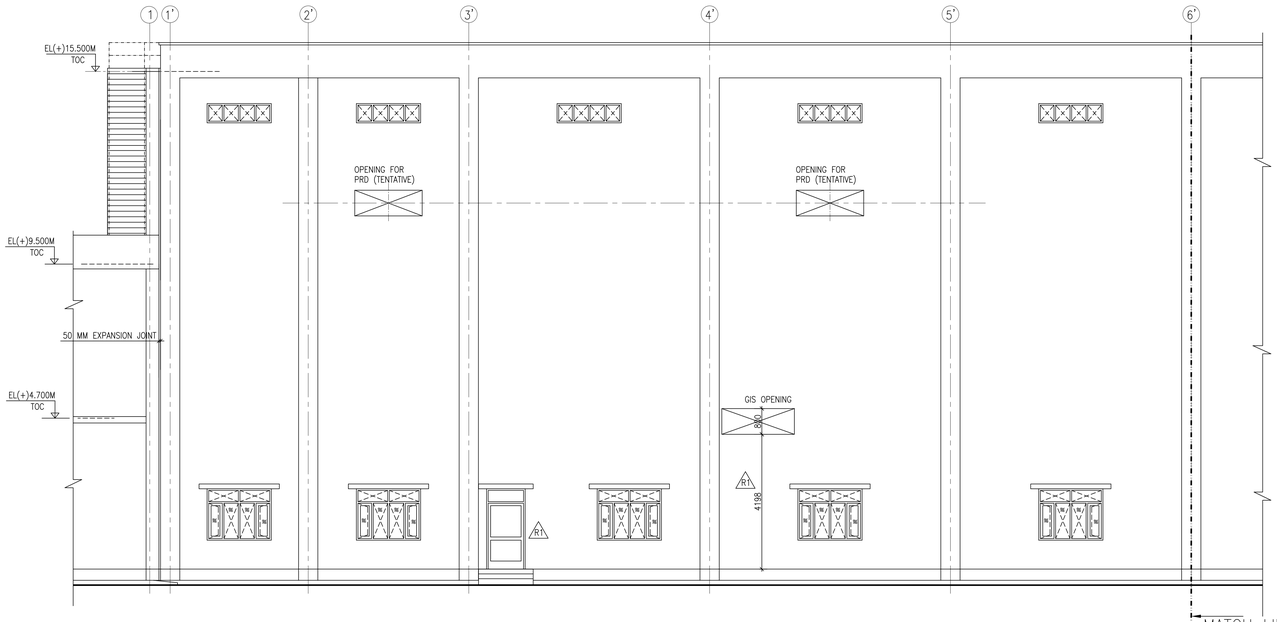
TITLE ARCHITECTURAL DRAWING GIS BUILDING (SECTION)

DEPT. SCALE 1: 75

SIGN

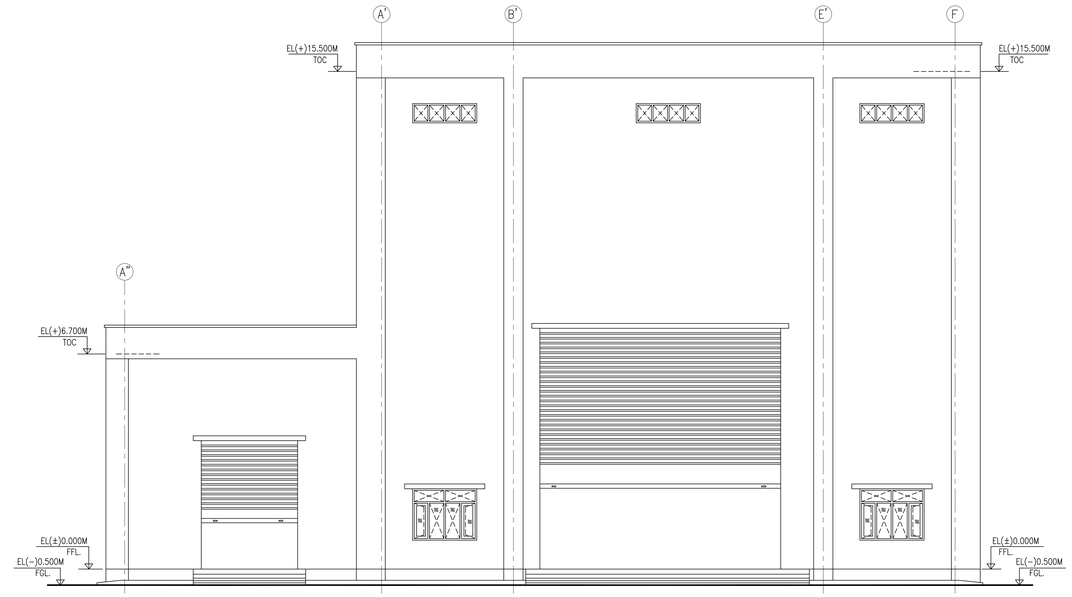
DRAWING NO. TB–1–400–607–640–3

SHEET 02 OF 02 REV. 01

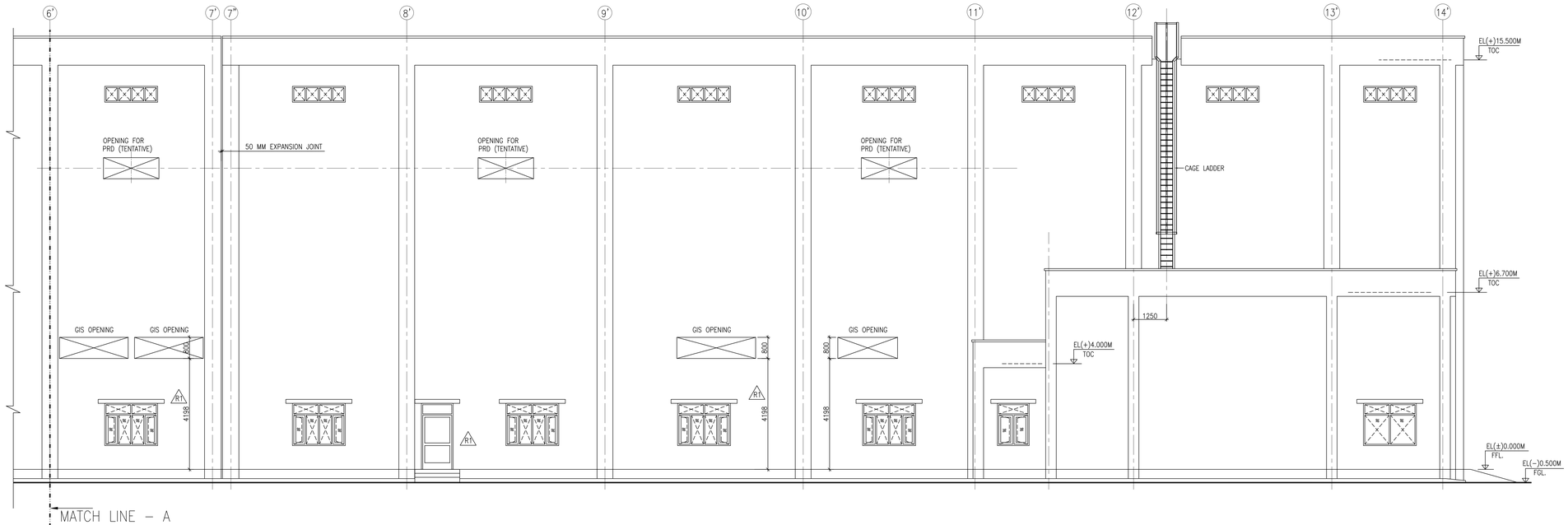


ELEVATION – 3

MATCH LINE – A



ELEVATION – 2



MATCH LINE – A

ELEVATION – 3

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															01	19.04.20	TKR	DKU	SG
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CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
JOB NO.	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA
STATUS	CONTRACT
DISTRIBUTION	

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	CHD	DKU		20.01.20
	APPD	AG		20.01.20

TITLE ARCHITECTURAL DRAWING GIS BUILDING (ELEVATION)

DEPT. | SIGN | SCALE 1:75

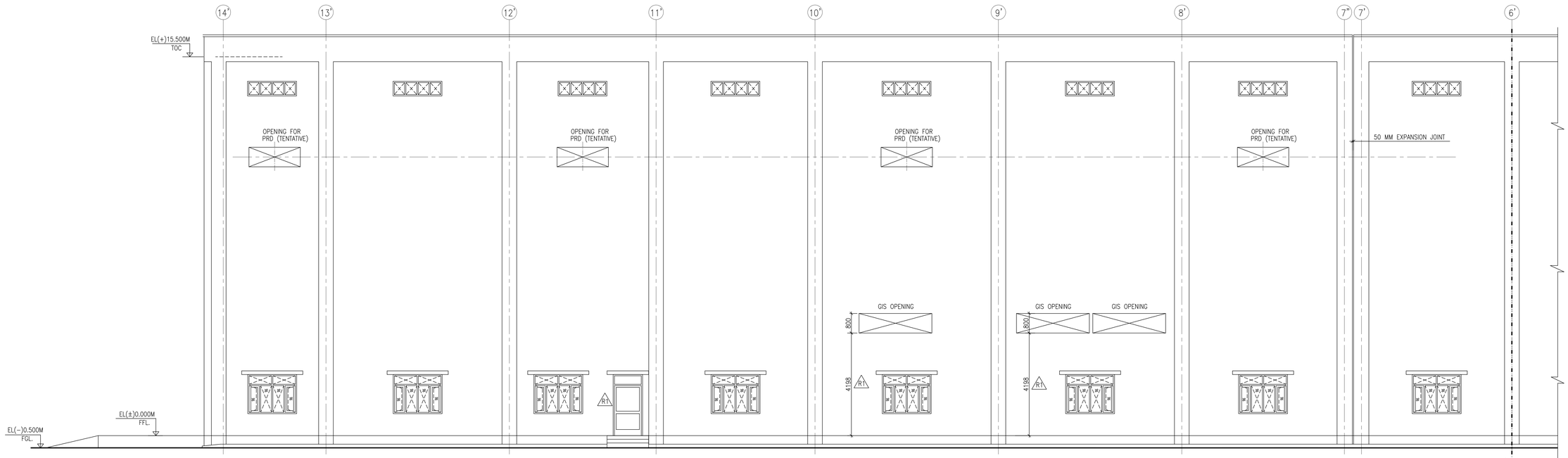
DRAWING NO. TB–1–400–607–640–2

SHEET 01 OF 02 | REV. 01

DRAWING No.

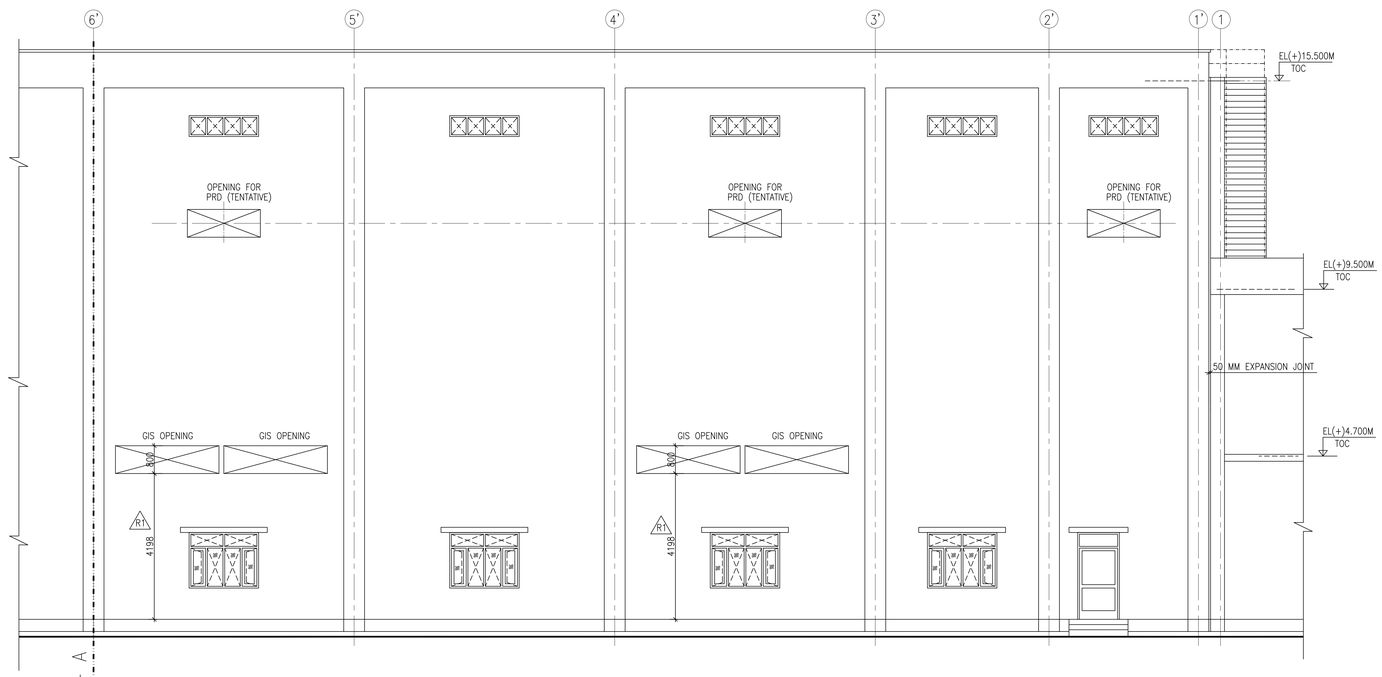
FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No.



ELEVATION – 1

MATCH LINE – A



ELEVATION – 1

MATCH LINE – A

NOTES:–

1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

2 ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.

3. ALL DOOR–WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.

REV.	DATE	ALTD	CHD	APPD
01	19.04.20	TKR	DKU	SG

REVISED AS PER COMMENTS

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

JOB NO.

STATUS CONTRACT

DISTRIBUTION

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E	DRN	TKR		20.01.20
	DESN	SS		20.01.20
	CHD	DKU		20.01.20
	APPD	AG		20.01.20

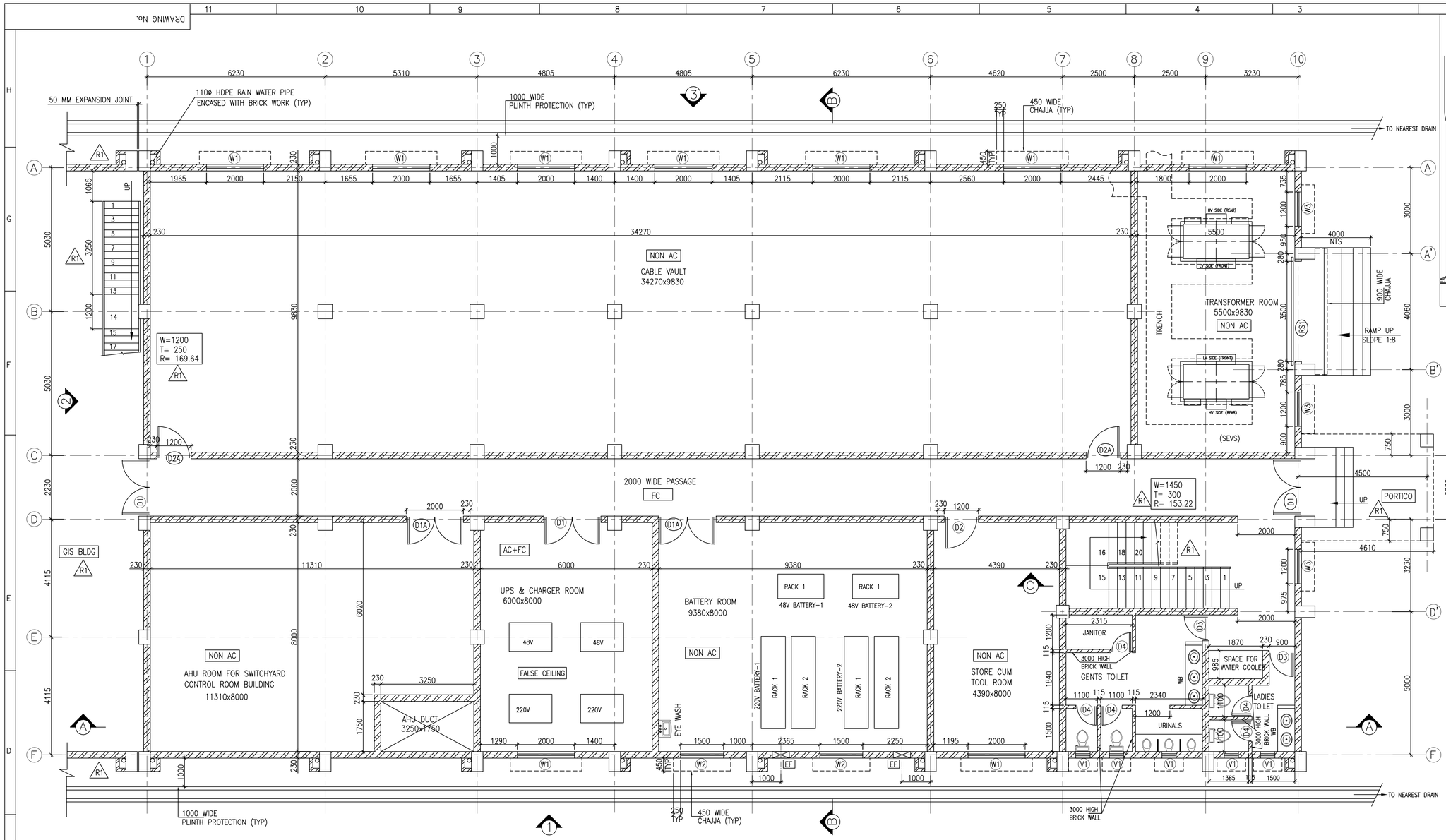
TITLE ARCHITECTURAL DRAWING GIS BUILDING (ELEVATION)

DEPT. SCALE 1: 75

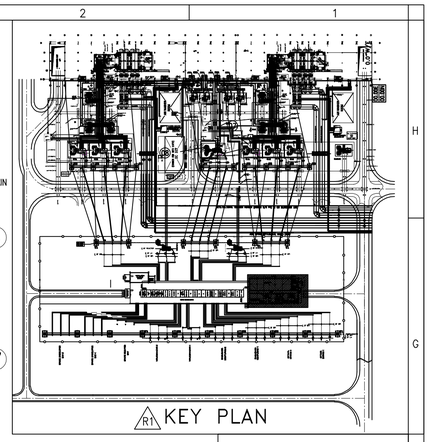
SIGN

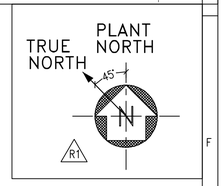
DRAWING NO. TB–1–400–607–640–2

SHEET 02 OF 02 REV. 01



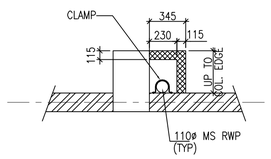
GROUND FLOOR PLAN





WATER PROOFING ON ROOF:

HIGH SOLID CONTENT LIQUID APPLIED ELASTOMERIC WATER PROOFING MEMBRANE WITH SEPARATE WEARING COURSE AS PER ASTM C -898. THICKNESS OF THE MEMBRANE SHALL BE 1.5 MM. THIS TREATMENT SHALL INCLUDE APPLICATION OF POLYMERISED MASTIC OVER THE ROOF TO ACHIEVE SMOOTH SURFACE AND PRIMER COAT. WEARING COURSE ON THE TOP OF MEMBRANE SHALL CONSIST OF 40MM. THICK PCC (1:2:4) CAST IN PANELS OF MAX. 1200x1200 SIZE AND REINFORCED WITH 0.56 MM. DIA. GALVANIZED CHICKEN WIRE MESH AND SEALING OF JOINTS USING SEALING COMPOUND/ ELASTOMETRIC WATER PROOFING MEMBRANE.



TYP. RWP FIXING DETAIL

LEGEND :-	
FGL	FINISHED GROUND LEVEL
FFL	FINISHED FLOOR LEVEL
TOC	TOP OF CONCRETE
FC	FALSE CEILING
UDI	UNDER DECK INSULATION
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
V	VENTILATOR
EF	EXHAUST FAN
WB	WASH BASIN

NOTES:-

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3. ALL DOOR-WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD	
R1	24.09.19	TKR	DKU	AG	REVISED AS PER COMMENTS

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE-I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

JOB NO.
STATUS CONTRACT
DISTRIBUTION

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E	DRN	TKR		14.08.19
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	CHD	DKU		14.08.19
	APPD	AG		14.08.19

TITLE ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (PLAN)

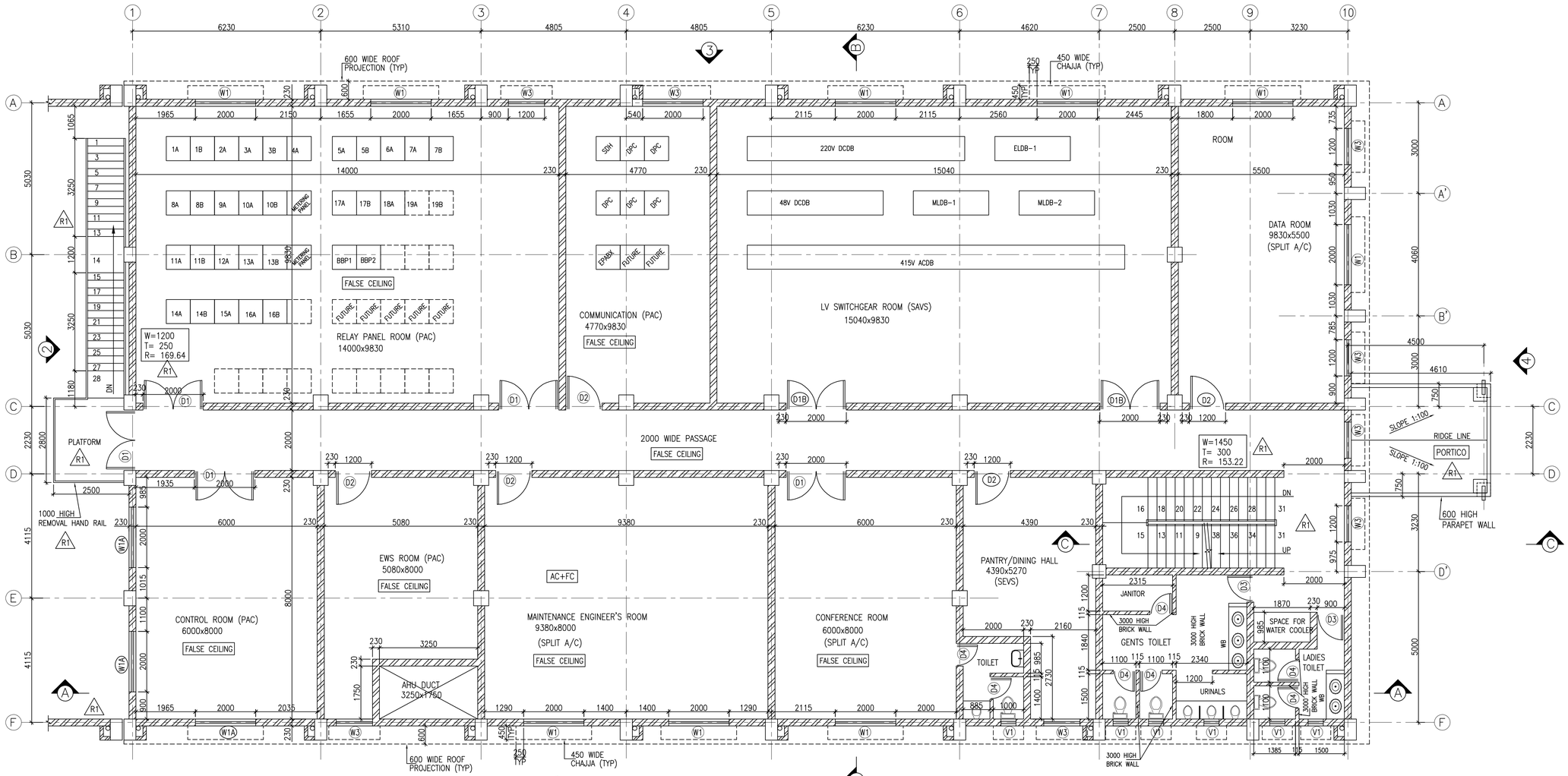
DEPT. SIGN SCALE 1:75

DRAWING NO. TB-1-400-607-620-1

SHEET 01 OF 03 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

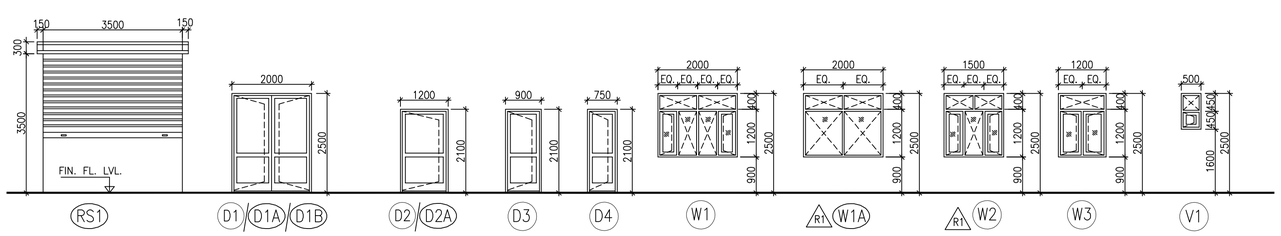
DRAWING No.



FIRST FLOOR PLAN

SCHEDULE OF DOORS & WINDOWS (AS PER TECHNICAL SPECIFICATION)

TYPE	OPENING SIZE	CILL LEVEL	LINTEL LEVEL	NOS.	DESCRIPTION
RS1	3500x3500	–	3500	1	STEEL ROLLING SHUTTER
D1	2000x2500	–	2500	8	DOUBLE SHUTTER ALUMINIUM GLAZED DOOR AS PER SPECS.
D1A	2000x2500	–	2500	2	DOUBLE SHUTTER STEEL FRAME DOOR AS PER SPECS.
D1B	2000x2500	–	2500	2	DOUBLE SHUTTER FIRE PROOF STEEL FRAME DOOR AS PER SPECS.
D2	1200x2500	–	2500	7	SINGLE SHUTTER ALUMINIUM GLAZED DOOR AS PER SPECS.
D2A	1200x2500	–	2500	2	SINGLE SHUTTER FIRE PROOF STEEL FRAME DOOR AS PER SPECS.
D3	900x2100	–	2100	4	SINGLE SHUTTER PVC DOOR FRAME AS PER SPECS.
D4	750x2100	–	2100	12	SINGLE SHUTTER PVC DOOR FRAME AS PER SPECS.
W1	2000x1600	900	2500	18	PARTLY FIXED & PARTLY OPENABLE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
R1 W1A	2000x1600	900	2500	3	FIX TYPE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
R1 W2	1500x1600	900	2500	2	PARTLY FIXED & PARTLY OPENABLE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
W3	1200x1600	900	2500	12	PARTLY FIXED & PARTLY OPENABLE ALUMINIUM FRAME GLAZED SHUTTER WINDOW AS PER SPECS.
V1	450x900	1600	2500	11	PARTLY FIXED & PARTLY OPENABLE ALUMINIUM FRAME GLAZED SHUTTER VENTILATOR AS PER SPECS.



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REV.	DATE	ALTD	CHD	APPD
R1	24.09.19	TKR	DKU	AG

REVISED AS PER COMMENTS

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

JOB NO.
STATUS CONTRACT
DISTRIBUTION

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TITLE ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (PLAN)

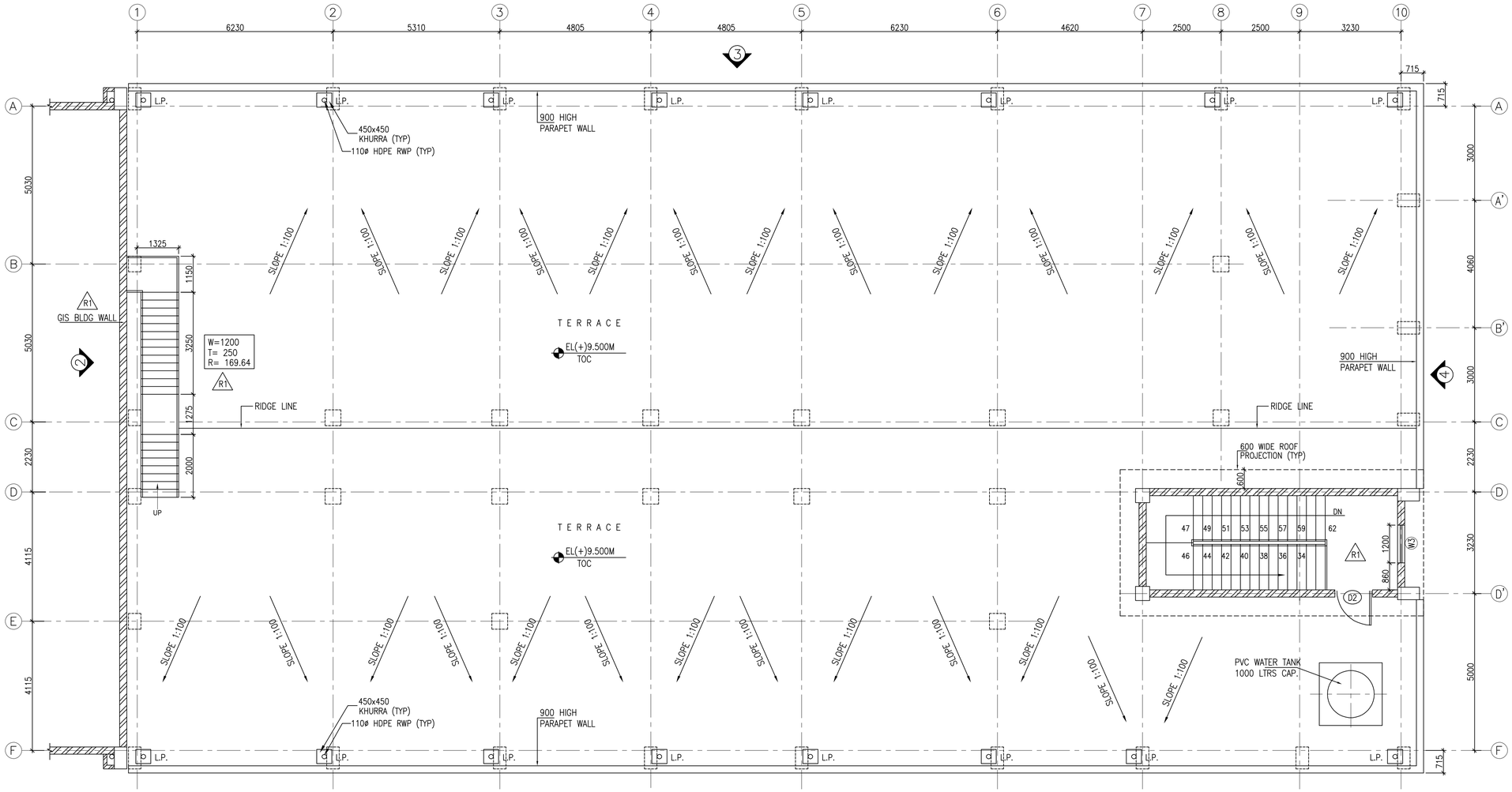
DEPT. SIGN SCALE 1:75

DRAWING NO. TB–1–400–607–620–1

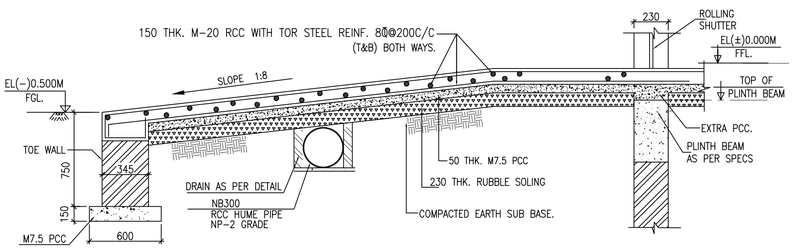
SHEET 02 OF 03 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

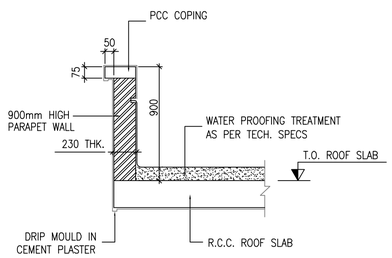
DRAWING No.



TERRACE PLAN



DETAIL OF RAMP



TYP. DETAIL OF PARAPET

NOTES:-

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REV.	DATE	ALTD	CHD	APPD
R1	24.09.19	TKR	DKU	AG

REVISED AS PER COMMENTS

JOB NO.

STATUS CONTRACT

DISTRIBUTION

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE-I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU

BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
NOIDA

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	APPD	AG		14.08.19

TITLE ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (PLAN)

DEPT. SCALE 1:75

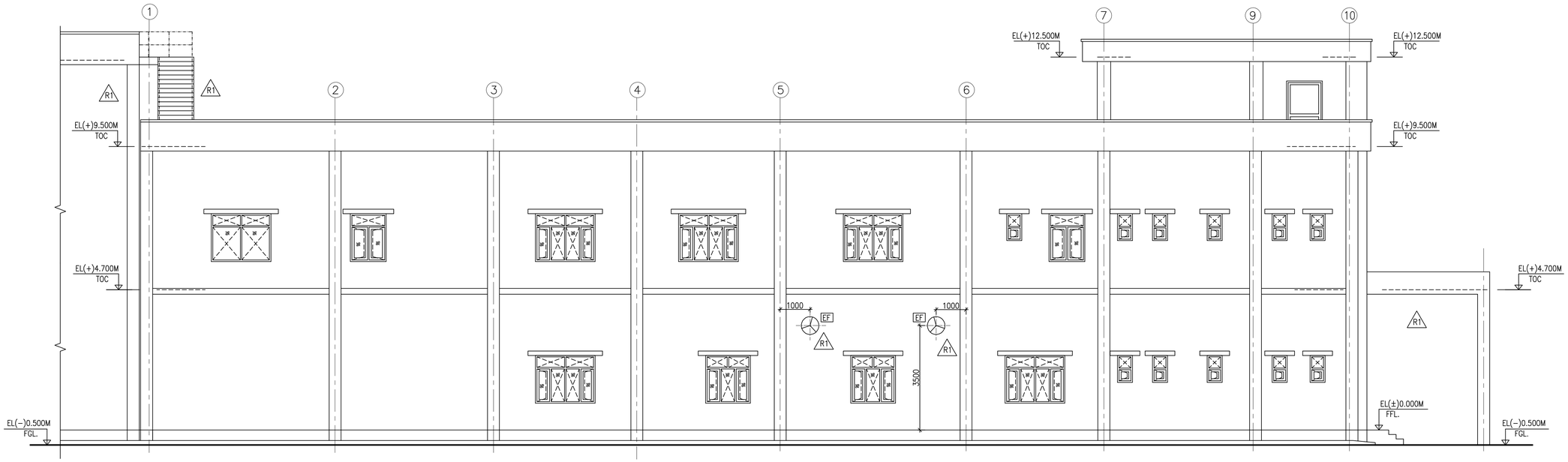
SIGN

DRAWING NO. TB-1-400-607-620-1

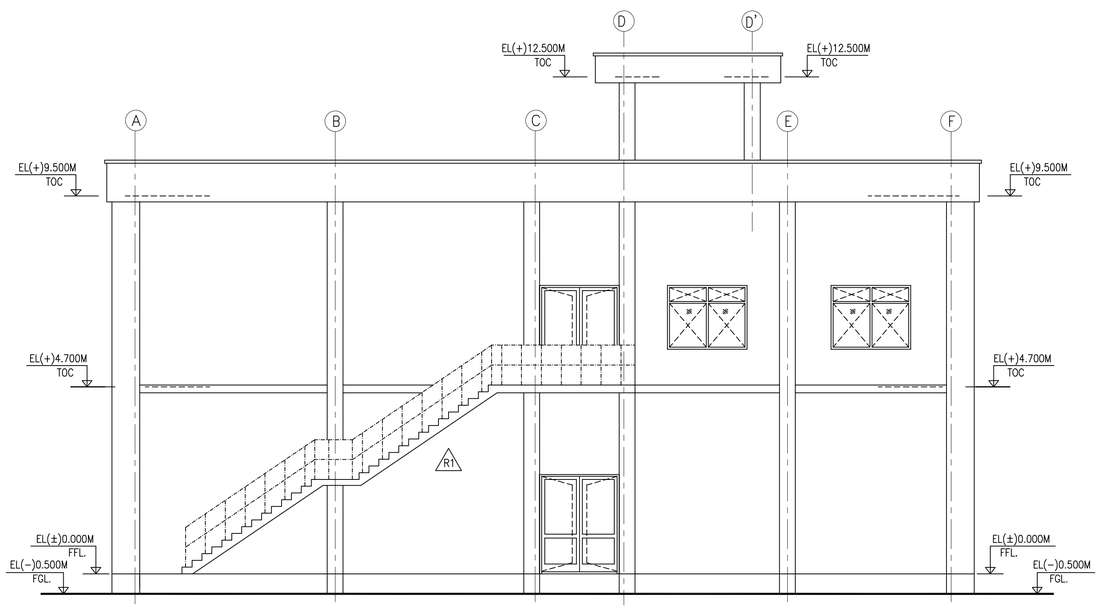
SHEET 03 OF 03 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

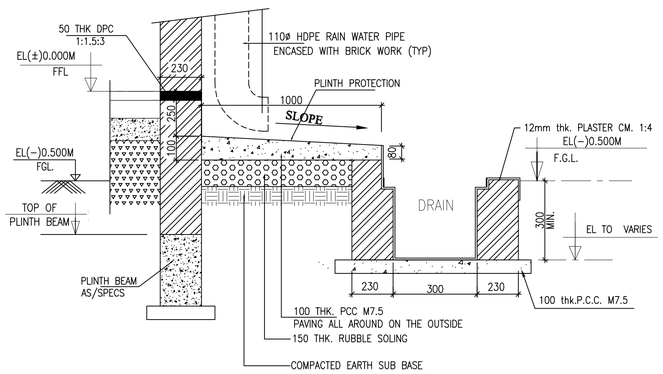
DRAWING No.



ELEVATION – 1



ELEVATION – 2



PLINTH PROTECTION ALONG BUILDING WITH DRAIN–TYPICAL

NOTES:–

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REV.	DATE	ALTD	CHD	APPD
R1	24.09.19	TKR	DKU	AG

REVISED AS PER COMMENTS

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

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	CHD	DKU		14.08.19
	APPD	AG		14.08.19

TITLE ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (ELEVATION)

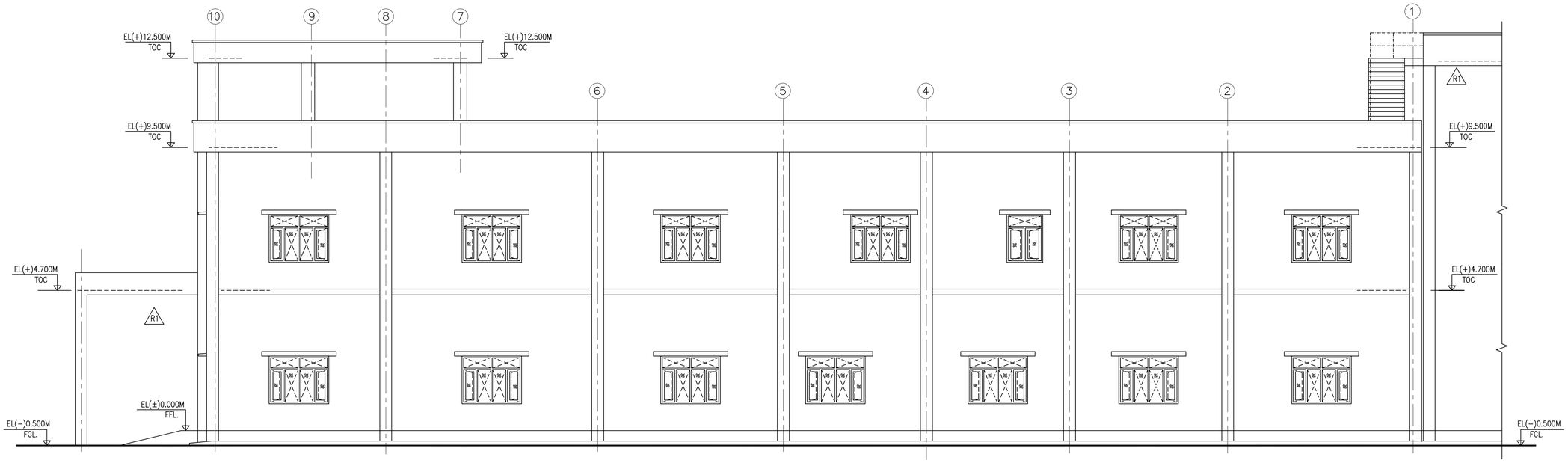
DEPT. SIGN SCALE 1:75

DRAWING NO. TB–1–400–607–620–2

SHEET 01 OF 02 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No.



ELEVATION – 3

ELEVATION – 4

NOTES:–

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REV.	DATE	ALTD	CHD	APPD	
R1	24.09.19	TKR	DKU	AG	REVISED AS PER COMMENTS

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CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
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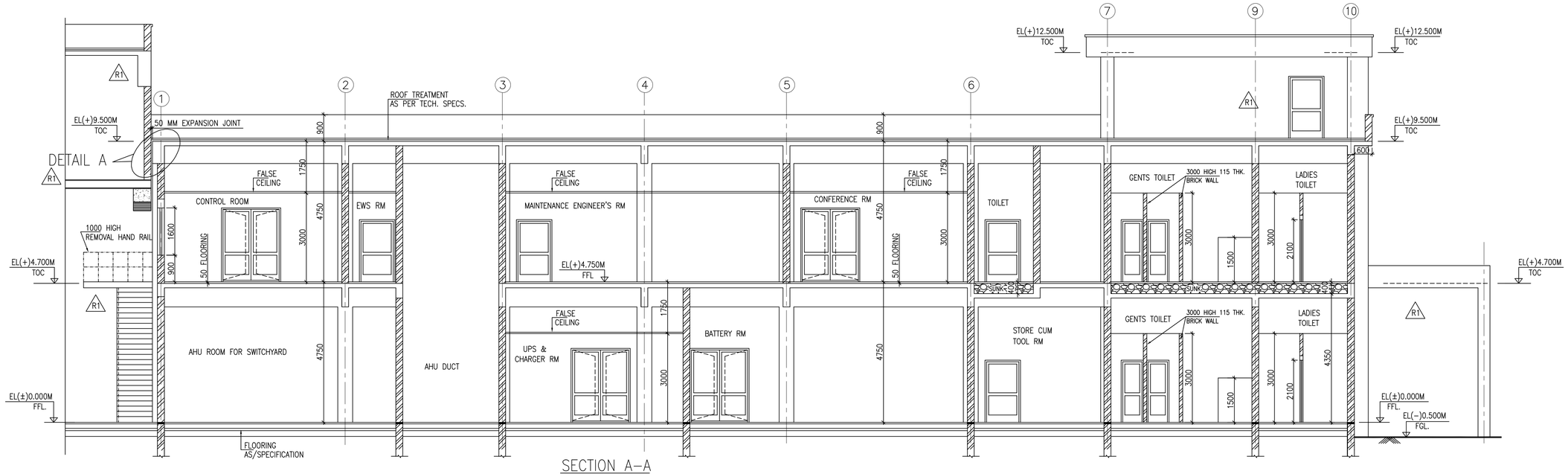
TITLE ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (ELEVATION)

DEPT. SIGN SCALE 1:75

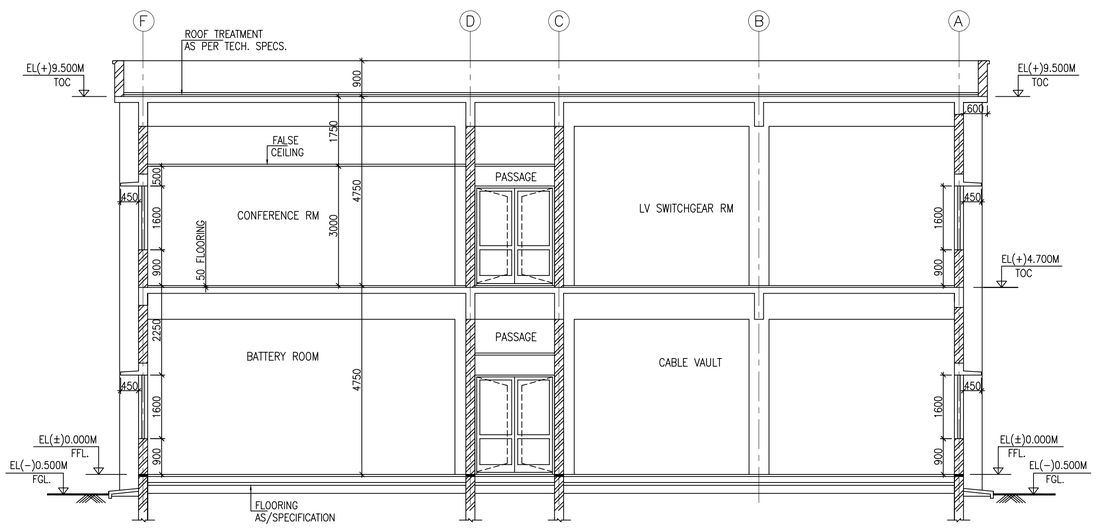
DRAWING NO. TB–1–400–607–620–2

SHEET 02 OF 02 REV. 01

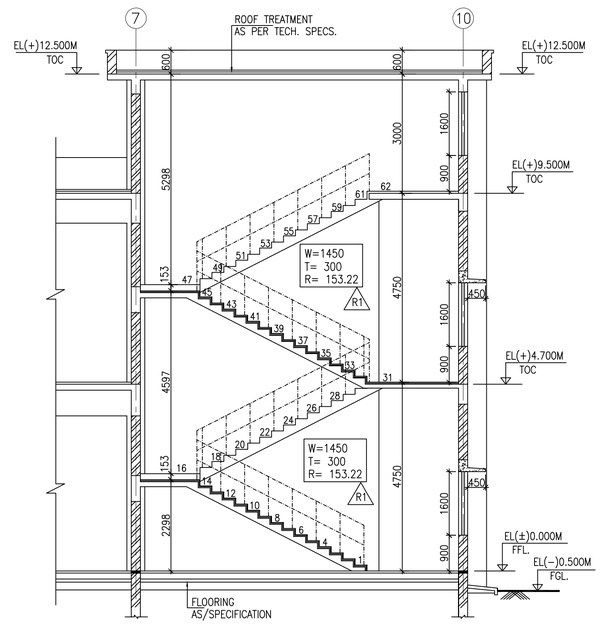
FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)



SECTION A–A



SECTION B–B



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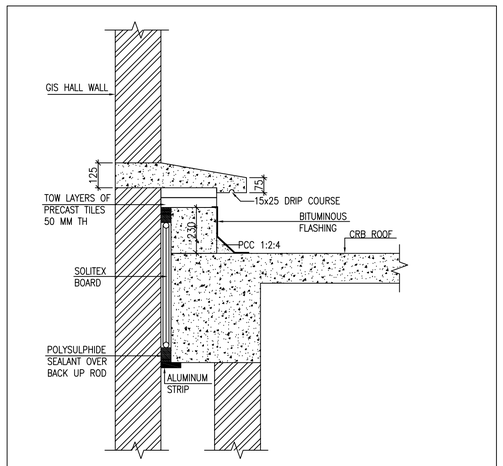

TYP. DETAIL OF EXPANATION JOINT AT GIS & CRB LOCATION

(DETAIL A)

NOTES:–

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R1	24.09.19	TKR	DKU	AG

REVISED AS PER COMMENTS

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CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
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	APPD	AG		14.08.19

TITLE ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (SECTION)

DEPT. SCALE 1: 75

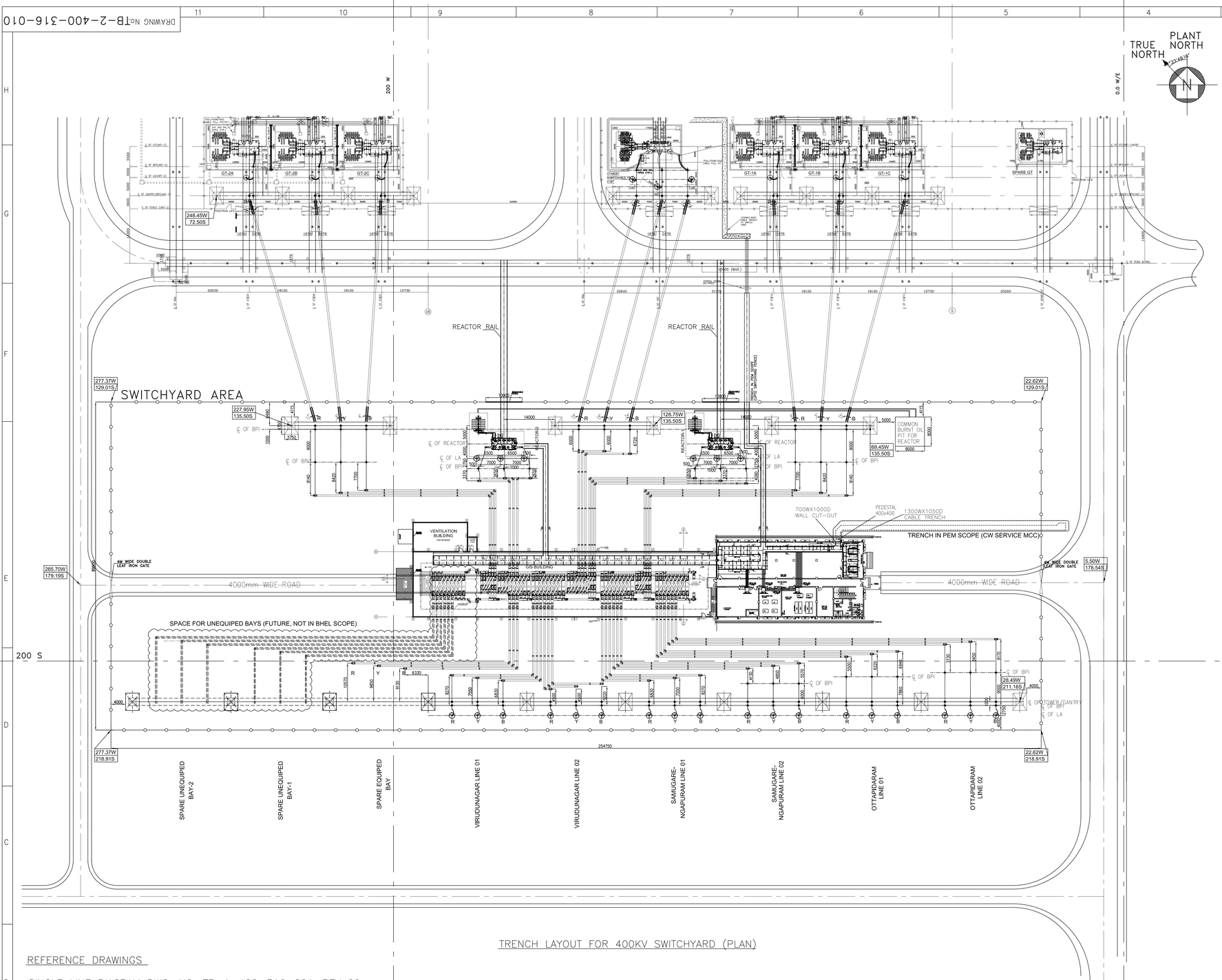
SIGN

DRAWING NO. TB–1–400–607–620–3

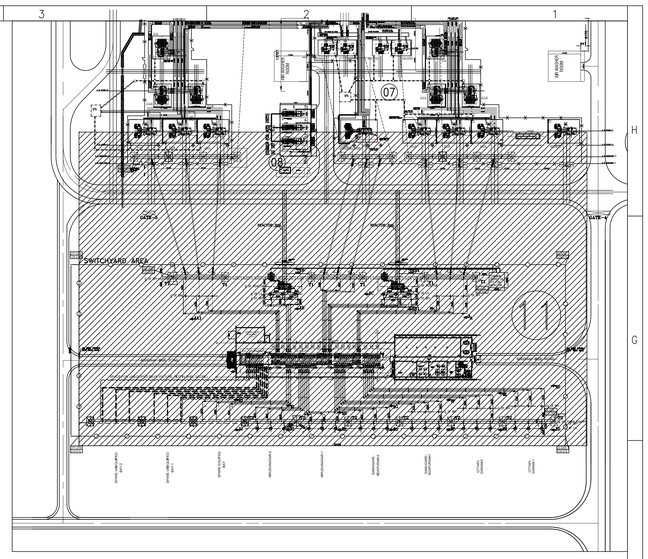
SHEET 01 OF 01 REV. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No. TB-2-400-316-010



TRENCH LAYOUT FOR 400KV SWITCHYARD (PLAN)



KEY PLAN

REFERENCE DRAWINGS

SINGLE LINE DIAGRAM DWG. NO. TB-1-400-316-001-REV 09
ARCHITECTURAL DRAWING CONTROL ROOM BUILDING (PLAN) DWG. NO. TB-1-400-607-620-1-REV 01
CONCEPTUAL GIS BUILDING LAYOUT DWG. NO. TB-1-400-316-005-R2
GIS LAYOUT DWG. NO. 1HYG900056-2-REV AD
PLOT PLAN DWG. NO. PE-DG-435-100-M001-REV 04
INSTALLATION DETAILS FOR CABLE SUPPORT SYSTEM (BOLTABLE TYPE) DWG. NO. PE-DG-435-507-E006 REV 01
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES GS AND FRP TYPE DWG. NO. PE-DG-435-507-E005 REV 02, SHEET 1 TO 14 OF 34

NOTE:

THIS DRAWING SHOULD BE REFERRED ONLY FOR TRENCH/CONDUIT ROUTING/DETAIL IN SWITCHYARD, GIS BUILDING & CONTROL ROOM BUILDING.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE-I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

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DEPT CODE		NAME	SIGN	
E	DRN	SY		11.02.2020
	DESN	SS		11.02.2020
	CHD	SKS		11.02.2020
	APPD	AG		11.02.2020

TITLE TRENCH LAYOUT FOR 400KV SWITCHYARD

DEPT. SCALE 1:300
SIGN

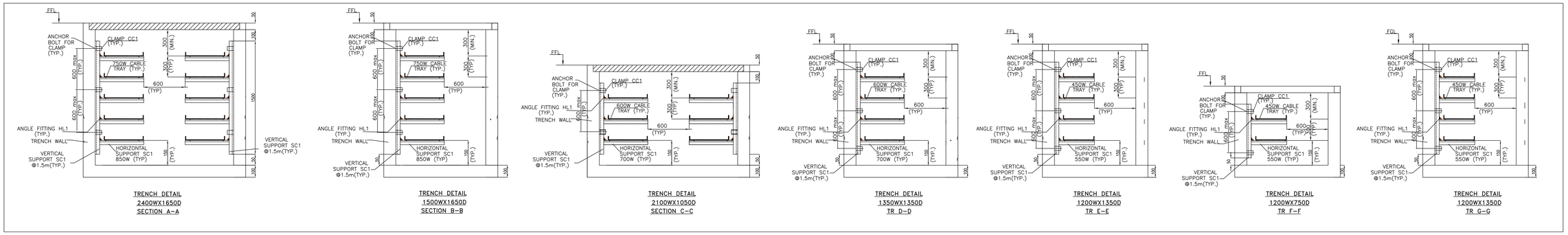
DRAWING NO. TB-2-400-316-010

SHEET 01 OF 04 REV. 00

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No TB-2-400-316-010

TRENCH SECTION



TRENCH DETAIL 2400WX1650D SECTION A–A

TRENCH DETAIL 1500WX1650D SECTION B–B

TRENCH DETAIL 2100WX1050D SECTION C–C

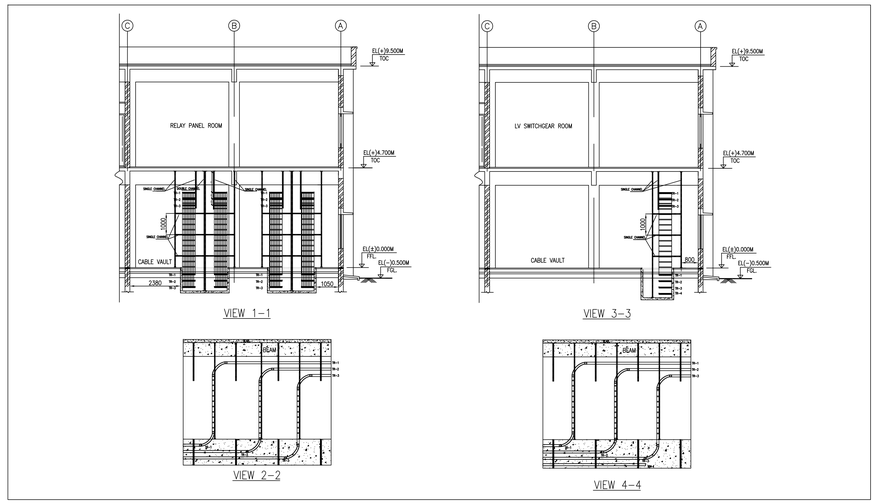
TRENCH DETAIL 1350WX1350D TR D–D

TRENCH DETAIL 1200WX1350D TR E–E

TRENCH DETAIL 1200WX750D TR F–F

TRENCH DETAIL 1200WX1350D TR G–G

VERTICAL CABLE RISER



A. CABLE TRAYS SUPPORT SYSTEM

1. CABLE TRAYS SHALL BE BOLTED TO TRAY MOUNTING SUPPORTS WITH A MINIMUM CLEARANCE OF 300MM BETWEEN CABLE TRAY TIERS / AS SHOWN IN THE DRAWINGS.
2. CABLE TRAYS SHALL BE SUPPORTED AT AN INTERVAL OF 2000MM FOR INDOOR HORIZONTAL RUNS, 1500MM FOR OUTDOOR HORIZONDAL RUNS AND 1000MM FOR VERTICAL CABLE RISERS/SHAFTS.
3. CABLE TRAY SUPPORT SYSTEM SHALL BE SO DESIGNED THAT IT IS ABLE TO WITHSTAND WEIGHT OF THE CABLE TRAYS, WEIGHT OF THE CABLES (75 KG/METRE RUN OF EACH CABLE TRAY), CONCENTRATED LOAD OF 75 Kg BETWEEN EVERY SUPPORT SPAN WITHOUT ANY PERMANENT DEFLECTION.
4. FOR SUPPORTING CABLE TRAYS, EMBEDDED STEEL INSERTS IF PROVIDED ON WALL/FLOOR/CEILING SURFACES SHALL BE UTILISED. IN CASE OF NON–AVAILABILITY OF EMBEDDED STEEL INSERTS OF EMBEDDED STEEL INSERTS THE CONTRACTOR SHALL HAVE TO SECURE THE SUPPORTS ON WALL/FLOOR/CEILING SURFACES BY PROVIDING SUITABLE ANCHORING SYSTEM/STEEL INSERTS HAVING ADEQUATE LOAD BEARING CAPABILITY.
5. FOLLOWING DRAWINGS SHALL BE REFERRED FOR INSTALLATION:
   - INSTALLATION DETAILS FOR CABLE SUPPORT SYSTEM (BOLTABLE TYPE) DWG. NO. PE–DG–435–507–E006 REV 01
   - TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES GS AND FRP TYPE DWG. NO. PE–DG–435–507–E005 REV 02, SHEET 1 TO 14 OF 34

B. CABLE INSTALLATION

1. CABLE INSTALLATION SHALL BE CARRIED OUT AS PER IS: 1255 AND OTHER APPLICABLE STANDARDS.
2. POWER CABLE AND CONTROL CABLE SHALL GENERALLY BE TAKEN THROUGH SEPARATE TRAYS. IN CASE BOTH OF THE CABLES SHOULD BE UNAVOIDABLY ACCOMMODATED IN THE SAME TRAY. A SEPARATOR OR A GAP IN BETWEEN SHALL BE PROVIDED.
3. THE ALLOCATION OF CABLES IN TRAYS SHALL BE IN THE FOLLOWING ORDER FROM THE TOP MOST TIER:
   - HT POWER CABLE (HT)
   - LT POWER CABLE (LV)
   - CONTROL CABLE
   - SIGNAL CABLE
4. MULTICORE HT POWER CABLES SHALL BE LAID IN SINGLE LAYER ONLY IN TOUCHING FORMATION. HT/LT SINGLE CORE CABLES TO BE LAID IN TREFOIL FORMATION WITH A CLEAR SPACING EQUAL TO DIAMETER OF THE TREFOILS.
5. LV POWER CABLES OF ABOVE 25 SQ.MM. SHALL BE LAID IN SINGLE LAYER ONLY. SMALLER SIZE CABLES CAN BE LAID IN 2 LAYERS.
6. CONTROL AND INSTRUMENTATION CABLES MAY BE LAID UPTO A MAXIMUM OF THREE LAYERS IN EACH TRAY.
7. ATLEAST 250 MM SPACING SHALL BE MAINTAINED BETWEEN TOP OF THE TRAYS AND BEAMS/PIPING ETC.
8. POWER AND CONTROL CABLES SHALL BE SECURELY FIXED TO TRAYS/SUPPORTS WITH SELF LOCKING TYPE NYLON CABLE STRAP WITH DEINTERLOCKING FACILITY AT EVERY 5 METER INTERVAL FOR HORIZONTAL RUN AND CABLES LAID IN VERTICAL RUN OF TRAYS SHALL BE SECURELY FIXED TO TRAYS/SUPPORTS AT EVERY ONE METRE INTERVAL. SINGLE CORE CABLES SHALL BE LAID IN TREFOIL FORMATION USING TREFOIL CLAMPS AT EVERY 2M INTERVAL.
9. ALL POWER CABLES SHOULD BE CLAMPED INDIVIDUALLY. THE SCREEN OF SINGLE CORE CABLES WILL BE BONDED TO EARTH AT ONE END ONLY. PREFERABLY AT SWITCHGEAR END.
10. IN GENERAL. POWER AND CONTROL CABLES SHALL BE LAID IN LADDER TYPE TRAYS.
11. BENDING RADIUS FOR CABLES SHALL BE AS PER MANUFACTURER RECOMMENDATION.
12. WHERE CABLES CROSS ROADS/RAIL TRACKS. THE CABLES SHALL BE LAID IN HUME PIPES EMBEDDED IN GROUND WITH A MINIMUM COVER OF 1 METRE OR WITH PVC DUCT BANK HAVING RCC COVERING FOR LOWER DEPTH.
13. IN EACH CABLE RUN WITH A ROUTE LENGTH OF MORE THAN 250M AND FOR ALL HT CABLES. SOME EXTRA LENGTH SHALL BE KEPT AT SUITABLE POINT/CABLE PULL PIT TO ENABLE ONE STRAIGHT THROUGH JOINTS TO BE MADE. SHOULD THE CABLE DEVELOP FAULT AT A LATER STAGE. CONTROL CABLE TERMINATION INSIDE EQUIPMENT ENCLOSURE SHALL HAVE SUFFICIENT LENGTHS SO THAT SHIFTING OF TERMINATION IN TERMINAL BLOCKS CAN BE DONE WITHOUT REQUIRING ANY SPLICING.
14. CONDUITS/PIPES WITH REQUIRED BENDING RADIUS SHALL BE USED FOR ROUTING OF CABLES FROM CABLE TRAYS TO EQUIPMENT/JUNCTION BOXES. PIPE SLEEVES SHALL BE USED FOR ROUTING OF CABLES BETWEEN FLOORS. ROAD CROSSING. ENTRY/EXIT FROM OUTSIDE OF BUILDING ETC. ALL CONDUITS/PIPE SHALL HAVE THEIR ENDS CLOSED BY CAPS TILL THE CABLES ARE PULLED. AFTER THE CABLES ARE PULLED. THE ENDS SHALL BE SEALED BY SUITABLE SEALING COMPOUND.
15. EACH CABLE SHALL BE TAGGED WITH NUMBERS. CABLES SHALL BE TAGGED AT THEIR ENTRANCE AT EVERY 30M AND EXIT FROM ANY EQUIPMENT, JUNCTION BOX. THE TAGS SHALL BE OF ALUMINIUM OR OTHER APPROVED MEANS WITH THE NUMBER PUNCHED ON IT AND SECURELY ATTACHED TO THE CABLE THE LOCATION OF CABLE JOINTS, IF ANY, SHALL BE CLEARLY INDICATED WITH CABLE MARKER WITH AN ADDITIONAL INSCRIPTIONS "CABLE–JOINT" AND "CABLE NUMBER".
16. FERRULES SHALL BE PROVIDED ON ALL CONTROL CABLE CORES IN ALL JUNCTION BOXES AND AT ALL TERMINATIONS. THE FERRULES SHALL CARRY TERMINAL NUMBERS AS PER DRAWINGS. ALL FERRULES SHALL BE COLOURED. PLASTIC & INTERLOCKED TYPE.
17. OUTDOOR TO INDOOR OPENING IN THE WALL OF CABLE VAULT, CONTROL ROOM BUILDING FOR CABLE ACCESS SHALL BE SEALED WITH FIRE PROOF MORTAR SEALING COMPONENT AFTER INSTALLATION OF THE CABLE SYSTEM.
18. THE TERMINATION AND CONNECTION OF CABLES SHALL BE DONE STRICTLY IN ACCORDANCE WITH CABLE TERMINATION KIT MANUFACTURERS INSTRUCTIONS/DRAWINGS.

C. RCC CABLE TRENCH

1. PROPER SLOPE SHALL BE ENSURED IN THE CABLE TRENCHES IN LONGITUDINAL AND ALSO IN TRANSVERSE DIRECTION FOR DRAINING OF WATER.
2. EARTHING CONDUCTOR SHALL BE RUN ALONG THE CABLE TRENCH BY CLAMPING OR WELDING TO TRAY SUPPORTS. CABLE TRAYS SHALL BE EARTHED TO THE EARTHING CONDUCTOR AT 30M INTERVAL.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

JOB NO.
STATUS CONTRACT
DISTRIBUTION

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP NOIDA

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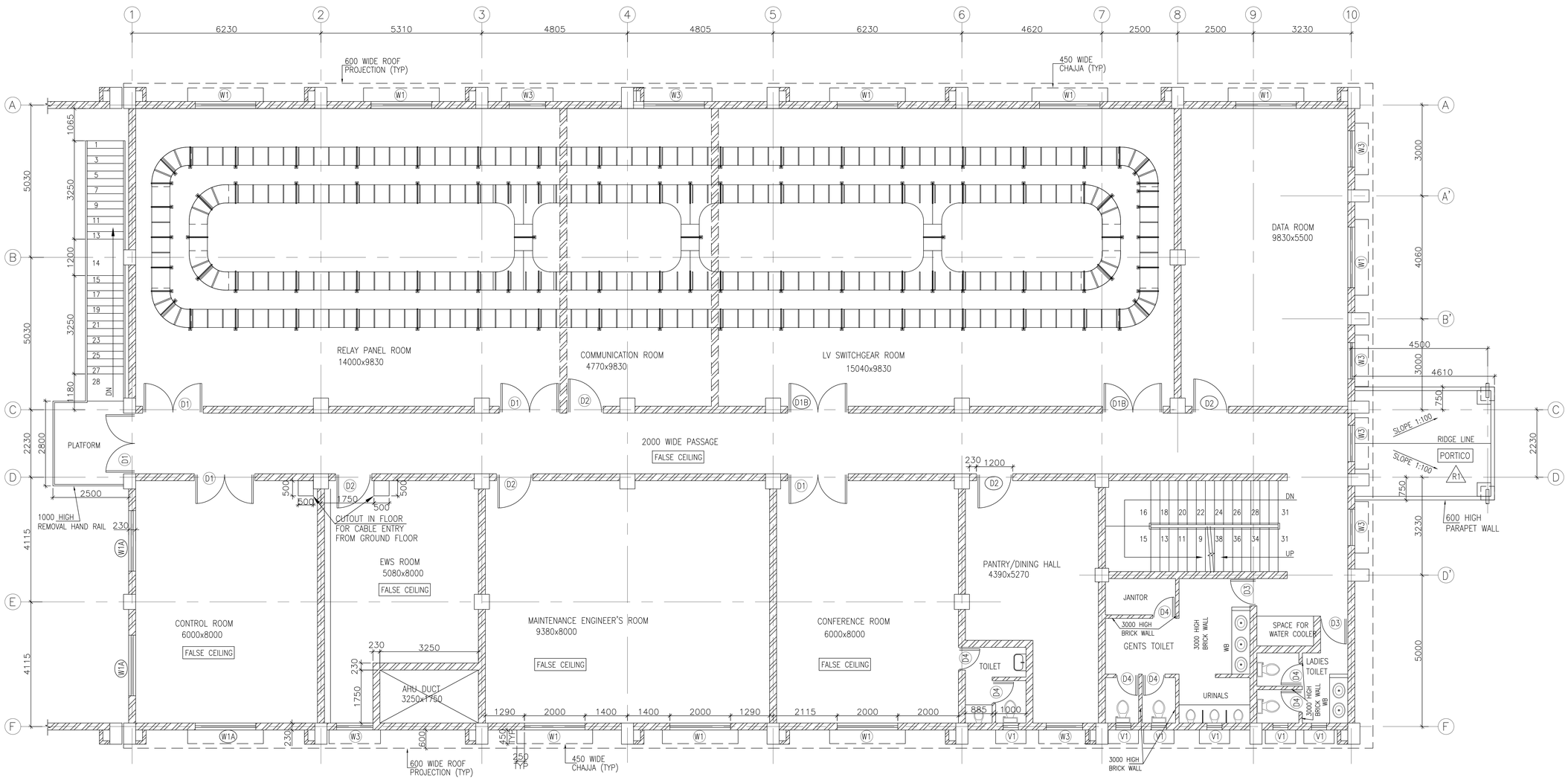
DEPT CODE		NAME	SIGN	
E	DRN	SY		11.02.2020
	DESN	SS		11.02.2020
	CHD	SKS		11.02.2020
	APPD	AG		11.02.2020

TITLE TRENCH LAYOUT FOR 400KV SWITCHYARD

DEPT. SCALE 1:300
SIGN
DRAWING NO. TB–2–400–316–010
SHEET 02 OF 04 REV. 00

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRAWING No. TB-2-400-316-010



CONTROL ROOM BUILDING FIRST FLOOR PLAN AT EL(+)4.550M

NOTE:

THIS DRAWING SHOULD BE REFERRED ONLY FOR CABLE TRAY LAYING METHOD ON UNDERHUNG CABLE SUPPORT ASSEMBLY

CABLE TRAY

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD	
01	31.07.19	SS	SKS	AG	Revised as per comments on Rev 00 vide letter TCE.11403A-EL-VDT-125 dated 02.07.2019

JOB NO.

STATUS CONTRACT

DISTRIBUTION

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE-I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU
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	CHD	SKS		11.02.2020
	APPD	AG		11.02.2020

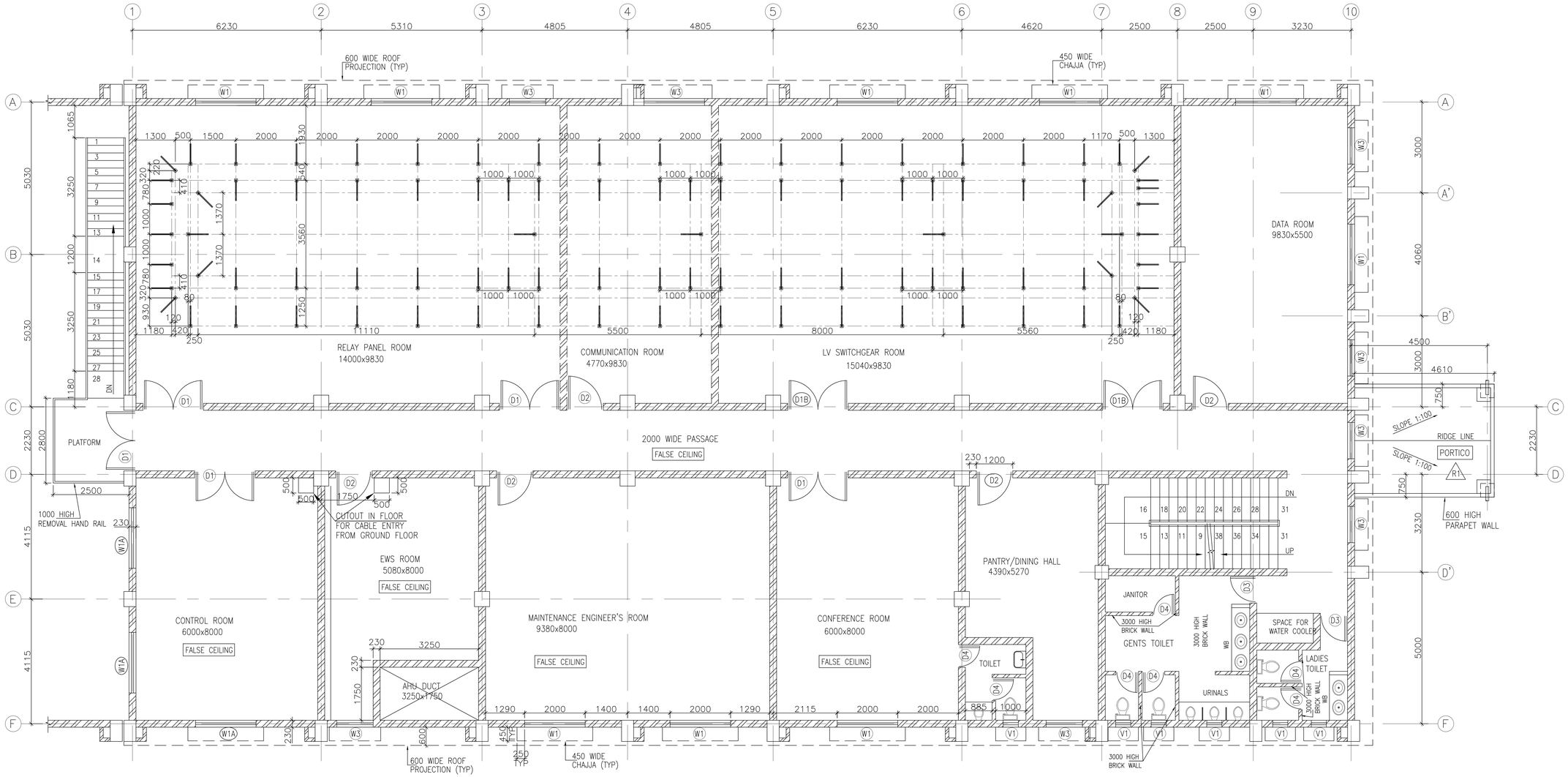
TITLE TRENCH LAYOUT FOR 400KV SWITCHYARD

DEPT. SCALE 1:300

SIGN

DRAWING NO. TB-2-400-316-010

SHEET 04 OF 04 REV. 00



CONTROL ROOM BUILDING FIRST FLOOR PLAN AT EL(+)4.550M

NOTE:

THIS DRAWING SHOULD BE REFERRED ONLY FOR THE LOCATION OF UNDERHUNG CABLE SUPPORT ASSEMBLY IN CABLE VAULT (BELOW RELAY PANEL ROOM, COMMUNICATION ROOM, LV SWITCHGEAR ROOM FLOOR) & CUTOUT IN FLOOR FOR CABLE ENTRY IN CONTROL ROOM & EWS ROOM.

UNDERHUNG CABLE SUPPORT ASSEMBLY

REV.	DATE	ALTD	CHD	APPD
01	31.07.19	SS	SKS	AG
	Revised as per comments on Rev 00 vide letter TCE.11403A-EL-VDT-125 dated 02.07.2019			

JOB NO.
STATUS CONTRACT
DISTRIBUTION

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE-I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
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	CHD	SKS		11.02.2020
	APPD	AG		11.02.2020

TITLE TRENCH LAYOUT FOR 400KV SWITCHYARD

DEPT. SCALE 1:300
SIGN
DRAWING NO. TB-2-400-316-010
SHEET 03 OF 04 REV. 00