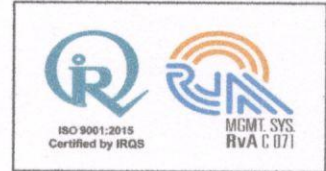




**KOLKATA PORT TRUST
HALDIA DOCK COMPLEX
AN ISO- 9001: 2015 ORGANISATION**



Office of Plant & Equipment Division,
Operational Administrative Building (1st floor),
Chiranjibpur,
P.O.:- Haldia,
Dist.:- Purba Medinipur,
State:- West Bengal,
India. Pin – 721 604.

Tel. No. : + 91- 3224- 252713/ 9434062312
[E-Mail : koushikm.hdc@kolkataporttrust.gov.in]

No.: SDM(P&E)-III/ 1054/ 1055

Dated : November 27, 2019.

To,

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Dear Sir,

Sub.: Budgetary Offer for the work of Supply, Installation, Testing and Commissioning of 3.3 kV HT Panel, 415 Volt LT Panels, 3.3 / 0.433 kV Transformers, 3.3 kV grade HT & 1.1 kV grade LT cabling work and other allied works for New Wagon Tippler Sub-station of Haldia Dock Complex, Kolkata Port Trust at Haldia, Dist.- Purba Medinipur, State- West Bengal – Regd.

Haldia Dock Complex, Kolkata Port Trust intends to execute the work of Supply, Installation, Testing and Commissioning of 3.3 kV HT Panel, 415 Volt LT Panels, 3.3 / 0.433 kV Transformers, 3.3 kV grade HT & 1.1 kV grade LT cabling work and other allied works for New Wagon Tippler Sub-station, inside Dock area of Haldia Dock Complex, Kolkata Port Trust at Haldia, Dist.- Purba Medinipur, State- West Bengal, India.

Tentative 'Bill of Quantity' as well as 'Technical Specification' for the said work are attached herewith for ready reference.

It will be kind enough if the budgetary offer be submitted from your end, latest by 6th December, 2019 (Friday), in line with the attached 'Bill of Quantity' as well as 'Technical Specification'.

Budgetary offer as well as other details, if any, may please be forwarded to the undersigned, at e-mail ID: koushikm.hdc@kolkataporttrust.gov.in

Thank you,

Yours faithfully,


(K. MUKHOPADHYAY)
Sr. Dy. Manager (P&E)
Haldia Dock Complex
Kolkata Port Trust
November 27, 2019
Encl: As stated above.

Bill of Quantity for Supply, Installation, Testing and Commissioning of 3.3 kV HT Panel, 415 Volt LT Panels, 3.3 / 0.433 kV Transformers, 3.3 kV grade HT & 1.1 kV grade LT cabling work and other allied works for New Wagon Tippler Sub-station of Haldia Dock Complex, Kolkata Port Trust.

SL. No.	DESCRIPTION	UNIT	QTY	RATE PER UNIT	AMOUNT
				(IN INR)	
				Excluding GST	(IN INR)
PART A- ELECTRICAL INSTALLATION AT WAGON TIPPLER SUB-STATION.:					
1	HT 3.3KV VCB Panel:- Design, fabricate, supply, installation, testing and commissioning of indoor HT 3.3 kV VCB Panel 1250 Amps, 3 phase, 50 Hz, 25 kA for 3 Sec. as per the Technical Specification (18 Panel).				
(i)	Supply	Set	1		
(ii)	Installation, testing and commissioning	Set	1		
2	1 MVA Distribution Transformer:- Design, Manufacture, supply, installation, testing and commissioning of following 3.3/0.433 kV Oil type transformer with off circuit tap changer & marshalling box of make as per the Technical Specification.				
(i)	Supply of 3.3/0.433 KV, 1MVA Distribution Transformer	No.	4		
(ii)	Installation, testing and commissioning	No.	4		
3	1600 Amps, LT Panel:- Design, Manufacture, Supply, installation, testing and commissioning of 1600 Amps, 21 Ways, LT Distribution Panel as per Technical Specifications.{ 1600 Amps ACB -3 Nos. (2 Nos. Incommer from Transformer and 1 No. Bus Coupler); 800 Amps ACB- 8 Nos.; 400 Amps MCCB- 06 Nos. and 100 Amps. MCCB- 4 Nos. }				
(i)	Supply	sets.	2		
(ii)	Installation, testing and commissioning	sets.	2		
4	3.3 kV(UE) XLPE, HT Cable:- Supply and laying of 3C x 185 Sq.mm. HT Aluminum XLPE cable including end terminations as per Technical Specification.				
(i)	Supply	Mtr	2000		
(ii)	Laying through existing RCC trench/Hume Pipe/ GI Pipe.	Mtr	1400		
(iii)	Laying by excavating trench.	Mtrs.	300		
(iv)	Laying through 150 mm dia. Hume pipe to be laid after excavating including supply of Hume pipe.	Mtrs.	75		
(v)	Laying through 150 mm NB GI Pipe to be laid after excavating, including supply of Pipe	Mtrs.	75		
5	3.3 kV(UE) XLPE, HT Cable :- Supply and laying of 1C x 1000 Sq.mm. HT Aluminum XLPE armoured cable as per Technical Specification.				
(i)	Supply	Mtr	1000		
(ii)	Laying through RCC trench	Mtr	1000		
6	3.3 kV XLPE, HT Cable end termination:- Supply of end termination kit for 1C x 1000 Sq.mm. HT Aluminum XLPE cable.				
(i)	Supply of Indoor end termination kit	No.	32		
(ii)	Installation, testing and commissioning	No.	32		
7	1.1 kV Grade XLPE insulated LT Cable :- Supply, installation, testing & commissioning of 4 Runs of Single Core 1.1 kV grade XLPE insulated Aluminium conductor cable of 1600 Amps. Capacity.				
(i)	Supply	Sets.	4		
(ii)	Installation, testing and commissioning	Sets.	4		
8	3.3 kV XLPE, HT Cable end termination and straight through:- Supply of straight through and heat Shrinkable type end termination kit for 3C x 185 Sq.mm. HT Aluminum XLPE cable.				
(i)	Supply of Indoor end termination kit	No.	6		
(ii)	Supply of st. through jointing kit	No.	10		
(iii)	Installation of indoor end termination kit and testing and commissioning	No.	6		
(iv)	Installation of straght through jointing kit and testing and commissioning	No.	10		

SL. No.	DESCRIPTION	UNIT	QTY	RATE PER UNIT (IN INR)	AMOUNT (IN INR)
				Excluding GST	
9	<u>1.1KV XLPE, LT Cable Supply and end termination:-</u> Supply and laying of 3.5C x 240 Sq.mm. LT Aluminum XLPE cable including supply of Heat shrinkable st. through and end terminations as per Technical Specification.				
(i)	Supply of 3.5C x 240 Sq.mm. LT Aluminum XLPE cable	Mtr	3000		
(ii)	Laying of 3.5C x 240 sq.mm. LT Aluminum XLPE cable through existing RCC trench / Escavated trench / G. I. Pipe / Hume Pipe	Mtr	3000		
(iii)	Supply of End Termination material.	Set	40		
(iv)	Installation, testing & commissioning of End Termination material.	Set	40		
(v)	Supply of straight through cable jointing kit	Set	20		
(vi)	Installation, testing and commissioning of straight through cable jointing kit.	Set	20		
10	<u>LT Aluminum XLPE cable:-</u> Supply, laying and termination of 1C x 1000 Sq.mm. LT Aluminum XLPE cable including end terminations as per Technical Specification.				
(i)	Supply of 1C x 1000 Sq. mm.	Mtr	250		
(ii)	Laying and termination through existing RCC trench and cable.	Mtr	250		
11	<u>Indoor APFC Panel:-</u> Design, Supply, installation, testing and commissioning of 250 KVAR, 440V rated indoor APFC Panel as per Technical Specification.				
(i)	Supply	No.	2		
(ii)	Installation, testing and commissioning	No.	2		
12	<u>Battery Charger with batteries:-</u> Supply and Installation of Maintenance Free Lead Acid battery with 2 (two) Hours battery backup for 30V, 180 AH Battery Bank with Float cum-Boast Charger as per Technical specifications.				
(i)	Supply	set	2		
(ii)	Installation, testing and commissioning	set	2		
13	<u>Cable Tray and support structure:-</u>				
(i)	Supply of GI ladder type Cable tray 450mm	Mtrs.	350		
(ii)	Supply of GI Support structure	T	2		
(iii)	Supply of GI perforated type Cable tray 100mm	Mtrs.	250		
(iv)	Installation, fixing of GI Support Structure and GI Cable tray.	LS	1		
(v)	Supply, fixing of aluminium clamps for laying of cable through Cable tray.	LS	1		
14	<u>Providing Earthing System with plate Earthing in accordance with BIS 3043 or latest amendment as per Technical Specification.</u>				
(i)	Supply	No.	40		
(ii)	Installation, testing and commissioning	No.	40		
15	<u>Supply and laying of 50 mm x 6 mm Hot dip galvanized Earthing flat / strip as per Technical specification.</u>				
(i)	Supply	Mtr	500		
(ii)	Laying	Mtr	500		

SL. No.	DESCRIPTION	UNIT	QTY	RATE PER UNIT (IN INR)	AMOUNT (IN INR)
				Excluding GST	
16	Supply of following electrical materials and accessories as per IER:-				
(i)	11 KV grade rubber hand gloves	Pair	3		
(ii)	Rubber insulating mat as per IS:15652 for Class of insulating mat-B, Size 1Meter x 2Meter, colour-Black	Nos.	35		
(iii)	First aid box	Set	2		
(iv)	Shock treatment chart and safety rules mounted on acrylic sheet with suspension clamp and front clear plastic sheet lamination.	Set	2		
(v)	Fire extinguisher (Mech foam extinguisher-50Ltrs.each -02Nos. and CO2(6.8Kg. each)-02Nos.) and Fire bucket 4 Nos. with pedestal stand	Set	1		
(vi)	5000V hand Operated Megger (Range-0-20000Ohms.)	No.	2		
(vii)	Box spanner set (Make: TAPARIA) with complete accessories with box	Set	1		
17	<u>Structural items:</u>				
(i)	Supply of GI Chequered Plates 8mm thick	T	3		
(ii)	Supply of GI Angles (65x65x6) mm	T	1		
(iii)	Supply of GI Channels (75x40x6) mm	T	1		
(iv)	Fabrication, Installation and commissioning of above structural items	T	5		
PART B- WIRING AND ELECTRIFICATION OF SUB-STATION.:					
1	<u>Wagon Tippler Sub-Station Building</u> Building Dimension {Ground Floor : 34.4 x 12.3 x 8 Mtrs. and First Floor : 27.0 x 12.3 x 6 Mtrs.}				
(i)	Supply	LS	1		
(ii)	Installation, testing and commissioning	LS	1		

TECHNICAL SPECIFICATION

1.0 GENERAL

1. The works will be executed to comply with the General Specifications for Electrical works and conforming to the Indian Electricity Act & rules, BIS & direction of Engineer.
2. The items of work shall be executed as per detailed technical specifications and scheme. In case of contradiction between schedule of work with its Additional Specification and the General Specification, the former shall prevail.
3. The work will be executed as per general arrangement drawing and detailed fabrication drawings duly approved by the Engineer. The various items of equipment will be ordered only after the drawings are approved and quantities in detail of various items are ascertained as per actual requirements. Therefore the actual quantities / measurement may vary from the stipulated quantities, which are only estimate.
4. The contractor/agency will engage suitable qualified/experienced/ licensed engineering supervisor for the work and suitable skilled personnel with required license for doing the erection work. Required special tools to be operated in the execution of the job.
5. The work will be performed as per the day to day instruction and approval of the engineer. All materials/ equipment will be used after taking approval of the Engineer.
6. Equipment will be duly inspected in the Manufacturer's works / premises by Third Party Inspection (TPI) Agency before despatch to the site.
7. The work will be executed as per the programme of completion of the project. The delivery & erection schedule of various materials/ equipment will be as per approval of Engineer.
8. The contractor holds responsibility for the entire job as per relevant specifications. If any item is left out within the schedule of work but if it is considered essential for the completion of the job, the contractor has to carry out the items as extra substituted item.
9. The contractor shall have to make arrangements, at his own risk and cost, for transportation of materials from the point of issue of stores to site of work, if any.
10. The contractor shall ensure that the staff employed by him for execution of the electrical work, possess the valid electrical license issued by competent authority. Consequences arising due to the default of the contractor in not complying with the above condition shall be the entire responsibility of the contractor.
11. All concealed work and earthing shall be done in the presence of the Engineer or his authorized representative.
12. The schematic diagram/dimensional drawings of the various electrical cubical panels shall be got approved from the Engineer before fabrication and shall comply with specifications and Indian Electricity Rules. The panels shall conform to IS: 8623/1993.

13. All panels/DB shall be suitable for 45°C ambient temperature.
14. The MCB shall be of the same make as that of MCB DB's. Contractor shall obtain approval of the Engineer before procurement of MCB DB's. All DB's shall be double door type confirming to minimum IP-54 degree of protection.
15. Miniature Circuit Breaker shall comply with IS -8828-1996 / IEC 898. Miniature Circuit Breakers shall be quick make and break type for 230 / 415 V A.C., 50Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10KA at 415V A.C. The MCB shall be DIN mounted. The MCB shall be current limiting type (Class - 3).
16. MCB shall be as per their tripping characteristics curves defined by the manufacturer. The MCB shall have the minimum power loss (watts) per pole defined as per the IS / IEC and the manufacturer shall publish the values.
17. The MCB housing shall be heat resistant and having high impact strength. The terminal shall be protected against finger contact to IP20 degree of protection.
18. All model of modular accessories required for the work shall be got approved from the Engineer among the approved makes. The base plate shall be preferably in sheet steel or otherwise in unbreakable polycarbonate. The cover plates shall be screw less type in shade approved by the Engineer. The GI box shall be of the same make as the modular accessories.
19. Contractor shall have to check the site order Book for any instructions of Engineer or his authorized representative and sign the site order book. He shall be bound to ensure compliance with the instructions recorded there in.
20. All the MCCB's shall have microprocessor based trip unit for reliable protection and accurate measurement. The rated Service breaking capacity (kArms) shall be 100% of Ultimate breaking capacity (kArms). All MCCB's shall be current limiting type with features as per relevant IS codes and specification. There has to be total discrimination between the incoming and outgoing MCCB's and MCB's, as required, at the MDB's and DB's level.
21. MCCB's shall be used with rotary handle and terminal spreaders and all terminals shall be shrouded to avoid direct contact.
22. All measuring CT's, unless otherwise specified shall be cast resin CT's with class 0.5 accuracy. All digital measuring meter shall be with class 0.5 accuracy unless specified otherwise.
23. Mechanical Castle key interlock shall be provided among the incomer MCCB's, wherever, as applicable, two different incomer sources are provided in the panel as per the directions of the Engineer. The same is deemed included in the scope of work.
24. All measuring and indicating instruments shall be protected through MCB's of 0.5 Amps rating.
25. General arrangement drawing of the switchboard, LT/HT switchgear shall be got approved by the Engineer before commencement of manufacturing.
26. Conduit layout as per switching arrangement shall be prepared by contractor and got approved from the Engineer before slab casting. At all expansion joints in the building suitable arrangement shall be ensured during conduiting.

27. Ratings, sizes and quantities shall be checked and considered for satisfactory operation of electrical system complete in all respect.
28. Conduits, Switchboards, Sockets to be provided on walls shall be open type unless specifically approved by Engineer.
29. Conduits on ceiling in existing system may be provided on surface and in new construction shall be open type.
30. All measuring and indicating instruments shall be protected through MCB's and isolating switches.
31. Breaker shall have LCD display to show the metering and protection parameters.
32. Equipments are to be inspected in the respective manufacturer works before dispatch and test reports as applicable as per BIS standards shall be provided for each equipment to Third Party Inspection (TPI) Agency. The TPI Agency is appointed by the Port and cost of TPI Agency is borne by the Port.
33. The firm shall deploy only licensed personnel as required under IE Rules, for execution of the electrical works. The firm shall be liable to submit the list of such personnel along with the attested copy of the licenses at the time of execution.
34. It is important that every equipment is tested fully before dispatch.
35. All materials for the work shall be supplied from approved list of manufacturer and any item, not covered in approved list, shall be supplied after getting approval from Engineer or his authorized representative.
36. Any materials brought for work which is not matching with specification will be rejected and the rejected materials shall be removed from site on the same day.
37. All fees payable to concerned authorities and other local bodies if any shall be paid by the contractors.
38. Any part or whole of the system which requires approval of the Central Electricity Authority, or any other statutory body, should be arranged by the Contractor at his cost. It is the responsibility of the Contractor to submit the system drawings with all details to the Electrical Inspectorate and obtain their approval.
39. Contractor shall obtain permit/approval from concerned authorities before commencement of work. All documents/drawings required for such permit/approval shall be prepared by the contractor.
40. Contractor shall have a valid "A" class electrical contract licence with HT installation issued by appropriate authorities.
41. Test certificates both type test and routine tests wherever required shall be furnished along with supply for all Electrical/Mechanical items.
42. Inspection / acceptance, in no way shall absolve the contractor from supplying material as per standards / codes and warranty or other obligations under the contract.

43. The contractor shall arrange the testing/measuring equipment by own cost to carry out pre-commissioning test of all equipment at site as per IER.
44. All electrical works shall be tested by the contractor in the presence of TPI Agency and to the entire satisfaction as per IE Rules.
45. Data to be furnished by the bidder after award of order
- a) The contractor shall submit detail shop/fabrication/layout drawings for equipments.
 - b) **Five** Set of copies of installation, operation and maintenance manuals, descriptive bulletins etc, shall be furnished prior to / at the time of despatch of all materials. Manuals shall include the following aspects:
 - i) Outline dimension drawing showing relevant cross sectional views, earthing details and constructional features including foundation drawing.
 - ii) Rated voltage, current, duty cycle and all other technical information which may be necessary for correct operation of the switchgear.
 - iii) Storage details for prolonged duration.
 - iv) Unpacking.
 - v) Handling at site.
 - vi) Erection
 - vii) Pre-commissioning test.
 - viii) Operating procedure.
 - ix) Maintenance procedures.
 - x) Precaution to be taken during operation and maintenance work.
 - c) Test Certificates

The contractor supply equipments from the Manufacturers, who are having type test certificate issued by CPRI / ERDA. Also, the contractor shall furnish the type test certificate issued by CPRI / ERDA to the manufacturers of similar rating during approval of above equipments.
 - d) On completion of work the contractor shall submit all drawings, manuals and test certificates, etc. for all equipment / materials ordered and as specified by the Engineer

2.0 SCOPE OF WORK

WAGON TIPLER SUB-STATION :-

Equipments, as mentioned hereunder, shall be supplied, delivered, erected / installed inside newly built sub-station building as per approved layout plan.

(a) Electrical Works (Supply, Delivery, Installation Testing & Commissioning) at Wagon Tippler Sub-station.

- 1)** 4 Nos. 3.3/0.433 kV, 1 MVA Oil type Transformer.
- 2)** 3.3 kV, 1250 Amps, VCB Panels (18 Sets).
- 3)** 3.3 kV (UE) XLPE, 1C X 1000 Sq. mm., Screened, Aluminium, armoured cables along with heat shrinkable cable end terminations.
 - i) From newly supplied 3.3 kV VCB Panel to newly supplied 3.3 / 0.433 kV, 1 MVA transformer as mentioned above (4 Run of 1C x 1000 Sq. mm.).
- 4)** 2 Nos. LT Panel, 1600A.
- 5)** 4 sets of 4 (four) Runs of Single Core 1.1 kV Grade XLPE Insulated Aluminium Conductor Cable of 1600 Amps. capacity from newly supplied 3.3/0.433 KV, 1 MVA Oil type Transformer (04 Nos.) to LT Panel (Incomer) as mentioned above.
- 6)** 2 Nos. LT APFC (Microprocessor Based) capacitor panels with capacitor bank of 250 KVAR rating each.
- 7)** 1.1 kV aluminium armoured XLPE cables along with cable end terminations from newly supplied LT panel, 1600 Amps as mentioned above to newly supplied LT APFC (Microprocessor Based) capacitor panel (Single Core 4 Run of 1000 Sq. mm.).
- 8)** 30V Battery Bank and battery chargers for Control supply of HT Panel and LT Panels.
- 9)** Indoor/outdoor illumination by LED fittings.
- 10)** Ceiling fans/pedestal fans/exhaust fans.
- 11)** Emergency lights.
- 12)** Plate Earthing of all Electrical Installations and Electrical Equipment.
- 13)** Fixing of GI cable trays of suitable size.
- 14)** Wiring, cabling work at sub-station.

(b) Civil Works

Following civil works are in the scope of the contractor.

1. Supply of Panel mounting channels of 75mm x 40mm x 6mm as per approved drgs.
2. Chequered Plate for covering cable trench.

(c) Salient Points.

- a. Equipment installation layout shall be submitted by the contractor before erection of equipment at site after approval by HDC, KoPT. Contractor shall arrange for all necessary means for erection / installation equipments as per manufacturer's guidelines.
- b. During execution of the work, if any damage takes place in the existing utility, the same will have to be mended good by the contractor, at their risk, cost and arrangement. Otherwise, the same will be repaired/ replaced by HDC, either departmentally or through outside agency and the cost of repairing/ replacement will be recovered from the contractor, with departmental charges.
- c. For the purpose of application (by HDC, KoPT) for obtaining necessary approval/ clearance from the Regional Inspectorial Organization, Central Electricity Authority / Statutory Authority, the contractor would have to submit/ deposit required documents, drawings, test certificates/ reports etc. to HDC, KoPT. The contractor along with the required documents, drawings, test certificates/ reports etc. would also have to be present during inspection by the Regional Inspectorial Organization, Central Electricity Authority / Statutory Authority.
- d. The contractor should clearly understand that though the application would be made by HDC, KoPT to the Regional Inspectorial Organization, Central Electricity Authority / Statutory Authority, for obtaining necessary approval/ clearance from them, it is the responsibility of the contractor concerned to obtain the approval/ clearance from the Regional Inspectorial Organization, Central Electricity Authority / Statutory Authority against the work executed by the contractor.

3.0 WORK NOT IN THE SCOPE.

Design & Construction of civil building and foundation for installing above mentioned switchgears at GC Berth sub-station is not in the scope of the contractor.

4.0 HT & LT CABLE.

4.1 Scope

Supply, laying, inspection, testing, commissioning and making terminations of 3.3 KV grade XLPE insulated power cables.

4.2 Codes & Standards

The design, construction, manufacture and performance of cables shall comply with all currently applicable statutes, regulations and safety codes of the locality where cables shall be installed. Nothing in this specification shall be construed to relieve the successful BIDDER of his responsibility.

All the cables shall conform to the latest applicable IS/IEC standards.

4.3 Power Cable

Power cables should be multicore earthed 33 kV grade aluminium stranded conductor colour coded, extruded XLPE insulated, extruded semi-conducting screened over each core and insulation, extruded inner sheathed, common extruded inner sheathed for multi core cable, galvanised steel strip armoured and overall extruded black sheath conforming to IS-7098 Part II. Armouring of multicore cable shall be of single layer, galvanised steel round wire or flat strip. The Cables shall be suitably designed for variation in power supply as follows:

The voltage variation $\pm 10\%$
Freq. variation $\pm 5\%$

Following cable size shall be supplied by the bidder:

- i. 3.5 Core, 240 Sq. mm LT Cable, 1.1 KV grade, XLPE U.G. Alu. Cable, PVC inner sheathed and PVC ST2 type outer sheathed, armoured, FR cables.
- ii. 1 Core, 1000 Sq. mm LT Cable, 1.1 KV grade, XLPE U.G. Alu. Cable, PVC inner sheathed and PVC ST2 type outer sheathed, armoured, FR cables.
- iii. 3 Core, 240 Sq. mm HT Cable, 3.3 KV (UE) grade, XLPE U.G. Alu. Cable, PVC inner sheathed and PVC ST2 type outer sheathed, armoured, FR cables.
- iv. 1 Core, 1000 Sq. mm HT Cable, 3.3 KV (UE) grade, XLPE U.G. Alu. Cable, PVC inner sheathed and PVC ST2 type outer sheathed, armoured, FR cables.

4.4

Laying of Cables.

For laying cables along building steel structures and technological structures the cable shall be taken by clamping with **Aluminium** saddles screwed to the GI flats welded to the structure. **The** flats are of **hot dip** galvanised after fabrication.

For laying cables along concrete walls, ceilings etc. the cables shall be taken by clamping with **Aluminium** saddles screwed to the **hot dip GI** flat welded on to the inserts. Where inserts are not available the saddles shall be directly fixed in the walls using metallic anchor fasteners and **GI** flat spacers of minimum 6 mm thick.

The **Aluminium** saddles shall be placed at an interval of not less than 500 mm both for horizontal and vertical runs. However, at the bends it shall be placed within 300 mm and where terminating to the equipment/junction box the cable shall be clamped immediately before such termination.

Cable Net Work shall include Power Cables, which shall be laid in buried trenches/ cable trays / through GI Pipes & Hume Pipes, rising main etc. whichever is applicable.

Cable routing shall be checked in the field to avoid interference with structures, heat sources, drains, piping etc. as far as possible and minor adjustments shall be done to suit the field conditions, wherever deemed necessary without any extra cost.

The HT cables while laying will have to be separated from existing HT, LT, Telecommunication, OFC Cables by adequate spacing or running through independent pipes, trenches or cable trays, as applicable.

All cable routes shall be carefully measured and cables cut to the required lengths leaving sufficient lengths for the final connections of the cables to the terminal of the equipments.

The various cable lengths cut-off from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the Bill of Quantity is only approximate. The Contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works as far as possible. Before starting Cable Laying, Cable Drum Schedule shall be prepared by contractor and get that approved by competent authority.

Cable as far as possible shall be laid in complete, uncut lengths from one termination to other. Cable shall be neatly arranged in the trenches/ trays/ pipes in such a manner so that crisscrossing is avoided and final take- off to the equipment/switch gears is facilitated.

Arrangement of cables within the trenches/ trays/ pipes shall be the responsibility of the contractor.

Removal of concrete covers for purposes of cable laying and reinstalling them in their proper positions after the cables are laid shall be done by the contractor at no extra cost. Cable shall be handled carefully during installation to prevent mechanical injury to the cables. During laying of cables, Cable Drum Lifting Jacks, sufficient numbers of Cable Rollers and other materials etc. as necessary must be used to avoid any mechanical injury to the cables. Directly buried cable

shall be laid underground in Cable Trenches duly excavated by the contractor as shown in the enclosed Drawing No. SK- 334.

The width of the trench shall vary depending upon the number of cables and diameter of each cable. Width of the Cable Trench should be such that all cables should be correctly spaced and arranged. The cables shall be laid in trenches as shown in the enclosed sketch. Before cables are placed, the bottom of the trench shall be leveled and filled with a layer of silver sand as shown in the Drawing No. SK- 334. This sand shall be leveled and the cables shall be laid over it. Bricks are to be placed at both sides of the cable. Then the cable inside the brick walls to be covered with sand up to the height of walls and sand shall be pressed lightly. A protective covering of Bricks shall be placed on top of protective Bricks placed at both sides of Cable. The remainder of the trench shall then be back filled with soil rammed and leveled. After laying of the cables in the trench and before placement of protective covering by brick, every cable shall be given an insulation test in presence of site engineer/ authorized representative. Also after back filling the trench with soil, rammed and leveled, insulation test of the cable shall be carried out in presence of Site Engineer/Authorized representative.

All wall openings/Pipe Sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside buildings/lined trench. At road/drain/pavements crossing, suitable sizes of GI Pipes are to be used. After the cables are installed and all testing is complete, the conduit/pipe sleeve ends shall be plugged with a suitable weatherproof plastic compound/ PUTTI, for sealing purpose. The cost of the same shall be deemed to have been included in the installation of cable laying through pipe sleeves/conduits and no separate payment shall be made. When cables pass through foundation walls, or other underground structures, if necessary, ducts or opening shall have to be provided by the contractor.

However, shall it become necessary to cut holes in the existing foundations or structures, the contractor shall determine their locations and obtain approval from competent authority before cutting is done. Cutting, if necessary and mending good of any cut portion should be done by contractor without any extra cost. At Road Crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not stack and get damaged by pipe ends. Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule. All GI Pipes shall be laid as per site requirements. The open ends of the pipes shall be suitably plugged after they are laid in final position. Laying of the cable will be as per the enclosed Drawing No. SK- 334. The contractor will have to submit the detailed cable route diagram, with detailing of the Hume Pipes & GI Pipes used, position of the straight through cable joints etc. for checking at our end and subsequent approval of the same. As built drawing (in triplicate) of the above cable route will have to be submitted after completion of the above work.

MEASUREMENT:

Cable length should be measured jointly prior to giving clearance for earth back filling etc. Distance between Socket of one end and Socket of other end of the laid cable to be considered for payment against both supply & laying of cable.

- 4.5 **Laying of Cables in Exposed/Embedded GI Pipes/Hume pipe Road Crossing, Railway Crossing, Drains, Culverts or any similar concrete structure etc.**

GI Pipes /Hume pipe for drawing cables in plant buildings shall be of **Heavy Duty**, galvanised, electric resistance welded, screwed type conforming to IS: 1239 (Part-I). GI Pipe/Hume pipe of the following sizes shall be used:

- a) 150 mm nominal bore GI pipe
- b) 150 mm dia. Heavy duty NP-4 Hume pipe.

For installation of cables in GI Pipe /Hume pipe. Complete system shall be installed first without cables but having suitable pull wires laid in the pipes to facilitate cable pulling.

Insulated type end bushings shall be used where conductors enter or leave GI pipe.

Ends of GI pipe shall be cut square and the threads out in the field shall have the same effective length and the same dimensions and taper as specified for factory out threads. Ends of pipe shall be reamed to remove burrs and sharp edge after threads are cut.

Exposed GI pipes shall run parallel or perpendicular to column lines or building lines so as to match with the architectural arrangement of the building. Concealed GI pipes shall run in direct lines with minimum bends.

Laying of Reinforced Concrete Pipe and Galvanized Mild Steel Tubes should be done wherever necessary, such as at Road Crossing, Railway Crossing, Drains, Culverts or any similar concrete structure etc. The scope includes cutting of road, Railway Crossing, Excavating of Trenches, etc. including mending good work. The depth of laying of the pipes should have to be matched with the underground cable trench, as far as possible and practicable. Making jointing between collars and pipes, with cement mortar (1 cement: 2 medium sand) and cutting the Reinforced Concrete Pipe to the required length, if necessary, to be done by the contractor at their own cost and arrangement. Cutting of Galvanized Pipe to required length and threading, bending, jointing by Socket as required, supply and fixing of support clamps/ brackets should be under the scope of contractor. Re-filling of the trench after laying the reinforced concrete pipes and galvanized mild steel tubes are also to be done by the contractor.

Rates are to be quoted accordingly.

4.6

Depth of laying

Sl. No.	Cable	Laying Type	Depth of Laying
1.	HT Cable	Open cut excavation with brick protection	1500mm
		Boring through GI pipe	2000mm
		Open cut excavation through Hume / GI pipe	2000mm
		Through existing RCC trench / Hume pipe / GI Pipe.	As per available depth.

Note: Road level to be considered as reference level.

4.7

Bricks

Crushing strength, efflorescence shall conform to class designation 10 (as per IS 1077, 1986) and as per the specification, given below:

- i) The brick shall have clear ringing sound.
- ii) The average size of the bricks shall be in the range of 250 mm (± 4 mm) x 125 mm (± 2 mm) x 75 mm (± 2 mm).

Cable Termination (Heat Shrinkable type)

Termination of aluminium conductor power cables shall be by means of compression method using compression type lugs.

The **End** termination for use on the cables shall be suitable for the type of cables offered.

The accessories shall be supplied in kit form and each component of the kit shall carry manufacturer's mark of origin.

The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. The instruction pamphlet shall also be included in each kit.

The contents of the kits shall be suitable for storage without deterioration under the climatic conditions given in the specification with shelf life exceeding 5 yrs.

Cable Straight through Jointing. (Heat Shrinkable type)

The contractor shall submit cable route plan and tentative location of straight through joints for approval to Competent Authority. No straight through joints are allowed in RCC Cable trench.

Additional length (Loop) of 5 mtrs. (approx.) cable should be kept at each end of the cables near the straight through cable joints. It is required to measure the insulation resistances of the cables before and after straight through cable jointing. This scope includes supply of all required materials including complete straight through cable jointing kits, with ferrules and all other accessories.

The accessories shall be supplied in kit form and each component of the kit shall carry manufacturer's mark of origin.

The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. The instruction pamphlet shall also be included in each kit.

The contents of the kits shall be suitable for storage without deterioration under the climatic conditions given in the specification with shelf life exceeding 5 yrs.

Cable Tags

All cables will be identified close to their termination points by cable nos. Cable numbers will be punched on Aluminium strip/ PVC Strip {2mm. thick (approx.)} securely fastened to the cable and wrapped around it. Alternatively, Cable Tags shall be circular in construction to which cable number can be conveniently punched.

Cable designations are to be punched with letter/number punches and the tags are to be tied to cables with piano wires of approved quality and size. Tags shall be tied inside the panels beyond the glanding as well as below the glands at cable entries. Along trays tags are to be tied at all bends.

Each underground cable shall be provided with Identification Tags (made of PVC) securely fastened at every 30 Mtrs. distance if the continuous length is more than 50 Mtrs. of its underground length. At least one tag at each end before the cable enters the ground will have to be provided. In unpaved areas, Cable Trenches shall be identified (by means of cable markers). These shall be placed at location of changes in the direction of cables and at intervals of not more than 30 Mtrs. and at Cable Joint Locations.

Packing and Markings

The cable shall be wound on a steel drum conforming to relevant BIS standard and packed. The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

The cable drum shall carry the following information stencilled on the drum :

- i) Manufacturer's Name and Trademark
- ii) Type of cable and voltage grade.
- iii) No. of cores
- iv) Nominal cross-sectional areas of conductor
- v) Cable code
- vi) Length of cable on drum
- vii) No. of lengths on the drum if more than one
- viii) Direction of rotation of Drum
- ix) Gross weight
- x) Weight of Drum with Ballens (if any)
- xi) Weight of cable
- xii) Reference of any Indian standard
- xiii). ISI Marking on the drum
- xiv) Year of Manufacturing

4.12 Tests & Test Reports

Type test certificate for similar type & Rating of Cables be submitted by successful bidder.

The Routine and acceptance tests specified in the applicable standards shall be arranged by the Contractor and carried out on **Cables** as per latest relevant IS Standards in presence of **Third Party Inspection Agency appointed by HDC at the manufacturer's works & at site respectively. The cost of the TPI Agency is borne by Port.** The Certified copies of test certificates shall be submitted before despatch.

5.0 OIL TYPE TRANSFORMERS

A Electrical Design

- i) Generally as per IS 2026 – Part 1, 2 & 4 of 1977 and Part 3 of 1981.
- ii) 3 phase, core type, oil filled
- iii) Rated output, voltage ratio, vector group shall be provided as specified in technical particulars for design.
- iv) Rated frequency 50 Hz, + 3%, -3%.
- v) Insulation level shall be designed according to the voltages specified below.

Sl. No.	Description	3.3kV System
1.	Nominal system voltage (kV)	3.3
2.	Max. system voltage (kV)	3.6
3.	One minute power frequency withstand voltage (kV)	10
4.	Peak impulse test withstand voltage (kV)	---

- vi) Transformers shall be capable of delivering rated current at an applied voltage up to 105% rated voltage without exceeding the temperature limits.
- vii) Overload capacity of the transformer shall be as per IS 6600 - 1972 unless specified otherwise.
- viii) Shall be operable at its rated capacity at any tap with voltage variation of $\pm 10\%$ of corresponding to voltage of the particular tap.
- ix) Permissible maximum temperature at rated output and principal tap at the ambient temperature of 50°C

Top oil (by thermometer)	85°C
Windings (by resistance method)	95°C
Maximum Hot Spot Temperature	105°C

- x) Transformers shall be designed to withstand the thermal and dynamic stresses due to short circuits at its terminals or symmetrical/asymmetrical faults on any winding. Short circuits withstand capacity for the bolted fault at the terminals shall not be less than 5 second duration with respect to fault level specified. Design calculation to be submitted for concurrence.
- xi) The maximum temperature at the end of the specified duration shall not be more than 250°C with the temperature prior to short circuit corresponding to maximum permissible overload.
- xii) Transformer shall be designed for minimum no-load and load losses within the economic limit.
- xiii) Designed for suppression of harmonics especially 3rd and 5th.

B Magnetic Circuit

- i) Low loss CRGO silicon steel shall be used.
- ii) Laminations shall be annealed in a non-oxidizing atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets after the cutting and punching operations.
- iii) CRGO sheets shall be coated with insulation varnish compatible with the sealing liquid.
- iv) Insulation to withstand annealing temperature as high as 850 Deg. C and shall reduce eddy current to minimum
- v) Ducts to be provided to ensure adequate cooling.
- vi) Core, framework and clamps arranged and tightened to securely hold laminations in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits.
- vii) Flux density under specified over voltage or frequency conditions shall be within the maximum permissible for the laminations. However, it shall not exceed 1.6 tesla at rated voltage & rated frequency.
- viii) Transformers shall be designed to withstand 110% over fluxing corresponding to rated voltage.
- ix) Magnetising current shall be maximum 1% of the rated current.

C Windings

- i) Material shall be electrolytic grade work hardened copper of high proof stress with more numbers of radial support.
- ii) Shall be pre-compressed, press board, pre-stabilization of coil & shall be subjected to shrinkage treatment.
- iii) Completed core and winding to be vacuum dried in full vacuum and impregnated immediately.
- iv) Shall be braced to withstand shocks due to rough handling and forces due to short circuit, switching or other transients.
- v) Permanent current carrying joints in winding and leads shall be brazed. Connections to bushings & OLTC shall be crimped.
- vi) Coils shall be supported using dried and high-pressure compressed wedge type insulation spacers, blocks & cylinders.
- vii) Insulating materials shall be compatible with transformer liquid under all service conditions.
- viii) Leads to the terminal board and bushings shall be rigidly supported.

D Insulation

Inter turn and inter coil insulation shall be designed such that dielectric stress is uniformly distributed throughout the windings under all operating conditions.

E Tank

- i) Welded thick gauge low carbon steel grade plates stiffened and reinforced to withstand without deformation all stresses applied during transport and operation or short circuit conditions.
- ii) Oil tight welds and joints shall be provided.
- iii) Fully assembled transformer with its radiators, conservator and other fittings shall withstand for one hour a pressure corresponding to twice the normal head of liquid or to the normal pressure plus 35 kN/sq.m, whichever is lower, measured of the base of the tank.
- iv) Plates shall be protected internally against corrosion due to insulating liquid.
- v) Provided with inspection opening and cover/with handling equipment) to provide access to bushing connections.
- vi) Form of cover shall be such as to prevent any stagnant water deposit and to drain gas bubbles towards the buchholz relay
- vii) Tank (with radiators when welded to tank) shall be capable of withstanding 250 mm of mercury vacuum.
- viii) Tank shall be suitably designed to suppress harmonics available in the system as well as generated by transformer.

F Conservator And Breather

- i) Conservator mounted on frame, integral with tank in such a manner that under all conditions and the lowest oil level the bushings remain under the head of liquid.
- ii) Conservator volume shall be sufficient to maintain oil seal from ambient to oil temperature of 90°C
- iii) Oil filling hole with cap and a drain valve to drain the oil completely shall be provided. One end of the conservator shall be bolted into position so that it can be removed for cleaning purposes.
- iv) Silica gel breather with inspection window and oil seal shall be mounted at 1.4 m from ground level and connected to conservator.
- v) Prismatic type oil level gauge with maximum and minimum levels marked.
- vi) One no. 150 mm dia. dial type magnetic oil level gauge with alarm & trip contacts shall also be provided.

G Oil

- i) The oil shall be as specified in IS: 335 and shall be suitably treated, free from moisture and have uniform quality throughout.
- ii) Oil shall be supplied for the first fill of oil and 10% excess in non-returnable drums.

H Pressure release device

- i) Adequate number of Pressure release device shall be provided on tank at suitable locations. This shall operate at static pressure less than hydraulic test pressure of tank. This should have one potential free contact for alarm/trip and should be wired to Marshalling box.
- ii) Discharge of Pressure release device shall be taken through pipes away from transformer and prevented from spraying on tank.

I Buchholz Relay

- i) Double float relay as per IS 3677 - 1985.
- ii) Shut off valves on either sides of the buchholz relay
- iii) Pot cocks at the top and bottom of relay drain plug, inspection window, calibrated scale, terminal box with oil tight double compression type brass gland.
- iv) Potential free, self reset independent alarm and trip contacts, rated to make, break and carry minimum 2 amps at 30 V DC. No auxiliary relay shall be used to multiply the contacts. Contacts are to be wired to the marshalling box.

J Cooling

General

The cooling system provided is as follows.

ONAN - Oil Natural, Air Natural

K Radiators

Radiators shall be detachable type directly mounted or separately mounted. Flanged, gasketed and bolted connections shall be used for connecting the radiators to the tank.

The following accessories shall be provided for each radiator/radiator bank

- i) Top and bottom shut off valves and blanking plates.
- ii) Bottom drain plug and top filling plug.
- iii) Lifting lugs
- iv) Thermometer pockets with thermometers in the inlet and outlet pipes (for separately mounted radiator banks).
- v) Top and bottom filter valves (for each separately mounted radiator bank).
- vi) Air release devices.
- vii) Provision for earthing

L Valves And Connections

- i) Valves of sluice type with hand wheels
- ii) All valves including radiator valves shall be made of gun metal only.
- iii) Clear indication of open and closed position
- iv) Provided with blanking plates or screwed plugs
- v) Padlocking facility to lock in closed/open position.

M Terminations

It shall be possible to withdraw the transformer easily after disconnecting the connections without disturbing the cable terminations.

- i) For cable termination
 - a) Air insulated cable end box suitable for the type and number of cables specified.
 - b) Air insulated disconnection chamber with inspection opening
 - c) Compressed type brass cable glands with tinned copper lugs.
 - d) Bolted type gland plates (non-magnetic material wherever specified).
 - e) Sealing kits with associated accessories like stress relieving cones, insulating tape, trifurcating boot, HT insulating tape.
- ii) For bus duct termination
 - a) When bus duct termination is specified, flanged throat shall be provided to suit termination of bus duct. Flange ends and inspection openings shall have weatherproof gaskets.

N Bushings

- i) Conforming to IS 3347 and IS 2099 for HT and IS 7421 for LT system.
- ii) Minimum rated current of line and bushings shall be 1.5 times rated current of the corresponding windings
- iii) Clamps and fittings made of steel or malleable iron shall be hot dip galvanized.
- iv) Bushings rated 400 Amps and above shall have non-magnetic clamps and fittings only.
- v) Bushing shall be solid porcelain type for LT system, solid porcelain / oil communicating type for voltage class upto 36 kV.
- vi) Porcelain shall be homogenous and free from cavities
- vii) Oil filled condenser type bushings should have the following:
 - Oil level gauge
 - Oil filling pipe and drain valve (if not hermetically sealed)
 - Tap for capacitance and tan delta test.
- viii) All clamps and fittings shall be hot dip galvanized.
- ix) No arcing horns should be provided on bushings
- x) Neutral bushings shall be provided as required for earthing of neutral point. This shall be connected to brass / tinned copper bar and brought to ground level through porcelain insulators.

O Bushing Current Transformers (Where Applicable)

- i) CTs for back up earth fault shall be provided on the neutral end.
- ii) Removable at site without opening transformer tank cover/active parts.
- iii) Secondary leads shall be brought to a weatherproof terminal box and from there to the marshalling box with 4 sq.mm copper armoured cable.

P Oil Temperature Indicator

150 mm dial type thermometer with manual reset maximum reading pointer. There shall also be two potential free contacts for alarm and trip signals. The alarm and trip settings shall be independently adjustable. The temperature-sensing element mounted in a pocket of oil, shall be connected to the indicator through capillary tubing. Contact rating at DC shall be minimum 0.5 amps.

Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Accuracy shall be better than +/- 1.5%.

Q Winding Temperature Indicator

- i. Local winding temperature indicator (WTI) for each winding, shall have a 150-mm diameter dial type indicator with a manual reset maximum reading pointer. There shall be two potential free contacts for alarm and trip signals. For transformers with forced cooling, another set of contacts shall be provided to start/stop the forced cooling system automatically. The settings for closing/opening of each contact shall be independently adjustable. Contact rating at DC11, 30 V DC shall be minimum 0.5 amps. The device shall be complete with lamp, sensing element, image coil, calibration device, auxiliary CTs etc. as required.
- ii. Temperature indicator dials shall have linear gradations to clearly read atleast every 2°C. Accuracy shall be better than +/- 1.5%.
- iii. Remote winding temperature indicator with resistance type temperature detector shall be provided additionally.

R Marshalling Box

- i) All outgoing connections from the transformer i.e. buchholz relay, temperature indicators, level indicators, CT secondary, fault contacts for

ii) Degree of protection of enclosure shall be IP 55.

- i) Externally hand operated with easily accessible links.
- ii) Designed for sustained over current of at least 150% of the rated current of the winding.
- iii) Shall not occupy any intermediate position between clearly marked tap positions.
- iv) Capable of repeated operation and withstanding short circuit forces.
- v) Tap position indication diagram
- iv) Inspection and/or repair shall not require removal of transformer core from tank.

Lamp continues to glow if fault persists.

T Earthing

- i) All metal parts of the transformer with the exception of individual core laminations, core bolts, and clamping plates shall be maintained at fixed potential by earthing.
- ii) Two tinned copper earthing terminals with nuts, washers etc. to be provided at diagonally opposite corners suitable to connect 75x12 GI strip.
- iii) One end of bushing CTs shall be earthed.

- i) Identification plate
- ii) Rating and diagram plates.
- iii) Valve schedule plate (For Power transformers)
- iv) First fill of oil as per IS-335, 1993 with 10% excess in non-returnable drums
- v) Cooling system complete with accessories (as specified)
- vi) Off-circuit tap switch (as specified)
- vii) OLTC (as specified)
- viii) Conservator with oil level gauge and drain plug.
- ix) Oil filling pipes with flange and dummy cover on conservator for filling/topping up of oil.
- x) Suitable number of dehydrating breathers.
- xi) Double float Buchholz relay with alarm and trip contact and shut off valves on either sides.
- xii) Oil filter valves at top and bottom of tank
- xiii) Drain off valve at lowest location to allow complete draining
- xiv) Oil sampling device at top and bottom
- xv) Explosion vent with double diaphragm and oil level gauge between 1st & 2nd diaphragm (for distribution transformers).
- xvi) Pockets for thermometers for oil temperature and winding temperature indicators.
- xvii) Dial type magnetic oil level gauge with low level alarm contacts.
- xviii) HV, LV and neutral bushings.

- xix) Dial type winding temperature indicator with maximum reading pointer and alarm and trip contacts
- xx) Dial type oil temperature indicator with maximum reading pointer and alarm and trip contacts
- xxi) Lifting lugs and jacking pads. For transformers with bell tank design, lifting lugs shall be provided on core and winding also.
- xxii) Earthing terminals and lugs
- xxiii) Inspection cover
- xxiv) By-directional rollers with locking arrangement (for distribution transformers)
- xxv) Marshalling box.
- xxvi) Haulage holes.
- xxvii) Bushing CTs as specified.
- xxviii) Flat base & foundation bolts.

TRANSFORMER 1000 KVA, 3.3 / 0.433 KV

Supply of 1000 KVA, 3.3 / 0.433 KV Oil type indoor distribution Transformers with tap Links, manufactured as per relevant IS. The transformer shall be designed for the specification given below:

Technical particulars (Distribution Transformer)

Sl. No.	Particulars		1000kVA, 3.3/0.433kV
1.	Specification		IS 2026, Part I - 1977 Part II - 1977 Part III - 1981 Part IV - 1977
2.	Type		Three phase, core type, oil filled
3.	Duty		Indoor
4.	Voltage HV/LV		3.3/0.433 kV
5.	Frequency		50 Hz
6.	No. of phase		3
7.	Continuous rating		1000 KVA
8.	Conductor		Copper
9.	Insulation class		Class A
10.	Cooling		ONAN
11.	Winding connection		Delta / Star
12.	Vector group		Dyn 11
13.	Neutral grounding		Solidly earthed
14.	System earthing	HV	Solidly earthed
		LV	Solidly earthed
15.	Percentage impedance		4.5%
16.	Termination	HV	Cable end box suitable for termination of 4 no. 1C x 1000 mm ² XLPE cable
		LV	Suitable for Bus duct.
17.	Temperature rise over 50°C ambient temp a) Top oil (measured by Thermometer)		35°C

Sl. No.	Particulars	1000kVA, 3.3/0.433kV
	b) In winding (measured by Resistance method)	45°C
	c) Hot Spot temp	55°C
18.	Bushing mounted CT's	
	a) LV Neutral bushing CT for EF class PS	-
	b) LV Neutral bushing CT for standby E/F protection class 10P15.	1
19.	Tap changer	Off Circuit (Rotary type)
	a) Range	±5%
	b) Total tap positions	5
	c) Taps above nominal voltage	2
	d) Taps below nominal voltage	2
	e) Voltage per step variation	2.5 %
	f) Tap change controls	Manual
20.	Impulse test withstand voltage	As per IS 2026, Part III – 1981
21.	One minute dry and wet power frequency withstand voltage	- do -
22.	Withstand time without injury for 3 phase short circuit at terminals	5 Secs.
23.	Auxiliary supply voltage	240 V AC/220V DC
24.	Parallel operation	Suitable for parallel operation with transformers of similar ratings
25.	Overload capacity	As per IS 6600 –1972
26.	Radiators	Detachable type on the tank
27.	Flux Density	1.6 tesla (Max.)
28.	Magnetizing current	1% of rated current
29.	Paint	Epoxy
30.	Paint shade	Shade 632 as per IS – 5
31.	Short circuit level on HV side	450MVA

6.0

VCB PANEL

i) Codes and Standards:

The switchboards and the mounted equipment shall conform to the latest revisions of the following Indian standards:

IS:12729	General requirements for switchgear and control gear for voltages exceeding 1000 V.
IS:13118	General requirement for circuit breakers for voltages above 1000 V.
IS:3427	Metal-enclosed switchgear and control gear for voltages above 1000 V but not exceeding 11000 V.
IS:5082	Material for data for aluminium bus bars.
IS:9920	Switches and switch isolators for voltages above 1000V.
IS:9921	AC disconnectors (isolators) and earthing switches for voltage above 1000 V.
IS:9046	AC contractors of voltage above 1000 V upto and including 1100 V.

IS:12661	HV motor starters.
IS:13703	Low voltage fuses.
IS:2705	Current transformers.
IS:3156	Voltage transformers.
IS:1248	Electrical indicating instruments.
IS:722	Integrating meters.
IS:3231	Electrical relays for power system protection.
IS:6875	Control switches and push buttons.
IS:694	PVC-insulated cables for working voltages voltage upto and including 1100 V.
IS:2544	Porcelain post-insulators for systems with nominal voltage greater than 1000 V.
IS:11353	Guide for uniform system of marking and identification of conductors & apparatus terminals.
IS:5578	Guide for marking of insulated conductors.
IS:3618	Phosphate treatment of iron and steel for protection against corrosion.
IS:6005	Code of practice of phosphating of iron and steel.
IS:5	Colours for ready mixed paints and enamels.

Wherever Indian Standards are not available, relevant IEC standards shall be applicable.

ii) **General Requirement**

The switchgear shall be of metal clad, single bus bar/Double bus bar as applicable, self standing, dust proof construction, indoor cubicle type fitted with vacuum circuit breakers in fully draw out execution.

The VCB shall be horizontally isolated, horizontally drawn-out type, truck mounted and ground operated.

The circuit breakers shall be suitable for following duties

⇒ To withstand inrush magnetizing currents of transformers and capacitor bank 'ON' and 'OFF' operation.

⇒ Transient surge produced by one CB due to severe chopping during rapid interruptions of inductive current e.g. motors, shall be within limits allowable for overhauled motors according to IEC34 part 1 otherwise suitable surge absorber shall be provided.

- The controls, indicating lamps, relays and meters shall be mounted on separate control & relay panel.
- Operation counter, close/open mechanical indications spring charged/discharged indication shall be provided.
- All circuit breakers shall have motor operated spring charged mechanism for closing and shunt tripping coil (30V DC). Closing coil shall be suitable to operate between 85% to 110% of rated voltage and tripping coil between 70-110% of rated voltage. Spring charging motor shall operate between 85-110% of rated AC. Voltage.
- Jumpers in the cubicle also shall be of same current rating as that of the breaker. Only the jumpers connected to CT shall be rated according to CT rating.
- A manually operated device to enable charging of closing springs.
- Manual / Mechanical tripping arrangement for emergency tripping of CBs.
- All circuit breaker truck shall have service, test and draw out positions. Test position shall engage only the auxiliary (control) contacts to close the CB during testing.
- Panel door switch shall be provided for illumination inside panel.
- Anti pumping feature shall be provided.
- All live parts shall be insulated by heat shrinkable sleeve only.

- The cubicle shall be provided with a position changing gear arrangement in such a way that by engaging detachable device from outside the front door, it shall be possible to move the breaker truck and change position without opening the cubicle door. Facilities for pad locking in each position shall be provided.
- Each cubicle shall have mimic diagram with metal strip.
- Each cubicle shall be of compartmentalized construction and shall have separate compartments for bus bars, CTs and outgoing cables, metering and protection devices.
- All circuit breaker trucks of same rating shall be identical in all respects (except metering and protective devices) and shall be interchangeable with similar breaker panel.
- Continuous earth bus shall be provided throughout the board.
- The position of various control switches, push buttons, and levers, etc. requiring manual operation shall be at a height not less than 450 mm and shall not exceed 1850 mm from the finished floor level.

iii) In the design of the switchgear the following positive interlocking shall be provided.

1. It shall not be possible to move the truck from the isolated to the Service Position unless low voltage plug and socket connections have been made.
2. It shall not be possible to disconnect the low voltage plug and socket as long as the circuit breaker truck is in service position.
3. It shall not be possible to withdraw the truck without disconnecting the low voltage plug and socket.
4. It shall not be possible to move the truck from the service to the isolated position or vice-versa with the circuit breaker in the 'ON' position.
5. It shall not be possible to switch on the circuit breaker when the truck is in between the isolated and the service positions (except in test position).
6. It shall be possible to switch on the earthing switch only when the truck is in the isolated position, wherever an integral earth switch is provided.
7. It shall not be possible to open the circuit breaker enclosure when the breaker is ON or to have access to any part of the draw out assembly which is live when the circuit breaker is in the service position.
8. Shutters shall be lockable in closed position.
9. Where local/remote selector switches are called for , it shall be ensured that:
 - * The breaker can be closed locally only if the breaker truck is in the test position and the local/remote selector switch is in local position.
 - * The breaker can be operated from remote panel (in shop) only when the breaker truck is in service position and the local/remote selector switch is in remote position.
 - * The breaker can be tripped locally regardless of the position of the breaker truck.

iv) Earthing Mechanism

The operating mechanism parts shall be designed to give longer life, trouble free operation and require minimum maintenance.

The material and components shall have chopping current limited to minimum.

v) Insulation Levels

Insulation levels corresponding to the rated voltage shall be as follows:

Nominal voltage (kV)	33
Highest system voltage (kV)	36
One minute power frequency withstand voltage (kV)	70
1.2/50 micro sec impulse withstand voltage (kV)	170
Clearance in air	As per IEC

vi) Short Circuit Strength

- Rated short time withstand current shall not be less than the system short circuit level specified for the stipulated duration.
- Rated peak withstand current shall not be less than 2.5 times the system short circuit level.

vii) Auxiliary Buses for Control & Protection

1. Control supply buses for AC & DC.
2. Signaling supply.
3. PT secondary voltage.
4. Spare buses.

viii) Provision of surge suppressor

In case of breakers like VCB that give rise to over voltage surges due to current chopping phenomenon, surge suppressors to be provided at the load side terminals of the breakers to limit the switching surges to value limited for as per IEC.

ix) Annunciation Schemes

- Flag indications for all faults for which individual protective relays have been specified.
- Warning signalling (as applicable) on individual panels:
 - a) All transformer warning / signalling conditions (group signal from corresponding transformer control panel / sub-station)
 - b) Loss of trip circuit supply
 - c) Earth fault.
 - d) Control supply failure
 - e) PT fuse failure / MCB tripping
- Emergency signalling for tripping of HT breakers on fault
- One common signal for warning and one signal for emergency from each panel to be wired to a common annunciation panel of the switchboard, where specified.
- Annunciators for warning and emergency signaling condition on individual panels of solid state facia window type. Common audio signaling with Accept, Reset, and Test push buttons for the switchboard where common annunciation panel is not specified. Audio signaling to have distinct tones for warning and emergency.

x) Bus Bar and Connections

- Power buses shall be of EC grade aluminium alloy equivalent to E91E WP as per IS-5082-1981 or Copper. Both rectangular and Round busbar are acceptable .The busbars shall be tinned /silver plated at joints.
- The continuous rating of the main horizontal bus shall not be less than the rating of the incomer specified.
- The vertical bus rating shall be as follows:-

incomer	:	Not less than that of horizontal bus
outgoing	:	Not less than that of the outgoing breaker, irrespective of relay setting.

- Design ambient temperature shall be 50°C & final operating temperature under continuous operation in enclosure limited to 90°C by thermometer method.
- Both horizontal and vertical bus bars to be designed and supported to withstand the thermal and dynamic stress corresponding to rated short time and peak withstand current specified.
- Cross-section of main horizontal bus to be uniform throughout the switchboard and continuous in one transport unit.

- Bus bar arrangement as per IS 375.
- Phase identification by colour in each panel.
- Bus bars (horizontal as well as vertical) shall be provided with heat shrinkable, non tracking, low absorption type sleeving conforming to international standards for full voltage for 33 kV, 11kV & 3.3kV switchboards.
- Bus bar support insulators of non-hygroscopic material having high impact and dielectric strength with an anti tracking contour.

xi) Internal Control Wiring

- Control wiring shall be carried out by 1100V grade PVC insulated; single core multi stranded copper wire of minimum cross section 2.5 sq. mm. Similarly, for CT circuits minimum cross section of 2.5 sq. mm shall be used.
- Flexible wire of 2.5 sq.mm shall be used from CT chamber to relay chamber and shall have protection against heat and mechanical damage due to flash over. Use of heatproof sleeves and rigid conduit shall be made to run the control wires from back to front.
- Wiring and terminal arrangement for all panels shall be carried out as per approved scheme.
- Flexible wires protected against mechanical damage for wiring to door mounted devices.
- Wires identified at each end in accordance with schematic diagrams by interlocked type ferrules. These shall be firmly located so that these do not move.
- *Colour code for control wiring*

AC - Black	Earth wire - Green
DC - Light grey	Trip circuit - Red

- All telemetering signals shall be wired to terminal strips.

xii) External Terminations

Control Terminations

- 650V grade multi-way open type terminal blocks of non-tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
- All terminals going out of the switchboard shall be brought to a separate terminal board marked "External Termination". These will be easily accessible.
- External terminal block shall be provided in the relay chamber with proper clamping facilities for cable dressing.
- Control terminals shall be suitable to receive two numbers 2.5 sq. mm copper conductor.
- 20% spare terminals in each control terminal block. Terminal blocks in separate groups shall be provided for DCS/PLC, remote control panels, transformer marshalling boxes, local push button stations, etc.
- Gland plate for control cables shall be of adequate size to accommodate and to facilitate glanding of all the control cables coming from external equipment.
- Terminal blocks shall be placed separately for internal looping and external looping.

xiii) Power Terminations

- Suitable for accepting cable/bus trunking as specified.
- Sufficient space and support arrangement inside each panel to accommodate HT cable termination kits and sealing kits suitable for the size and number of XLPE cables. Dummy panels to be provided adjacent to the switch panel, where the required number cable terminations cannot be accommodated in the cabling chamber of the main panel. Rear extension not acceptable.

- Where more than one cable has to be terminated per unit, the arrangement shall permit connection and disconnection of cables separately without disturbing other cables.
- Push - ON type/Heat-shrinkable type cable end terminations / straight-through jointing kits shall be used wherever required.
- Where specified the following cable termination accessories, suitable for the type, size and number of cables to be terminated, to be supplied with switchboard.
 - ⇒ Cable sockets with all HT terminals (sockets set at such an angle that cable tails can be brought up for termination with minimum bending and setting)
 - ⇒ HT cable termination and sealing kits
 - ⇒ Power cable termination facilities shall be designed to facilitate easy approach to CTs.
 - ⇒ Double compression type brass cable glands and crimping type tinned heavy duty copper lugs for HT, LT power and control cables.

xiv) Protection and Measurement

a) Electrical Protection

Selection of protective scheme will be based mainly on reliability, sensitivity, selectivity. All main protections shall be fast acting type in order to clear the faulty system from the healthy system in earliest possible time to minimise damage to equipment and ensure continuity of power supply.

b) Protective scheme requirement

- All the main protective relays shall be microprocessor based numerical and communicable type.
- Auxiliary relays, timers switches, etc. required to make the scheme complete shall be considered as part of the scope of work.
- All CT-PT shall be suitable for the relay-meter requirement - lead burden
- All CT-PT wires shall be brought to test terminal blocks before connecting to circuits.
- The circuits of various protections (coming from other panels) shall be connected to master trip relays through auxiliary relays (flag indicated).
- VAA type auxiliary relays shall be provided for each transformer fault. Connection of the relay shall be through links to facilitate maintenance.
- Relay ranges and scale of meters shall be finalized during drawing approval stage.
- Contact arrangement, number of poles/ways in control/selector switches shall be as per the requirement/approved scheme.
- ICTs whenever considered necessary shall be included in the scope
- For control supply distribution, panel to panel separate set of terminal blocks shall be provided at top of the panel. All items / accessories required for above in each panel and in incoming panels shall be provided by the supplier.
- All relays shall be hand/self-reset type with flag indication. NO/NC contacts for relays shall be as per the requirement of approved protection, annunciation and interlock schemes. Wherever required supplier shall provide auxiliary relays for contact multiplication.
- Annunciation facia shall be mounted on Incomer switchgear panels and details shall be finalized during drawing approval stage.
- Centre line of switches, lamps, meters shall be matched to give uniform appearance and mounting height of switches shall be between 1.1 to 1.8 m.

xv) Current Transformer (Panel Mounted)

- Separate sets of current transformers shall be used for differential protection and separate cores shall be used for, over current protection and measurement purposes. CT's on incomer side shall be mounted before incomer breaker and CT's for outgoing feeder shall be mounted after the breaker.
- Short time ratings and insulation level of CT's shall be similar to rating of associated breaker.
- CT ratios specified are provisional. Where outputs and accuracy are not specified, these shall be such as may be required by the circuits in which they are used. Generally, the protection CT's and metering CT's shall have 5P20 and 0.5 class respectively.
- CT's shall be bar / window primary type.
- CT's shall have shorting link on secondary side to facilitate insertion of meters on secondary side without opening CT circuits.
- CT Ratio shall be as marked on the Single Line Diagram attached with this Specification.

xvi) Potential Transformers

- Fixed type line PT mounted in separate panel shall be acceptable. However, if line PT is located in incomer breaker panel, draw out type PT shall be considered.
- High voltage side of PTs shall have fuses and MCCB's on low voltage side
- Low voltage star winding shall have all three phase and neutral connections brought out to terminals and one phase shall be earthed.
- Insulation levels shall be similar to rating of associated board.
- Accuracy class 1.0 shall be used.
- VA burden shall be selected based on meters and relays connected with the PT.

xvii) Relays

- Relays shall be Microprocessor based numerical and communicable type. Protocol for communication shall be IEC 61850.
- All relays shall be flush mounted in dust proof cases and shall be mounted on front side of cubicle.
- Major relays are as indicated in the specification or single line diagram.
- Master trip relay shall be hand reset and shall have 3 NO and 3 NC contacts in addition to those required by the protection/control scheme.
- All timers and protection relays shall have flag indicators.
- Relay ranges, exact type, number of aux. relays, timers shall be finalized during drawing approval stage.
- All instantaneous current protection relays shall be of 3 pole type.

xviii) Indicating Instruments

- All indicating instruments shall conform to IS: 1248-1983 and IS - 2419-1979.
- Shall be capable of withstanding system fault current taking into account CT saturation.
- Shall be back connected.
- Shall be located in the upper part of the panel.
- Shall have 96 sq. mm square flush case, non-reflecting type, clearly divided and indelibly marked scales, sharply out lined pointers and zero adjusting device.
- The minimum scale reading shall not be more than 10%. Maximum reading shall be 150% full load for transformers panels.
- Each voltmeter shall be calibrated with coil hot. The scale shall be open between 60% to 125% of normal volts and shall be suppressed below 60% of normal volts.

- Class of accuracy shall be 1.0 or better.
- The full load reading of each ammeter shall occur at the most prominent part of the scale. The minimum scale reading shall not be more than 10%. Maximum reading shall be 150% full load for transformer panels and 600% full load for motor panels.

xix) Annunciators

- Shall be of static type.
- Hooter and bell for trip and alarm indication respectively.
- Shall be suitable to work on DC supply as specified.
- Test, accept and reset facilities (with push button) shall be provided on each panel.
- Suitable audio - visual indication shall be provided on DC failure. Audio alarm with reset facility shall be provided. Visual indication shall be panel-wise.
- Spare annunciation points shall be wired upto terminal blocks. 20% spare facias shall be provided.
- Each point shall have two bunch LEDs in parallel.
- All trip points facia shall have red colour and non trip points white colour.
- The cover plate of facia shall be flush with panel
- Shall be capable to receive simultaneous signals
- Shall be capable to receive signal during testing mode
- Scope of supply includes all interconnections, bell hooter, buzzer, alarm facility, push button etc. required to achieve complete function of above scheme.
- Sequence shall be as follows :

	Visual	Audio
On occurrence of fault	Lamp flashing	on
On acceptance	Lamp steady "on"	off
On reset	Off	off
On test	Lamp flashing	on

- Annunciation in the switchboard shall have following provisions:
 - Each transformer & other feeder shall have 12-way uniform facia.
 - Each bus PT shall have 12-way uniform facia.
- Bus coupler or tie shall have sufficient facia (for each feeder to indicate tripping +20% spare)
- One common point shall be provided to indicate operation of annunciation system of the complete board (in case of any trouble in the board in tie feeder, bus coupler, incomer etc.)
- All auxiliary relays of transformer feeders shall have 4 NO contacts all master trip relays shall have 2 NO contacts for remote/DCS/PLC indication for repeat annunciation in addition to contacts required for scheme under scope of works.

xx) Control supply

- Control supply buses shall run throughout the switchgear.
- Two DC feeders shall be taken in each board controlled by MCCB's.
- In each panel for controlling of its DC supply MCCB (DC duty) shall be used. DC auto changeover and manual changeover facility shall be provided. Failure of DC supply shall be monitored in the switchboard as well as at remote.
- 240V AC shall be taken from station aux. board.
- Each section shall have separate feed with automatic change over scheme.
- Each panel shall have one MCB for controlling its AC supply.
- Sub circuits shall be protected with HRC fuses/ MCB in each panel for indication lamps, closing & tripping circuits.

xxi) Earthing Devices

- Either integral earthing switch or a separate earthing switch shall be provided to facilitate earthing of busbars and any feeder circuit.
- Earthing truck (if included) shall have PT and alarm provision. (Separate trucks shall be provided for feeder and bus earthing through bus PT panel in each switchboard). One no. earthing truck for feeder earthing and one no. for busbar earthing shall be provided for each board. It shall not be possible to use bus-earthing truck for feeder earthing and vice-versa.
- Rating of earthing device shall be in line with associated board.
- Interlock provision shall be there so that incomer cannot be closed if bus-earthing device is connected.
- In case feeders are having integral earth switch, earthing trucks may not be required.

xxii) Control and Selector Switches

- Control switches for circuit breaker ON/OFF control - 3 position spring return to neutral with lost motion device and pistol grip handle.
- Other control and selector switches - stay put type with wing type knobs.
- Ammeter selector Switches- 4 position, make before break.
- Voltmeter selector switches- 7 positions as required.
- Colour : Black
- Contact Rating:

Continuous	10 amps
AC11	4 amps, 240V
DC11	0.5A, 30V, L/R- 40ms.

xxiii) Push buttons

Contact Rating

Continuous	10 amps
AC11	4 amps, 240V
DC11	0.5A, 30V, L/R- 40ms.

COLOR:

ACCEPT	BLUE
RESET	BLACK
TEST	YELLOW

xxiv) Control Circuit Fuses:

HRC link type conforming to IS 9224-1979.

xxv) Protective Earthing

- Continuous earth bus of minimum size 50x6 mm of copper or equivalent aluminum/galvanized steel section, designed to carry the peak short circuit and short time fault current as specified.
- Provided at the bottom extending throughout the length of the board, bolted/brazed to the frame work of each panel with an earthing terminal at each end for terminal at each end for terminating external earth conductor.
- Vertical earth bus for earthing individual functional units.
- Hinged doors earthed through flexible earthing braid.
- Looping of earth connection resulting in loss of earth connection to other devices when the loop is broken not permitted.
- Withdrawable units provided with self aligning, spring loaded, silver plated copper scrapping earth contacts of make before/break after type, ensuring earth continuity from service to the test position.

xxvi) Test and Maintenance Equipment

Each board to be supplied with 1 set of test plugs.

xxvii) Constructional Features

Mechanical Design

- Sheet steel clad, compartmentalized, floor mounted, free standing design.
- Minimum sheet steel thickness: doors and covers - 2 mm cold rolled, other load bearing members - 2.5 mm
- Doors shall be provided with lock and key arrangement
- Degree of protection shall be IP5X.
- Assembled on base channel of structural steel ISMC 75 painted black.
- Operating height shall be between 450 to 1800 mm. Switchboard height not to exceed 2500 mm.
- Earthed metallic barriers between compartments and between vertical sections.
- Seal off bushings wherever bus bars pass through metallic partition.
- Lockable front doors with concealed hinges with door not forming part of the draw-out truck.
- Panels shall be extensible on both sides.
- Removable sheet steel covers shall be provided at rear.
- Explosion vent for each chamber
- Control cables entry shall be from front side.
- CTs shall be located in such a way that they are easily accessible.
- Panel door switch shall be provided for illumination inside the panel.
- All live parts shall be insulated by taping, supported by suitably designed insulators. Proper insulation of bus bars, upper and lower contacts of breakers and sealing of opening of bushings shall be provided to eliminate accidental contacts.
- Screw wire mesh in the power cable chamber of incoming feeder is to be provided.

INDOOR 3.3KV HT VCB PANEL

This includes, Design, fabrication, supply, installation, testing and commissioning of HT panel indoor 3.3 kV, 1250 Amps, 3 Phase, 50 Hz, 25 kA VCB for 3 Sec.

• Incoming Feeder With PT:

This includes supply at site, Vacuum Circuit Breaker, suitable for 3.3 kV, 25 kA, 1250 Amps., 500 MVA, 3 Phase, 50 Hz effectively earthed, neutral system comprising of proper housing of breaker, safety shutters, isolating plugs and socket and VCB trolley with 3 nos. Vacuum Interrupters with safe aligning finger type, isolating contacts suitable for vertical/horizontal isolation and horizontal draw out. Necessary control Protection and metering circuits are completely assembled, wired and enclosed in a weather and dust proof cubicle.

The HT Panel shall be made of sheet steel enclosure, dust and vermin proof, suitable for indoor use. This shall be suitable to receive power at 3.3 KV, 50 Hz, 3 phase AC with all equipment fittings and accessories for efficient and trouble free operation.

- a) 3.3 kV, 1250 Amps. VCB The self-tripping mechanism with numerical relay with IDMT, over current, earth fault and Instantaneous protection including TVM, MFM and all others panel's indications lamps.
- b) Incoming cable entry box shall be provided for the required cable entry.
- c) Insulation level
 - i) 1.2/50 microsecond Impulse 75 kV peak withstand voltage
 - ii) One minute power frequency 28 kV rms withstand voltage
- d) Rated current
 - i) Continuous
 - Bus bar 1250 A
 - Incoming/outgoing 1250 A

- circuit breaker
- ii) Short time current for 3 seconds 25 kA rms
- e) Circuit breaker
- | | |
|----------------------------|------------------|
| i) Rated breaking capacity | 25KA / 3 Sec. |
| Symmetrical. | |
| ii) Rated making capacity | 62.5 KA |
| iii) Total breaking time | 7 cycles maximum |
| iv) Operating sequence | As per IS/IEC |
- f) Make : As per the list of makes enclosed herewith.
- g) Shunt trip coil : 30 V DC
- h) Closing coil : 30 V DC
- i) Busbar chamber with Copper busbars, heat shrinkable PVC sleeved/ powder coated with colour code. The busbars shall be of high conductive electrolyte copper.
- j) 230VAC space heaters with ON-OFF switch and thermostat.
- k) 1phase, resin cast with fuse unit, draw out, line connected PT ratio of 3300//3/110 //3Volts of 100VA burden to meet with auxiliary power requirement of metering and protection. Having accuracy of 0.5/3P.
- l) Epoxy cast resin CTs with 15VA burden, STR of 25 KA for 1 sec., metering accuracy class 0.5 and protection accuracy 5P20/PS and having of CTR 1250-800/5-5-5A.
- m) The Trivector meters shall be digital type of approved make and it should display Amps, Volts, KVA, KW, KWHr, KVAR, PF and MD etc. The meter shall provide with external port for remote monitoring.
- n) The Multi-Function Meter (MFM) shall be digital type of approved make and it should display Amps, Volts, KVA, KW, KWHr, KVAR, PF, Frequency and etc. The meter shall provide with external port for remote monitoring.
- o) Breaker ON-OFF LED indicating lamp.
- p) Circuit trip/healthy indicating LED lamp with pushbutton.
- q) Breaker spring charged LED lamp indication.
- r) TNC (Trip Neutral Close) switch.
- s) Numerical relays consist of IDMTL + Inst 3 O/C + Inst E/F relay+REF.
VAX - 31 Trip circuit supervision.
VAJH - 23 master trip. All relays shall be SCADA enabled with event/data logging features.
- t) Operating handle, spring charging handle and other required accessories shall be supplied.
- u) Cable box suitable for receiving single length of 3C x 400 Sq. mm HT XLPE cable.
- v) Hand held lamps for panel internal illumination shall be provided with 240V AC source.
- w) Hooter for tripping.
- x) 30V DC external supply shall be provided for control circuit of complete breaker operation.
- y) Type of charging: Manual as well as motorized mechanism with 230V AC operated motor.
- z) Bus bar support insulator:-Non hygroscopic, track resistant, high strength insulator.(Calculation for validating dynamic force withstand capability to be submitted during drg. Approval)

- **Outgoing Feeder (without PT):**

Technical Specification same as Incoming feeder but without PT. The auxiliary relay for transformer shall be provided.

The VCB shall be complete with necessary interconnection with fine feruled wiring, foundation bolts, earthing, etc. The VCB shall be supplied to conform to relevant IS, amended up to date, along with manufacturers test certificate. Required no. of Danger

board /Stickers of HT voltage in two languages English/Hindi is to be provided on the panel.

Epoxy cast resin CTs with 15VA burden, STR of 25 KA for 1 sec., metering accuracy class 0.5 and protection accuracy 5P20/PS and having of CTR 400-200/5-5-5A.

The necessary approval of the drawing of VCB panel shall be obtained from HDC before fabrication. Panel shall be connected with earthing as per IER.

INSTALLATION OF INDOOR HT VCB PANEL:

This includes installations, testing and commissioning of VCBs at 3.3KV sub-station VCB with P.T. as incomer and without PT as outgoing feeder.

All the VCB's shall be erected by using suitable size of M.S. channel foundation bolts including grouting of the bolts of each VCB panel. Each panel shall be connected with separate and distinct Earthing. After installation of VCB panel, necessary test and trial are to be carried out for proper functioning of safety, devices, relay etc. and before charging VCB all the tests required under relevant ISS and IEC – Rules 1956 shall be carried out and the result shall be in conformity with specifications and copies of test results shall be furnished to EIC. The work includes all Labour & materials required for installation & commissioning of VCB and shall be done as directed by E.I.C.

Tentative lay out:-

Incomer Feeder : 3 Nos.

Bus Coupler : 1 No.

Outgoing Feeder : 14 Nos.

i) 2nd Oil Jetty Sub-station : 1 No.

ii) Coal Stacker-cum-Reclaimer : 1 No.

iii) Lock Generating Sub-station : 1 No.

iv) Ore Conveyor : 1 No.

v) Coal Conveyor : 4 Nos. [2 Nos. for HT Motors for Yard Conveyors and 2 Nos. for allied Vacuum Contactor]

vi) Transformer (1000 kVA, 3.3 / 0.433 kV) Feeder : 4 Nos.

vii) Spare : 2 Nos.

7.0 LT Panel (PCC-1 & 2)

7.1 Scope

This specification covers manufacture, assembly factory test, supply, delivery, field test and installation of L.T. distribution board of voltage not exceeding 1000 V AC complete in all respect with all equipment fittings and accessories for efficient and trouble free operation as required herein under.

7.2 Codes & Standards

The design, construction, manufacture and performance of equipment shall conform to latest applicable standards and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment shall be installed. Nothing in this specification shall be construed to relieve the BIDDER of this responsibility.

Equipment shall conform to the latest applicable Standards as mentioned. In case of conflict between the Standards and this specification, this specification shall govern.

IS: 13947 (Part 2&5), 1993 -Low voltage switchgear & control gears
 IS: 2147, 1966-Degree of protection
 IS: 13947 (Part 4, Sec.I), 1993
 BS: 60947-4-1, 1992: IEC: 158-Contactor for voltage not exceeding 1000V AC.
 IS: 375, 1993-Marking and arrangement of bus bars
 IS: 694, 1990 & IS: 8130, 1984-PVC Insulated cables and aluminium conductor
 IS: 1248, 1991-Direct acting electrical indicating instruments
 IS: 13703, 1991 -Low voltage fuses
 IS: 13118 (All parts), 1991 -Alternating current circuit breakers
 IS: 2705 (Part 1 to 4), 1992-Current transformers
 IS: 3156 (Part 1 to 3), 1992-Voltage transformers

7.3 **Power Supply System**

The incomer power supply shall be 415V, 3 phase, 4 wire, 50 Hz, effectively earthed AC system. The fault level for the switchgear shall be as per single line diagram.
 Variation of voltage and frequency from their rated values shall be as per IE rules.

7.4 **Ambient Conditions**

The following site conditions shall be considered for the design: -
 Reference temperature : 50°C

7.5 **Sheet Metal Work**

The switchgear frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than **2.5 mm**.

Frames shall be enclosed by sheet steel of thickness not less than **2.5 mm** cold rolled, smoothly finished, levelled, and free from flaws. Doors and covers shall be made of sheet steel of thickness not less than **2.0 mm** cold rolled. Stiffeners shall be provided wherever necessary.

All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

Cut-outs shall be true in shape and avoid of sharp edges.

The complete structure shall be rigid, self-supporting, free from vibration, twists and bends.

7.6 **Painting**

All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with applicable standards.

Oil, grease and dust shall be thoroughly removed by emulsion cleaning.

Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.

A smooth coat of powder coating to be provided of approved colour.

Finished painted appearance of equipment shall present an aesthetically pleasing appearance like light grey, free from dents and uneven surfaces.

Constructional Features

Switchgear panel shall be:

- a) of the metal enclosed, indoor, floor mounted modular type
- b) made up of the requisite vertical sections
- c) of dust and vermin proof construction
- d) provided with a degree of protection of IP-52
- e) easily extendable on both sides by the addition of vertical sections after removing the ends covers.
- f) provided with a metal sill frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated.
- g) provided with labels on the front indicating the switchgear designation.
- h) of uniform height of not more than 2450 mm
- i) of single front execution
- j) provided with neoprene gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors.
- k) provided with aluminium bus bars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure.
- l) Feeder pillars/kiosk should be fabricated from 2.5 mm thick CRCA steel and conform to IP: 54 degree of protection.

Operating devices shall be incorporated only in the front of the Switchgear.

The switchgear shall be provided in distinct vertical sections each comprising:

- a) A completely metal enclosed bus bar compartment running horizontally.
- b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.
- c) Enclosed vertical bus bars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical bus bars
- d) A vertical cable alley covering the entire height. The cable alley shall be minimum 200 mm wide for motor control modules and 500 mm wide for circuit breaker controlled modules.
- e) A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.

- f) Each outgoing feeder compartment having 3-pole MCCB shall have neutral link of suitable rating at the MCCB compartment.

Each vertical section shall be equipped with space heaters with thermostat, CFL lamp and power socket.

One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal bus bar compartment. However, each shipping section shall have metal sheets at both ends.

All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

For draw out type, ACB modules, only the handles of control and selector switches, push buttons, knobs and cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing. Control circuit must have separate compartment and separated from power circuit.

Current transformers shall be mounted with suitable base and shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment. **The Control cable shall be 2.5 Sq.mm.**

In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.

The withdrawal chassis shall move on suitable guides and plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

Cable alleys shall be provided with suitable hinged doors. Adequate number of slotted cable support arms shall be provided for dressing the cables.

All doors shall be provided with concealed type hinges and captive screws with padlocking arrangement, suitably earthed with 2.5 sq.mm copper conductor flexible cable.

The withdrawal chassis housing circuit breakers shall be of the fully drawout type.

The withdrawal chassis housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully fixed or *drawout* type.

7.8

Interchangeability

All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable, without having to carry out modifications. For trouble free interchangeability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

Components and equipment that are not fully interchangeable are liable for rejection. BIDDER shall replace all such equipment by fully interchangeable equipment at his cost.

The draw-out contacts shall be only between copper/copper alloy faces, which are silver or tinplated. The contact design shall be such that there should be no arcing/deformation under associated peak short circuit currents.

Switchgear shall be designed in such a way that all component equipment and bus-bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubicle, with reference ambient temperature outside the switchgear cubicles.

All dummy cubicles necessary to meet the requirements of this specification shall be included in the Bidder's scope.

No equipment/devices associated with a particular circuit shall be mounted in any other circuit module.

7.9

Main Buses & Tape

Switchgear shall be provided with three phase bus bars and neutral.

Bus bars shall be of uniform cross section throughout the length of the switchgear

The bus bars shall be made of high conductivity electrolytic aluminium, suitable to withstand a fault current as specified in BoQ and SLD.

Bus bars shall be provided with at least the minimum clearances in air as per applicable standards for a 500V, 3 phase, 4 wire system.

All bus-bars, bus-taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free plastic insulation of high dielectric strength (450 V/mil) to provide a permanent high dielectric non-ageing and non-tracking protection; impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phases. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. The dielectric strength and properties shall hold good for the temperature range of 0°C to 90°C.

Bus bar shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Bus bar supports shall be made of glass reinforced moulded plastic material (DMC).

Separate supports shall be provided for each phase of the bus bars. If a common support is provided for all three phases, anti-tracking barriers shall be incorporated.

Bus bar joints shall be complete with high tensile steel bolts, washers and nuts. Bus bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

Auxiliary Buses

Auxiliary buses for control power supply, space heater power supply or any other

specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Supply transformer(s), auxiliary bus bars and necessary connections to the supply transformers and associated circuits shall be in the Bidder's scope.

7.10

Air Circuit Breakers (ACBs)

The ACBs shall comply to IEC 60947 Part I & II and IS 13947 II and shall be suitable for operation on 415 Volts, 50 Hz 3 Phase system.

The breaker shall comply with Isolation function requirements of IEC 60947, Part-II, section 7.1.2 and shall be clearly marked as "Suitable for Isolation/ Disconnection" to ensure safety of operating personnel. The ACB shall have rated operational voltage = 440 V, rated insulation voltage = 1000 V and rated impulse withstand voltage = 12/8 KV and utilization category 'B'.

7.11

Circuit Breakers

Circuit breaker shall be:

- of the air break type
- of the shunt trip type
- provided with mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker.
- provided with mechanically operated, red 'trip' push button, shrouded to prevent accidental operation.
- provided with locking facilities in the 'Service', 'Test', and 'Isolated', positions. In test position the breaker shall be tested without energising the power circuits. The breaker shall remain fully housed inside the compartment in the test position.
- provided with minimum 6 NO and 6 NC potential free auxiliary contacts, rated 10A at **240V A.C.**
- The cubicle compartment of the ACB in the LT panel shall be provided with 'red', 'green' and 'amber' indicating lamps to show 'closed', 'open' and 'Auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.
- The ACB panel shall be provided with mechanical indicator (ready to close) on the front facia to facilitate safety of the operator before closing the ACB.
- Circuit breakers shall be provided with the following interlocks.
- It shall not be possible to plug-in a closed circuit breaker, or to draw out a circuit breaker in the closed position.
- It shall not be possible to operate a circuit breaker unless it is in the fully plugged-in, test, or fully isolated position.
- Circuit breaker closing and trip coils shall be rated for satisfactory operation on a control supply 30V DC

Operating Mechanism

- The spring charging motor shall be rated at 240V AC.
- The closing action of the circuit breaker shall charge the tripping spring ready for tripping.

- Speed of closing of contacts shall be independent of the speed with which the handle is operated.
- All stored energy mechanisms shall be provided with mechanical indicators to show the 'charged' and 'discharged' conditions of the spring.
- Circuit breakers provided with stored energy operating mechanisms shall be provided with the following interlocks.
- The circuit breaker shall not close unless the spring is fully charged.
- Shocks, vibrations, or failure of springs shall not operate the breaker or prevent intended tripping.
- Mechanical contact wear indicator shall be mounted directly on the moving contacts to indicate the degree of erosion of the contacts.

Protection coordination

The Microprocessor based release shall be an integral part of ACB provided on circuit breaker for short circuit, over load, instantaneous and earth fault protection with adjustable current & time settings along with LCD display for displaying of instantaneous value of 3 phases, neutral currents.

The release shall incorporate microprocessor to offer accurate, faster and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following zones.

- i) Overload or long time protection with adjustable time delay
- ii) Short circuit or short time protection with adjustable time delay.
- iii) Instantaneous protection with no intentional delay.
- iv) Ground fault protection with time delay.
- v) Release shall have facility of online changing of current and overload setting.

The microprocessor based trip units shall be provided with following features also:-

1. Designed to withstand tough industrial environments i.e. high ambient temperatures, switching surges, electromagnetic interferences.
2. Reliably self-powered by built in current transformers.
3. LED display indication of each of over load, short circuit and earth fault.
4. Testing of release shall be possible without tripping the breaker through integrated test button which shall check the healthiness of trip unit electronics and associated CT circuits without tripping the breakers.
5. LED alarm display for microprocessor fault.

All ACB's must be rated ambient temp 50°C.

7.12

Moulded Case Circuit Breaker

The Moulded case circuit breaker (MCCB) shall conform to latest IEC-60 947-2/ IS13947- 2. The circuit breaker shall comply with the isolation function requirement of IEC 60 947-2 section 7.1.2 to marked as suitable for isolation/ disconnection to facilitate safety of operating personnel while the breaker is in use.

Moulded case circuit breakers shall be fixed type, microprocessor release having adjustable O/L & S/C settings with trip-free, manually closing mechanism,

accommodated in a Moulded housing of robust and vermin-proof construction matching with switchboards. All MCCBs shall be designed and tested to IS - 13947 Part II to breakers shall be provided with an inverse time delay electronic over current trip device. The trip device shall be direct acting.

The MCCB shall have rated operating voltage = 690V with min. Insulation voltage = 750V and rated impulse withstand voltage = 8KV.

MCCB shall be provided with Class II insulation between front cover & internal power circuits to avoid any accidental contact with live current carrying path with the front cover open.

The tripping devices shall be ambient temperature compensated type. The insulating case and cover shall be made of high strength heat resistant and flame retardant thermosetting insulating material.

They shall have line load reversibility. 3-phase breakers shall be designed to break all the poles simultaneously and they shall have a single mechanism.

They shall have auxiliaries and accessories whenever required for signalling, interlocking, shunt trips, under voltage release, castle lock, etc.

All the circuit breakers used shall have guaranteed breaking capacities sufficient for the maximum short circuit duties that could possibly be imposed on the different breakers. The MCCBs fixed in main switchboard shall have breaking capacity as indicated in BOQ & SLD.

MCCB shall have $I_{cs}=I_{cu}$ for the entire range as per BOQ and rated at ambient 50°C.

MCCB's shall be used with rotary handle and terminal spreaders, phase barrier and all terminals shall be shrouded to avoid direct contact.

7.13

Miniature Circuit Breakers (MCB)

MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards.

MCB shall be provided with overload/short-circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 10 kA r.m.s. at 415V AC. It shall comply to Class III energy limiting class. MCB shall comply with IS - 8828 - 1996/IEC 898. MCB shall have minimum power loss (watts) per pole defined as per IS/IEC and the manufacturer shall publish the values.

The MCB housing shall be heat resistant and heavy a high impact strength. The terminal shall be protected against finger contact to IP 20 degree of protection.

7.14

Measuring Instruments, Metering & Protection

General

Direct reading electrical instruments shall be in conformity with IS-1248. The accuracy of all measuring instruments shall be as specified in the BOQ. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between -10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments

meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per BOQ.

Analog type Ammeters and Voltmeters

Electrical indicating instruments shall be of minimum 96 mm square size, suitable for flush mounting.

Indicating instruments shall have position for zero adjustment outside the cover. Instrument dials shall be parallex free with black numerals on a white dial. Ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

Ammeters provided on motor circuits shall be provided with a suppressed extended scale to indicate motor starting current. Voltmeters shall be provided with fuse of suitable capacity.

Multi-Function Meter

It shall be suitable for measuring, saving and supervision of electrical parameters in low and medium voltage mains.

The Meter shall have following Features.

- Clear LCD Display
- Visualization of all the three phase grid parameters along with Min/Max/Measured/average.
- The meter shall have communication port of RS 485 and shall be compatible with SCADA System.
- It shall come along with the software for data acquisition.
- It shall be compatible with PLC.
- The accuracy class shall not be more than 0.5%

Current Transformers

Current transformers shall be in conformity with IS: 2705 (part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1kv. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 5A unless otherwise specified.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of the system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be done with minimum 2.5 sq. mm copper conductor, ZHFR wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

7.15

Miscellaneous

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting. Indicating lamps shall be of the LED type.

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

7.16

Cable Terminations

Cable entries and terminals shall be provided in the Distribution Boards to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry/exit of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

7.17

Push Buttons

Push buttons shall be:

- of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.
- fitted with self-reset, 2 NO and 2 NC contacts.
- provided with integral escutcheon plates marked with its function.

'Start', 'Open', 'Close' push buttons shall be green in colour.

'Stop' push buttons shall be red in colour.

All other push buttons shall be black in colour.

Emergency stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

7.18

Internal wiring

Wiring inside the switchgear/panel shall be carried out with 1.1 kV grade, zero halogen FR stranded conductor wires. Minimum size of conductor for power circuits is 4 sq mm copper. Control circuits shall be wired with copper conductor of at least **2.5 sq. mm for CT circuits /other control circuits**.

Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.

Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.

Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on screw less terminal blocks upto 4 sq. mm size. Not more than two connections shall be made on any one terminal.

7.19

Terminal Blocks

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

Terminals shall be numbered for identification.

Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks.

Screw less, cage clamp type terminal blocks shall be used for cable sizes upto 6 sq. mm. **Bus Bar** type terminal blocks shall be used for cables above 6 sq. mm.

Terminals for CT secondary leads shall be disconnecting link type and shall have provision for shorting.

7.20

Earthing

Each Panel shall be provided with an earth bus bar running along the entire length of the board. Material and size of the earth bus bar shall be as per IS. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the earthing conductor of size and material indicated in data sheets. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to the earthing conductor.

Earth bus bars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the switchboard and earth bus bar shall be provided by using insulated copper wires/bare bus bars of cross section equal to that of the bus bar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to the earth bus bar using 650 V grade, 2.5 sq. mm stranded, copper ZHFR, earthing conductor.

7.21

Labels

Labels shall be anodised aluminium with white engraving on black background

shall be provided for each incoming and outgoing feeder of Distribution Boards.
Labels shall be properly secured with fasteners.

DATA SHEET FOR LT PANELS / DISTRIBUTION BOARD

A) SWITCHGEAR PARTICULARS

- | | | | |
|----|------------------|---|-------------|
| 1. | DESIGNATION | : | |
| 2. | BUS BAR MATERIAL | : | ALUMINIUM |
| 3. | FP/TPN | : | 4 POLE/TPN |
| 4. | TYPE | : | INDOOR |
| 5. | CABLE ENTRY | : | FROM BOTTOM |

B) SWITCHGEAR AND BUS BAR RATING

- | | | | |
|----|------------------------------------|---|---|
| 1. | SUPPLY SYSTEM | : | 415V, 3-phase, 4W, 50HZ EFFECTIVELY EARTHED |
| 2. | MAX SYSTEM VOLTAGE | : | 433 ± 10% |
| 3. | BUS BAR RATING | : | 1600A |
| 4. | ONE MINUTE POWER FREQUENCY VOLTAGE | | |

A) POWER CIRCUITS : 2500 V

B) CONTROL CIRCUITS: 1500 V

C) AUX. CIRCUITS : 2000 V
CONNECTED TO
SECONDARY OF CTS

5. REFERENCE AMBIENT TEMPERATURE : 50°C

6. MAX. TEMPERATURE OF BUS BARS AND DROPPERS : 85°C

7. SHORT CIRCUIT WITHSTAND

A) SHORT TIME (1 SEC) : 50 KA (RMS)

8. FEEDERS DETAIL

A) INCOMER AND BUSCOUPLER: 1600A- 03Nos. 4 Pole ACB's.

B) OUTGOING: 630A-08Nos. 3Pole ACB's.

C) OUTGOING: 400A-06Nos. 3Pole MCCB's

C) SWITCHGEAR CONSTRUCTION REQUIREMENTS

1. THICKNESS OF SHEET STEEL (COLD ROLLED)

- | | | | |
|----|-------------|---|--------|
| A) | FRAME | : | 2.5 MM |
| B) | DOORS | : | 2.0 MM |
| C) | COVERS | : | 2.0 MM |
| D) | GLAND PLATE | : | 3.0 MM |

2. DEGREE OF PROTECTION : **IP-52/54** OF IS-2147, 1966

3. COLOUR FINISH AS PER IS-5)

- | | | | |
|----|----------|---|--|
| A) | INTERIOR | : | GLOSSY WHITE |
| B) | EXTERIOR | : | LIGHT GREY, SEMI-GLOSSY, POWDER COATING. |

4. EARTHING BUS

- A) MATERIAL : Aluminium
 B) SIZE : 50 X 6 MM with stainless steel bolts & Nuts.

5. CLEARANCES IN AIR OF LIVE PARTS

- A) PHASE TO PHASE : As per relevant IS
 B) PHASE TO EARTH : As per relevant IS

5 LT BUSDUCT

A) Electrical Design

- i) Electric power supply
 - 415 V, 3 phase 50 Hz system neutral solidly grounded
 - System short circuit level as specified.
- ii) Insulation level
 Rated insulation voltage : 1100 V
 One minute power frequency voltage : 2.5kV
 * Clearance in air (minimum) -
 Phase to phase (mm) : 25.4 mm
 Phase to earth (mm) : 19.0 mm
- iii) Short circuit strength
 * Rated short time withstand current not less than the system short circuit level duration 1 sec for 415 V.
 * Rated peak withstand current not less than 2.1 times the system short circuit level.
- iv) Rated current
 * Rated continuous current as specified while in enclosure and at specified ambient temperature with maximum temperature of bus bars limited to 90 deg. C
 * Neutral bus where specified with rating not less than half the rating of phase bus.

B) General Arrangement

- LT busduct: Rectangular, Non segregated phase, totally enclosed type.
- Comprising of following sections, as applicable, to make the installation complete and to match with the terminal equipment :
 - ⇒ Switchgear lead-in section with flexible hood.
 - ⇒ Straight section in standard length
 - ⇒ Matching section (length as required)
 - ⇒ Transformer lead-in section
 - ⇒ Corner sections (horizontal and vertical)
 - ⇒ Phase cross-over section
- 240V AC space heater to be provided at suitable intervals and wired to external terminal box with heat resistant cables.
- Silica gel breathers at appropriate locations.
- Horizontal bends to be avoided by positioning the switchboard incomers at appropriate place.

C) Construction Details

- Degree of protection for enclosure IP 52 or better for indoor installation, and IP55 for outdoor part.
- Enclosure material: Aluminium/ steel sheet, as specified of minimum thickness 2.0 mm.
- Enclosure construction rectangular welded construction.
- Maximum temperature of enclosure under rated operating conditions limited to 75 deg. C
- Bolted covers with gaskets for easy inspection and access to insulators and

- bus bar joints.
- Gasketed (Neoprene) connections between adjacent sections of metallic enclosure.
- Rubber bellows at each end to take care of vibrations.
- Provision for mounting on brackets.
- Supply of painted MS supporting structures with necessary hardware shall be included in the scope of supply.
- Surface treatment.
- Two coats of epoxy paint for outdoor and synthetic enamel paint for indoor application, preceded by de-rusting, cleaning chemically, degreasing, pickling in acid, cold rinsing, phosphating, passivating and spraying with two coats of zinc oxide primer.
- Shade of paint :
 - ⇒ Interior : Black
 - ⇒ Exterior : Light grey shade 631 of IS-5 (unless otherwise specified)

D) Busbars and connections

- Material EC grade aluminium alloy equivalent to E91E WP conforming to IS 5082, 1981; or high conductivity electrolytic grade copper as per IS-613, 1984.
- Final operating temperature of both bus bars and joints under continuous operation in enclosure limited to 90 deg. C by thermometer method.
- Bus bar arrangement as per IS-375, 1963.
- Phase identification by colour at ends and at regular intervals.
- Busbar joints of bolted type, with zinc bichromated high tensile steel bolts, nuts and spring washers.
- Busbar surfaces to be tinned at joints and coated with oxide inhibiting grease prior to jointing.
- Flexible connections for termination on equipment.
- Expansion joints on straight runs with joints staggered in adjacent phases.
- Bimetallic joints for jointing between dissimilar metals.
- Busbar support insulators of non-hygroscopic material, having high impact and di-electric strength, with an anti-tracking contour.

E) Protective earthing

- Aluminium earth bus of size 50 x 10 mm running throughout the length of the busduct, positively connected to the body of the busduct.
- Provision at each end of busduct for terminating external earth conductor.

F) Technical particulars for Design

1.	Application	Indoor
2.	Rated system voltage and frequency	415 V
3.	System earthing	Solidly earthed
4.	Rated continuous current as specified ambient conditions (in enclosure)	1600A
5.	Rated short time withstand current (kA.rms) and its duration	50 kA for 1Sec
6.	Rated peak withstand current (peak)	105 kA
7.	Temp rise over ambient of 50 deg. C - Busbars - Enclosure	40 deg. C 25 deg. C
8.	Busbar material	Aluminium
9.	Neutral bus	To be provided
10.	Earth bus material	Aluminium
11.	Earth bus size	50 x 10
12.	Supporting insulators	SMC/ FRP
13.	Busduct enclosure material	Aluminium

14.	Busduct enclosure material thickness	2.5 mm
14.	Busduct support structure	To be provided

8.0 BATTERY BANK AND BATTERY CHARGER

➤ TECHNICAL SPECIFICATIONS OF BATTERY

The 30 V, 180 AH DC Battery Bank should be consisted of Maintenance free, Lead Acid type batteries with 2 (two) Hours battery backup. The **Battery Bank** should be complete in all respect and equipped with all necessary accessories like, **Inter-cell Connectors (Copper), Connecting Leads**, etc. The spares / attachments, which are meant necessary for the smooth functioning of the equipment and specially are not mentioned here shall be assumed to be included in the scope of supply.

Battery racks suitable for accommodating 15 cells should be supplied & installed by the Contractor. The racks should be made of wood and to be so designed and placed as to permit easy handling of the cells while in operation.

The wooden battery racks should have acid resisting and flame proof coating.

➤ TECHNICAL SPECIFICATIONS OF BATTERY CHARGER :

ii) The **Battery Charger**, to be used for charging **30 V, 180 AH Battery Bank** , should be of **Float-cum-Boost Charger** Type , having provision for **auto Changeover** from **Boost to Float & vice-versa** and following Technical features:-

- a) Should be suitable for Indoor installation and to be supplied with all accessories.
- b) Should have facility to regulate the Battery Charging current and output voltage as per requirement (to be indicated by the Manufacturer of the Battery Bank) and limiting the total current within the maximum capacity of the charger.
- c) Should have provision for automatic switching to ensure different applications of both 33 KV & 3.3 KV Panels to be installed at the existing G.C. Berth Substation & newly constructed 3.3 KV Switch-Station. Suitable control arrangement is to be provided to ensure that output D.C. voltage is always within the limits specified, even if the cell voltage is high.
- d) Should be suitable for operation in **Manual Mode**, besides the **Auto Mode**. Suitable device is to be provided for adjusting charging current and voltage when the charger is to be operated in Manual Mode.

iii) **Other Technical Particulars :**

a) **Output Voltage:**

Nominal: 30 V DC

Maximum: 36 V DC

Minimum: 24 V DC

b) **Charging Current :**

Maximum continuous output current: 16 Amps

Maximum continuous D.C. Load: as per requirement.

Maximum Battery Charging Current: to be indicated by the manufacturer of the Battery Bank.

c) **Type:** Solidstate , both Auto & Manual Control.

d) **Input Voltage:** 230 V – 250V A.C., Single Phase.

- e) **Input Frequency:** 50 Hz $\pm$ 5%.
- iv) **Protection** :
- a) The charger shall be protected against following conditions with provision of delayed protective and / or indicative action as per scheme requirement.
 - b) Input Voltage Surge.
 - c) Input over / under voltage.
 - d) Output over / under voltage / short circuit / over load.
 - e) Earth fault in + ve and - ve D.C. output.
 - f) Battery reverse polarity.
- v) **The Charger shall incorporate the followings** :
- a) M.C.B. for incoming / outgoing supply
 - b) H.R.C. / glass cartridge / semi conductor fuses for different circuits. All fuses shall be properly labelled for proper identification.
 - c) Surge Arrestors.
- vi) **Indication** :
- The charger shall be provided with following L.E.D. indications to identify abnormalities through incorporation of suitable scheme.
- a) Mains ON
 - b) Output ON
 - c) Input over / under voltage and power supply fail.
 - d) Output over / under voltage.
 - e) Earth Fault
 - f) Battery reverse polarity
- All indicating LED lamps, switches, control knobs, terminal blocks, etc., shall be properly labelled for easy identification.
- vii) **Meters** :
- Following meters with selector switches shall be provided to measure the following:
- a) Analogue Ammeter. of appropriate scales with Selector Switch for measuring battery float / boost charging current and output current.
 - b) Analogue Voltmeter of appropriate scales with Selector Switch for measuring battery and output voltage.
 - c) Analog Voltmeter for measuring input AC Voltage.
- viii) **Control** :
- Following controlling arrangement shall be provided for different functions of battery charger:
- a) AUTO/MANUAL Selector Switch
 - b) Manual operation controlling device
 - c) Mains ON
 - d) Output ON
 - e) Voltmeter Selector Switch
 - f) Ammeter Selector Switch

ix) **Enclosure** :

The chargers shall be enclosed in floor mounted type enclosure with provision for proper ventilation.

x) **Two sets of Instruction Manuals for Erection, Operation & Maintenance , two sets of Drawings for Equipment Details and two sets of Circuit Diagram** should be submitted along with the above Battery Charger unit.

9.0 **CABLE TRAY**

GI Cable tray

Cable tray shall be prefabricated Trays should be made of M.S Angle of size 50 mm. x 50 mm. x 6 mm. for both side runner with Spans Limited to 2.5 meter(approx.). Cross Support should be of M.S Flats of size 450 mm. x 32 mm. x 6 mm. (approx.) welded to Runner Angle at 300 mm. (approx.) apart. After fabrication the same shall be Hot dip galvanised to achieve thickness of galvanisation shall be as per IS.

Perforated cable trays for control wiring shall also be Hot dip galvanised to achieve thickness of galvanisation shall be as per IS.

FRP Cable tray

Pre-fabricated perforated type trays made of FRP shall be used for laying cables. The trays shall have vertical edge of height not less than 50 mm on both sides. The control/power cable shall be clamped by means of suitable PVC straps both for horizontal to vertical direction and vice-versa and further these straps shall be clamped with Aluminium clamp with stainless steel bolts for every one meter.

Insert plates of suitable sizes shall be fixed in trench / wall for fixing of cable trays, at an interval of 1000 mm apart in horizontal run and 500 mm apart in vertical run and also at each bend / turning.

Suitable covers shall be provided on cable trays to be fixed outside trenches.

10.0 **EXTERNAL AND INTERNAL ELECTRICAL WORKS**

EXTERNAL ELECTRICAL WORKS

Light Fitting and Accessories

a. **Scope**

This specification covers the design, material specification, manufacture, testing, inspection and delivery to site and installation & commissioning of lighting fittings and their associated accessories.

b. **Standards**

The light fittings and their associated accessories such as lamps/tubes, reflectors, housings, ballasts, etc. shall comply with the latest applicable standards as specified. Where no standards are available, the supply items shall be backed by test results shall be of good quality and workmanship & any supply items, which are bought out by the Bidder, shall be procured from approved Bidders acceptable to the Employer.

c. **Light Fittings - General Requirements**

Luminaire housing should be completely made of Pressure / High Pressure Die Cast Aluminium (corrosion resistant). Single / multi pc in construction.

Aerodynamic shape with adequate strength to withstand max wind speed.

Precision optical system for tubular lamp, Optical compartment duly brightened and anodized aluminium & Lamp position adjustable from back without use of tools. The optics should be suitable for adjustment of toe-in/throw and spread to suit different road widths and spacing.

Luminaires should be duly chromatised and coated with pure polyester to minimum 45 micron thickness to a shade RAL7035. Alternatively in specific cases Poly Urethane Coating of other decorative shades as recommended.

Toughened heat resistant glass sealed with gasket and SS toggles.

Choice of self-stopping ignites.

Luminaire should be opened from top and fixed with help of two nos. clamps.

Luminaire conforming to IEC60598.

d. **Earthing**

Each lighting fitting shall be provided with an earthing terminal suitable for connection to the earthing conductor.

All metal or metal enclosed parts of the housing shall be bounded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

e. **Painting/Finish**

All surfaces of the fittings shall be thoroughly cleaned and degreased. The fittings shall be free from scale, rust, sharp edges and burrs.

When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mills for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.

The housing shall be stove-enamelled/epoxy stove-enamelled-vitreous enamelled or anodised as indicated on flameproof fittings is prohibited.

The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90° over ½" dia mandrel.

The finish of the fittings shall be such that no bright spots are produced either by direct light source or by reflection.

f. **Reflectors**

The reflectors shall be made of CRCA sheet steel/aluminium/silvered glass/chromium plated sheet copper as indicated for above mentioned fittings, unless otherwise specified.

The thickness of steel/aluminium shall comply with relevant standards specified. Reflectors made of steel shall have stove enamelled/vitreous enamelled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enamelled/mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.

Aluminium paint on the reflectors of flame-proof lighting fittings is prohibited. Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflection coefficient such as to ensure the overall light output specified by the Bidder.

Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

g. **Lamp/Starter Holders**

Lamp holders shall comply with relevant standards. They shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with in normal installation and use. They shall be rotary, spring, loaded resilient type, either moulded from urea formaldehyde.

The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

h. **Ballasts**

The ballasts shall be designed, manufactured and supplied in accordance with the relevant standards. The ballasts shall be designed to have a long service life and low power loss.

Ballasts shall be mounted using self-locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dusting, non-combustible enclosures.

The ballasts shall be of the inductive, heavy-duty type, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with tapings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Bidder.

Separate ballast for each lamp shall be provided in case of multi-lamp fittings. The HF ballast should not interfere with the computer.

i. **Starters**

Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio suppression capacitor, suitably designated to withstand striking voltage of tube and to ensure long lamp life.

The starters shall generally conform to the relevant standards.

j. **Capacitors**

The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

The capacitors shall be suitable for operation at supply voltage and shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.95 lag or better.

The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.

k. **Lamps**

The lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments/electrodes shall not break under such circumstances. Metal halide lamps shall be as per Bidders specification. Lamps/tubes shall conform to relevant standards and shall be suitable for supply voltage and frequency specified.

INTERNAL ELECTRICAL WORKS

a. **Wiring**

Wiring is to be done in the looping system of wiring without any jointing. Phase wires shall be looped in switch control points and neutral shall be **looped at outlet points**. For **Open** conduit system hot dip **GI** Conduit, Aluminum saddles shall be used.

b. **Point Wiring**

Point wiring shall include all works necessary to complete wiring of a switch circuit of any length from the tapping point on the distribution circuit to the following via the switch.

- a) Ceiling rose and connector (in the case of ceiling/exhaust fan points).
- b) Back plate (in case of fluorescent fitting with down rods, etc.).
- c) Socket outlet (in the case of socket outlet points).
- d) Lamp holder (in case of wall brackets, bulk head and similar fittings).

The following shall be needed to be included in the point wiring.

- a) Switch
- b) Ceiling rose/connector as required.
- c) Any special or suitable round block for neatly housing the ceiling Rose/connector and covering the fan hook in case of fan point.
- d) Wooden box, bushed conduit, porcelain tubing where cable passes through wall etc.
- e) Hot dip GI Conduit covering upto 1.5 m from floor.
- f) Earth wire from three pin socket outlet point/fan regulator to common earth including earth bus except the earth wire from the first tapping point of live wire to the distribution board.
- g) All wood or metal blocks, boards and boxes, sunk on surface type, including those required for mounting fan regulator but excluding those under the main and distribution switchgear.
- h) All fixing accessories such as clips, rails, screws, phil plugs, wooden plugs, etc. as required.
- i) Looping the same switch board and inter connections between points on the same circuit.
- j) Providing fish wire in conduit while recessed conduit work is undertaken.

c. **Circuit Wiring**

Circuit wiring shall mean wiring from the distribution board upto the 1st nearest tapping point of that circuit.

d. **Submain Wiring**

Submains wiring shall mean wiring from the main/distribution switchgear to another main/distribution switch gear.

e. **Load on Circuit**

Lights, 5 A sockets and exhaust fans/axial flow fan may be wired on a common circuit. Such circuit shall have 10 points of light, exhaust fan and socket outlets or a load of 800 watt, whichever is less. It shall, however, be ensured that in one switch board, wiring of one circuit is only provided.

f. **Size of Conductor**

All the wires shall be stranded annealed copper conductor PVC insulated. The smallest copper conductor to be used for lighting circuits shall be 1.5 mm² and for main lighting circuits 2.5 mm², for 15 A sockets circuits 4 sqmm copper conductor shall be used. Wiring shall be done in the 'looping system'. Phase or live conductors shall be looped at the switch box and neutral conductor can be looped from the light, exhaust fan or socket outlet, neutral conductor and earth continuity wire shall be brought to each switch board situated in rooms and halls. These shall be terminated inside the switch boards with suitable connectors and the switch board shall be adequate size to accommodate one number 5 amps socket outlet and control switch in future.

g. **Conduit capacity**

Maximum number of PVC insulated cable conforming to IS: 694-1977 that can be drawn in one conduit shall be follows:

Nominal cross- sectional area of conductor in sq.mm	Size of Conduit											
	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	3	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

- Note : 1. The above table shows the maximum capacity of conduits for a simultaneous drawing of cables.
2. The columns headed 'S' applies to runs to conduit which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

h. **Rigid GI Conduit Wiring**

In this system of wiring, no bare or twist joints shall be made in through run of cables. If the length of final circuit/submain is more than the length of the standard coil, joints shall be made by means of approved mechanical connectors in suitable and approved junction boxes.

The chase in the wall shall be neatly made and in ample dimensions to permit the

conduit to be fixed in the manner desired. In case of buildings under construction, conduits shall be buried in the wall before plastering. These shall be grouted and covered with 1:4 cement and mortar, neatly finished at the plane of the unplastered brick work and scratched for provided key to the plaster and cured. Under no circumstances finished plastered surfaces shall be allowed to be chased for the conduit work. Before taking up chasing of the wall, the routes shall be marked and got approved by the engineer. The horizontal chase shall be avoided as far as possible. In case of exposed brick/rubber masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

MS Conduit pipes shall be fixed by heavy gauge saddles secured to suitable wood plug or other approved manner at an interval of not more than one metre but on either side of the coupler of bends or similar fittings. Saddles shall be fixed at a distance of 30cm from the centre of such fittings. The saddles shall not be less than 20 gauge for larger dia.

All conduits after erection shall be tested for electrical continuity.

Fixing of standard bends or elbows in roof slab shall be avoided and all curves maintained by bending the conduit itself with a long radius which will permit easy drawing of conductors.

Suitable junction/inspection boxes according to requirements shall be provided to permit periodical inspections and to facilitate replacement of wires. However, such boxes shall be located and arranged suitably so that they are not in irregular positions. These locations shall also be specifically shown in the conduit layout of the shop drawings and approval shall be obtained before installation.

However, such installations and the number of such boxes shall be minimised. The boxes shall be mounted flush with the wall or ceiling. Minimum 65 mm depth junction boxes shall be used in roof slabs and depth of boxes in other places shall be as per IS:2667-1977. All outlets such as switches, wall sockets, etc. shall be flush mounting type.

i. **Internal Illumination**

a **General**

Illumination system shall consist of lighting switches, power receptacles, distribution boards, sub distribution boards, complete with switch fuses, junction boxes, pull boxes, terminal blocks, glands, conduits and accessories (elbow, tees, crosses, bends, etc.) and supporting and anchoring materials, lighting fixtures complete with fluorescent tubes, incandescent lamps, mercury vapour lamps, sodium vapour lamps and lighting cables. All materials, fittings and appliances used in the electrical installation shall conform to the relevant IS specifications and shall be anticorrosive painted.

b **Illumination Levels**

The following minimum levels of illumination shall be provided in the respective areas:

	<u>AREA</u>	<u>ILLUMINATION LEVEL</u>
a)	Offices	300 Lux
b)	Switchgear Rooms	300 Lux
c)	Toilet, Staircase	100 Lux

d)	Substation - Transformer Room	200 Lux
e)	Generator Room	200 Lux
f)	Road	25 Lux

c **Lighting Equipment**

The specification covers distribution board, fittings, poles, switches, receptacles, conduits, wires, cables and miscellaneous hardware necessary for complete lighting work.

d **Light Fittings/Luminaries**

The fixtures/luminaries offered shall conform to IS: 10322 and comply with the following requirement:

- a) The fixtures shall be suitable for operation on a nominal supply of 240 Volts, single phase, 50 Hz voltage with variation of $\pm 10\%$.
- b) Fluorescent light fittings shall be of high power factor type and shall be supplied with control gear of all necessary accessories for mounting.
- c) The ballast shall be of the inductive and heavy duty type, filled with polyester or equivalent. They shall be free from hum and protected from the atmosphere. The ballast shall have low power loss. The ballasts shall conform to IS: 1534 (Part I).
- d) All other indoor areas shall be illuminated using fluorescent tube fixtures or high bay sodium vapour luminaire complete with reflectors. Office areas shall have decorative type fixtures. The luminaires/fixtures shall conform to IS: 10322.
- e) All lighting fixtures shall be supplied complete with fluorescent lamps and all necessary accessories for their satisfactory operation.
- f) Lighting fixture reflector shall generally be manufactured from sheet steel or aluminium of not less than 20 SWG. They shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools.
- g) Each fixture shall be complete with a four way terminal block for the connection and looping of incoming and outgoing supply cables. Each terminal shall be able to accept two 2.5 sq.mm solid copper conductor and shall be provided with a terminal suitable for earth wire.
- h) The enamel finish shall be non-porous and free from blemishes, blisters and fading.
- i) The fixture shall be free from scale, rust, sharp edges and burrs.
- j) All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified.

e **Receptacle Units**

Industrial type receptacle units of approved make of 15 A rating with switches conforming to IS: 3854 and sockets conforming to IS: 1293 shall be supplied. The units shall be suitable for mounting flush on stove enamelled sheet steel boxes generally conforming to IS: 5133 (Part I). The approximate quantities of various types of receptacles are given in the Bill of Quantities.

f **Ceiling Fan**

Ceiling fan shall be suitable for 230 V, 1 phase, 50 Hz and shall be completed with standard mounting accessories such as suspension rod top and bottom Canopy, electronic regulator, rubber reel etc. The fan shall conform to IS: 374. The electronic type fan regulator shall conform to IS: 11037. The general and

safety requirement for fans and regulators shall conform to IS: 12115.

g Exhaust Fan

Impeller shall be with blades of an aerofoil design. Blades shall be mounted on streamlined hub. Impeller shall be mounted directly on motor shaft.

Casing shall be of heavy gauge construction properly reinforced for rigidity. It shall be provided with suitable support.

In case of vane axial fans, guide vanes shall be provided on the discharge side.

Motor shall be totally enclosed. The speed of fan shall not exceed 1500 rpm.

Material of Construction

- | | | |
|----|--------------------|---------------------------|
| a) | Casing | Mild Steel |
| b) | Impeller | Mild Steel/Cast Aluminium |
| c) | Inlet/outlet cones | Mild Steel |

h Earthing

Each lighting fitting shall be provided with an earthing terminal suitable for connection to the earthing conductor.

All metal or metal enclosed parts of the housing shall be bounded and connected to the earthing terminal so as to ensure satisfactory earthing continuity through the fixture.

i Switches and Accessories

Switches

All switches shall be placed in the live conductor of the circuit and no single pole or fuse shall be inserted in the earth or earthed neutral conductor of the circuit. Single pole switches (other than for multiple control) carrying not more than 15 Amps may be of the piano type and the switch shall be 'ON' when the knob is down.

Lamp holders for use in brackets and the like shall have not less than 1.3 cm Nipple and all those for use with flexible pendant shall be provided with cord grips. All lamp holders shall be provided with shade carriers. Where centre contact Edison Screw lamp holders are used, the outer or screw contact shall be connected to the 'middle wire' or the neutral or to the earthed conductor of the circuit.

j Socket Out-lets

Each socket outlet 5 A and 15 Amps shall be controlled by a switch. The switch controlling socket outlet shall be on live side of the line. In an earthed system, socket outlets shall be 3 pin type with shutter so that unless earth pin contact is made, live pins should not be exposed. All switches shall conform to IS: 3854 and socket outlets to IS: 1293.

k Switch Boxes/Regulation Boxes/Laminated Sheets

The switch or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes, the wall thickness shall not be less than 16 gauge for boxes upto a size of 20 cm x 30 cm and above this size, 14 gauge MS boxes shall be used. Except where otherwise stated, 3 mm thick phenolic laminated sheets shall be fixed on the front with aluminium alloy/brass/cadmium plated iron screws as approved by the Purchaser. Clear depth of the box shall be minimum 60 mm and this shall be increased suitably to accommodate mounting

of fan regulators in flush pattern.

To facilitate drawing of wires in the conduit, G.I. fish wires of 16 SWG shall be provided with laying of recessed conduit.

11.0 EARTHING SYSTEM

11.1 General

Only Plate Earthing shall be adopted. The earthing and lightning protective systems shall comply with all currently applicable standards, regulations and safety codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the Bidder of this responsibility. Wherever the word GI is used it means that hot Dip GI.

Earthing Strip shall be of **hot dip GI** of size **50mmx6mm for Body & of Copper 50mmx6mm for Neutral** protected against corrosion and readily accessible. The strip shall be connected to earthing terminals with Stainless Steel nut – bolts. **The strip shall be clamped with Aluminum saddles and stainless steel nut-bolts. The Cost of Strip and required accessories, labour shall be included in the overall cost (offer).**

The installation work shall conform to the latest applicable Electricity Rules, standards (IS: 3043) and codes of practices.

- After award of the Contract, the Contractor shall, carry out soil resistivity measurements at the site. A detailed earthing design shall be submitted for approval based upon the results of these tests.
- The total resistance of the earth grid shall be less than 1 ohm.
- The earthing & lightning conductors and electrodes shall be supplied. Conductors shall be free from rust, scale and other electrical and mechanical defects and all materials used shall conform to relevant standards or approved by the Employer. The sizes, materials and quantity shall be as listed.
- Copper earthing stranded conductors shall be annealed soft drawn type. Copper earthing rods and flats shall be hard drawn type. Lead coating shall be provided on copper conductors to prevent its corrosion in aggressive environments.
- Steel earthing conductors above ground shall be hot-dip galvanized, unless otherwise stated, to prevent atmospheric corrosion. If painted steel conductors are required they shall be painted with two coats of approved anti-corrosive paint.
- Flexible braids of sizes & materials shall be supplied for earthing of operating handles of isolators and earthing of equipment on moving platforms.
- The links in suitable enclosures shall be supplied for connection between each lightning conductor down comer and earth electrode.
- Cad welding type jointing equipment shall be supplied whenever specifically indicated.

11.2 Scope of Installation Work

The successful Bidder shall install bare/insulated, copper/aluminium conductors, braids,

etc., required for system and individual equipment earthing. All work such as cutting, bending, supporting, painting/coating drilling, brazing/soldering/welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the scope of work. All incidental hardware and consumable such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bitumastic compound, anti-corrosive paint as required for the complete work shall be deemed to be included as part of the installation work.

The scope of installation of earth conductors in outdoor areas, buried in ground shall include excavation in earth upto 600 mm deep and 450 mm wide, laying of conductor at 600 mm depth (unless stated otherwise), brazing/welding/ cadwelding as reburied of main grid conductor joints as well as risers of 500 mm length above ground at required locations and backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. If the excavated soil is found unsuitable for backfilling, the Bidder shall arrange for suitable soil from outside.

The scope of installation of earth connection leads to equipment and risers on steel structures/walls shall include laying the conductors, welding/cleating at specified intervals, welding/brazing to the main earth grids' risers, bolting at equipment terminals and coating welded/brazed joints by bitumastic paint. Galvanized conductors shall be touched up with zinc rich paint where holds are drilled at site for bolting to equipment/structure.

The scope of installation of electrodes shall include installation of these electrodes such as (a) directly in earth, (b) in constructed earth pits, and connecting to main buried earth grid, as per enclosed drawings/relevant standards. The scope of work shall include excavation, construction of the earth pits including all materials required for construction of the earth pits and connecting to main earth grid conductors.

The scope of installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying, and fastening/cleating/welding of the down comers on the wall/columns of the building and connection to the test links above ground level.

Normally an earth electrode shall not be situated less than 2m from any building. Care shall be taken that the excavations for earth electrodes may not affect the column footing or foundation of the building. In such cases, electrodes may be further away from the building.

The location of the earth electrodes shall be such that the soil has reasonable chances of remaining moist, as far as possible. Entrances, pavements and roadways are definitely avoided for locating the earth electrodes.

The scope of installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.

11.3 Work Details

Earthing conductors along their run on walls and columns shall be supported by cleating/welding at intervals of 750 mm and 1000 mm respectively.

Wherever earthing conductors cross underground service ducts and pipes, it shall be laid 300 mm below; the earthing conductor shall be bounded to such service ducts/pipes.

Wherever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.

Suitable earth risers approved by the Engineer-in-Charge shall be provided above finished floor/ground level, if the equipment is not available at time of laying of the main earth conductors. The minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided shall be marked in

project drawings.

Earth leads and risers between equipment earthing terminals and the earthing grid shall follow as direct and short a path as possible.

Neutral connection shall never be used for the equipment earthing.

Each neutral point of a transformer shall be earthed to two separate earth electrodes for connection with earthing system.

Shield wire in sub-stations shall be connected to the earthing grid through test links at every alternate switchyard portal tower.

A separate earth electrode bed shall be provided adjacent to structures supporting lightning arrestors and coupling capacitors. Earth connections shall be as short and as straight as practicable. For arrestors mounted near transformers, earth conductors shall be located clear of the tank and coolers.

Wherever earthing conductor passes through walls, galvanized iron sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Bidder by suitable water proof compound. Water stops shall be provided wherever earthing conductor enters the building from outside below grade level. Water stops and above mentioned sleeves shall be provided by the Bidder.

11.4 Earthing Connections

All connections in the main earth conductors buried in earth/concrete shall be welded/brazed type. Connection between main earthing conductor and earth leads shall also be of welded/brazed type. Cadwelding type connections shall be done if specifically indicated.

Connection between earth leads and equipment shall be of bolted type, unless specified otherwise or shown in the drawings. Equipment Bidders shall provide earthing terminals on their equipment.

Welding and brazing operations and fluxes/alloys shall be of approved standards.

All connections shall be of low resistance. Contact resistances also shall be minimum.

All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.

Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

11.5 Earth Electrode

Electrodes shall as far as practicable, be embedded below permanent moisture level.

Electrodes shall be housed in test pits with concrete covers for periodic testing of earth resistivity. Installation of rod/pipe/plate electrodes in test pits shall be convenient for inspection, testing and watering wherever required.

11.6 Plate Earth Electrode

For plate electrode minimum dimension of the electrode shall be as under:-

i)GI plate electrode 60 cm x 60 cm x 10 mm thick

Heavy duty cast iron frame with cover shall be suitably embedded in the masonry.

Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in the layers of 250 mm thick uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the Bidder shall

arrange for a suitable soil from outside.

11.7 Method of Connecting Earthing Lead to Earth Electrode

In the case of plate earth electrodes, the earthing lead shall be securely bolted to the plate with two bolts, nuts, check-nuts and washers.

All materials used for connecting the earth lead with electrodes shall be GI in case of GI pipe and GI plate earth electrodes and of copper in case of copper pipe / plate electrodes.

The earthing lead shall be securely connected at the other end to the main board.

11.8 Size of Earthing Conductor

The earthing system shall be designed in such a way that over all earth resistance is less than one ohm. The soil resistivity shall be measured at site by the Bidder. If required, number of earth electrodes to be increased by the Bidder to achieve the required earth resistance.

12.0 DISMANTLING

Dismantling of existing 3.3 kV HT Panel, 415 Volts LT Panel, 3.3 kV / 415 Volt Transformer and other electrical gadgets installed inside existing wagon tippler sub-station including 3.3 kV & 1.1 grade HT & LT cables is not included in the scope of work of the contractor against the instant tender.

13.0 LIST OF APPROVED MAKES

SL.No.	ITEM	Name of Manufacturers
1	Transformer	VOLTAMP / BHARAT BIJLEE/CGL/SIEMENS/SCHNEIDER
2	VCB Panel	SIEMENS / ABB / SCHNEIDER
3	HT Cable	FINOLEX / RPG / APAR INDUSTRIES / TORRENT / HAVELLS / UNISTAR /POLYCAB
4	LT Cable (XLPE)	UNISTAR / FINOLEX/ HAVELLS / RPG / APAR INDUSTRIES/POLYCAB
5	Outdoor CT	SCHNEIDER / JYOTI / KAPPA / PRAGATHI
6	Outdoor PT	SCHNEIDER / JYOTI / KAPPA / PRAGATHI
7	Volt meter and Ammeter	AE / MECO / YOKINS / NIPPEN
8	LA	OBLUM / LAMCO / ELEKTROLITES
9	Load break switch Panel	A BOND STAND / ELTECH CONTROLS/ MEGAWIN
10	LT Panels	SIEMENS / L&T / SCHNEIDER / ABB
11	Cable St.through jointing / end Termination Kit	3M / RAYCHEM /DENSON
12	Battery	HBL/EXIDE/AMARON/ AMCO
13	Selector switches, Push buttons, Emergency Switches	KAYCEE / L & T / GE / BCH / LEGRAND

SL.No.	ITEM	Name of Manufacturers
14	HRC Fuses	L & T / GE / SIEMENS / ABB / INDO KOPP
15	Indicating light	AE / KAYCEE / VAISHNAV / L & T / SIEMENS
16	MCB	L & T / LEGRAND / SIEMENS / ABB / SCHNEIDER
17	Sub Distribution Board	L & T / LEGRAND / SIEMENS / SCHNEIDER / HENSEL
18	EL MCB	L & T / SCHNEIDER / LEGRAND / SIEMENS / ABB
19	PVC insulated copper conductor single/multi core stranded wires of 650/1100 volt grade	HAVELLS / FINOLEX / RPG / UNIFLEX / NICCO / RR Kables
20	Steel Conduit/PVC Conduit	BEC / AKG / NIC
21	Switches, TV & Telephone Socket outlets, Boxes	MK / CLIPSAL / LEGRAND / NORTH WEST / ANCHOR
22	Light Fixtures(LED)	PHILIPS / BAJAJ / WIPRO / CROMPTON/HAVELLS
23	Ceiling fans/Wall bracket fans / Exhaust Fans	HAVELLS / CROMPTON GREAVES / USHA / ORIENTAL
24	Cable lug & Cable Gland	DOWELLS / JHONSON / RAYCHEM
25	Terminal Blocks	WAGO & CONTROLS / PHOENIX CONTACTS / OBO BETTERMANN
26	Lightning Protection	DUVAL MESSIEN / SOUTH ASIAN ENTERPRISE LTD. / OBO BETTERMANN
27	Multi-function Meter	ABB / SIEMENS / L&T / HPL SOCOMEC/CONZERVE (ENERCON)
28	DWC HDPE Pipe	DURA LINE / CARLON / EMTELLE
29	Contactors	L&T / SCHNEIDER / SIEMENS/ABB / BCH
30	MCCB	L&T / SIEMENS / SCHNEIDER / ABB
31	Push Buttons	SIEMENS / ABB / TELEMECANIQUE / L&T / SCHNEIDER
32	Relays	L&T / ABB / SIEMENS / SCHNEIDER/AREVA
33	Timers	L&T / SIEMENS / TELEMECANIQUE/ABB
34	Indicating Light	L&T / SIEMENS / TELEMECANIQUE / ABB / GE
35	Indicating Instruments	AE / MECO / CONZERVE / L&T

SL.No.	ITEM	Name of Manufacturers
36	Panel CTs	L&T / AREVA / JYOTI / KAPPA / PRAGATHI
37	Panel PTs	AREVA / KAPPA / PRAGATHI
38	ACB	SCHNEIDER / SIEMENS / ABB / L&T
39	Selector Switch	KAYCEE / L&T / SIEMENS / BCH / GE / SALZAR
40	Capacitor Banks	EPCOS / L&T / UNIVERSAL/ABB
41	Trivector Meter (Digital)	L&T / SCHNEIDER / SIEMENS / HPL SOCOMEC
42	Capacitor Panels	ABB / L&T / EPCOS / SCHNEIDER
43	Power Factor Correction Relay	EPCOS / L & T / ABB
44	Elastomeric Mat	PREMIER POLYFILM LTD / POLYELECTROSAFE / CHALLENGER
45	Structure	JINDAL/ SAIL / TISCO
46	MS & GI Conduits Accessories	STEEL MARK / NIC
47	Items not covered above	As per samples approved

14.0 INSPECTION AND TESTING.

Equipment will be duly inspected in the manufacturer's works / premises **by TPI Agency** before dispatch to the site. **Cost of TPI Agency will be borne by the Port.**

Inspection of the items to be supplied by the contractor will be carried out **by the TPI Agency or representative of Engineer prior to despatch**, as per the procedure mentioned in the for the relevant Item. Such inspection will be carried out within 10 days from the date of receipt of Inspection Call from the contractor.

The Engineer of the Contract reserves the right to waive inspection at Manufacturer's premises (witnessing tests) and to inspect (physically) the materials at site, after delivery, against Manufacturer's Internal Test Certificate.

The job of installation and commissioning will be inspected by the **representative of Engineer in different stages** and also after completion of the job. For this, the contractor shall have to submit a **Field Quality Assurance Plan (FQAP)**, which will be subsequently approved by the Engineer and the inspection will be carried out in accordance with the approved FQAP.

Inspection and Testing by the representative of General Manager (Engg.) shall not relieve the successful bidder of their obligation for supplying the items and execution of the entire work in accordance with the **Contract Condition** and relevant **Acts, Rules and Codes of Practice**

14.1 30 V DC Battery Bank:

The Battery Bank will be inspected at site, after delivery, by **the TPI Agency or the representative of Engineer**, based on Manufacturer's Internal Test Certificate.

14.2 **Battery Charger:**

The Battery Chargers will be inspected at site, after delivery, by **the TPI Agency** or the representative of Engineer, based on Manufacturer's Internal Test Certificate.

14.3 **HT XLPE Cables :**

Following tests will be witnessed by **the TPI Agency** or the representative of Engineer at Manufacturer's works before despatch:

a) **Routine Tests** as per IS:7098-II

b) **Acceptance Tests** as per IS:7098-II

Manufacturer's Certificate for **Type Test** (as per IS: 7098), for similar type cable, should be made available to **the TPI Agency** or the representative of Engineer during the above inspection.

14.4 **6000 KVA, 33 KV / 3.3 KV, 3 Phase, 50 Hz Transformer :**

a) **Routine Tests** and **Temperature Rise Test** (as per IS:2026) will be witnessed by **the TPI Agency** or the representative of Engineer at Manufacturer's works before despatch

b) Manufacturer's Certificate for **Type Test** (as per IS: 2026), for any Transformer of at least 33 KV, 6000 KVA rating, should be made available to **the TPI Agency** or the representative of Engineer during the above inspection. In addition to the above, Radiator Banks, Pressure and Vacuum test of the Transformer tank to be tested as per CBIP Manual during manufacturing and test reports shall be submitted during final inspection.

14.5 **6000 KVA, 33 KV / 11 KV, 3 Phase, 50 Hz Transformer :**

a) **Routine Tests** and **Temperature Rise Test** (as per IS:2026) will be witnessed by **the TPI Agency** or the representative of Engineer at Manufacturer's works before despatch

b) Manufacturer's Certificate for **Type Test** (as per IS: 2026), for any Transformer of at least 33 KV, 6000 KVA rating, should be made available to **the TPI Agency** or the representative of Engineer during the above inspection. In addition to the above, Radiator Banks, Pressure and Vacuum test of the Transformer tank to be tested as per CBIP Manual during manufacturing and test reports shall be submitted during final inspection.

14.6 **1000 KVA, 11 KV/3.3KV / 0.433 KV, 3 Phase, 50 Hz Transformer:**

a) **Routine Tests** and **Temperature Rise Test** (as per IS:2026) will be witnessed by **the TPI Agency** or the representative of Engineer at Manufacturer's works before despatch

b) Manufacturer's Certificate for **Type Test** (as per IS: 2026), for any Transformer of at least 11 KV, 1000 KVA rating, should be made available to **the TPI Agency** or the representative of Engineer during the above inspection. In addition to the above, Radiator Banks, Pressure and Vacuum test of the Transformer tank to be tested as per CBIP Manual during manufacturing and test reports shall be submitted during final inspection.

14.7 **Vacuum Circuit Breaker Panel**

Vacuum Circuit Breaker units:

a) **Routine Tests** (as per IS: 13118) will be witnessed by **the TPI Agency** or the representative of Engineer at Manufacturer's works before despatch.

b) Manufacturer's Certificate for **Type Test** (as per IS: 13118), for similar type equipments, should be made available to **the TPI Agency** or the representative of Engineer during the above inspection.

Current Transformers:

Following tests will be witnessed by **the TPI Agency or** the representative of Engineer at Manufacturer's works before despatch:-

- a) **Routine Tests** as per IS: 2705.
- b) **Verification of Terminal Markings and Polarity** as per IS:2705

Manufacturer's Certificate for **Type Test** (as per IS: 2705), for similar type equipments, should be made available to **the TPI Agency or** the representative of Engineer during the above inspection.

Potential Transformer:

Following tests will be witnessed by **the TPI Agency or** the representative of Engineer at Manufacturer's works before despatch:

- a) **Routine Tests** as per IS:3156
- b) **Verification of Terminal Markings and Polarity** as per IS:3156

Manufacturer's Certificate for **Type Test** (as per IS: 3156), for similar type equipments, should be made available to **the TPI Agency or** the representative of Engineer during the above inspection.

Complete VCB Panel:

Inspection will be carried out by **the TPI Agency or** the representative of Engineer before despatch. Manufacturers' Test Certificates for the components like **Relays, Ammeter, Voltmeter, Static KWH Meter & Maximum Demand Meter**, should be made available to **the TPI Agency or** the representative of Engineer during the above inspection.

14.8 LT Panel:

Following tests will be witnessed by **the TPI Agency or** the representative of Engineer at Manufacturer's works before despatch:-

- a) **Routine Tests** as per IS: 8623.
- b) Type test certificate for similar type & Rating of LT Panels be submitted by successful tenderer.

Manufacturer's Certificate for **Type Test** (as per IS: 8623), for similar type equipments, should be made available to **the TPI Agency or** the representative of Engineer during the above inspection.

14.9 LT Bus Duct:

The Bus Ducts will be inspected at site, after delivery, by **the TPI Agency or** the representative of Engineer, based on Manufacturer's Internal Test Certificate and fitment certificate.

14.10 LT Cables:

The LT Cables will be inspected at site, after delivery, by **the TPI Agency or** the representative of Engineer, based on Manufacturer's Internal routine Test Certificate as per IS:7098-I.

14.11 APFC Panel:

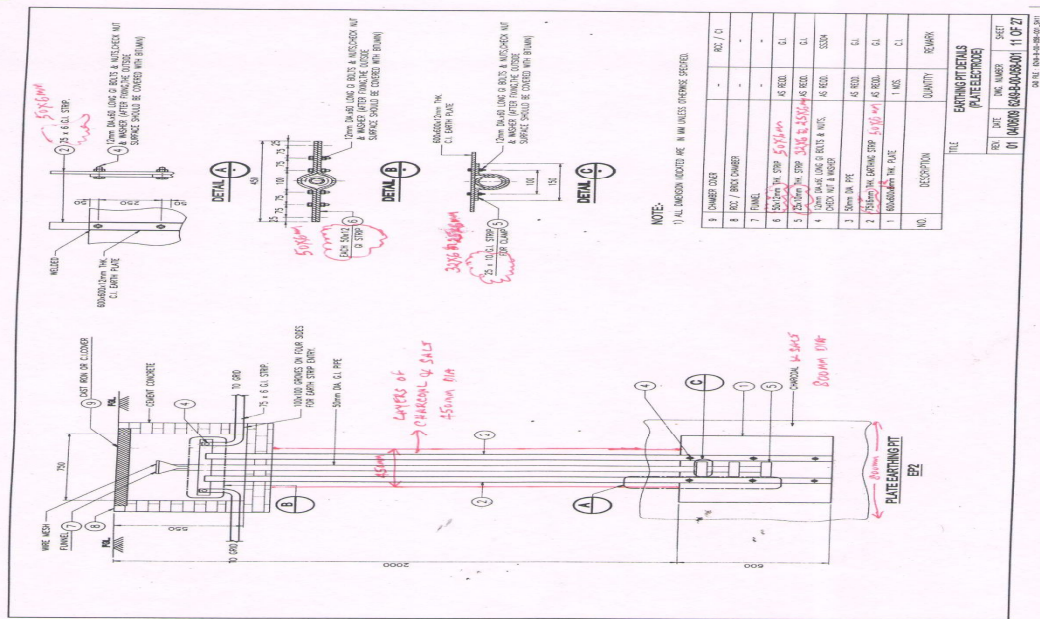
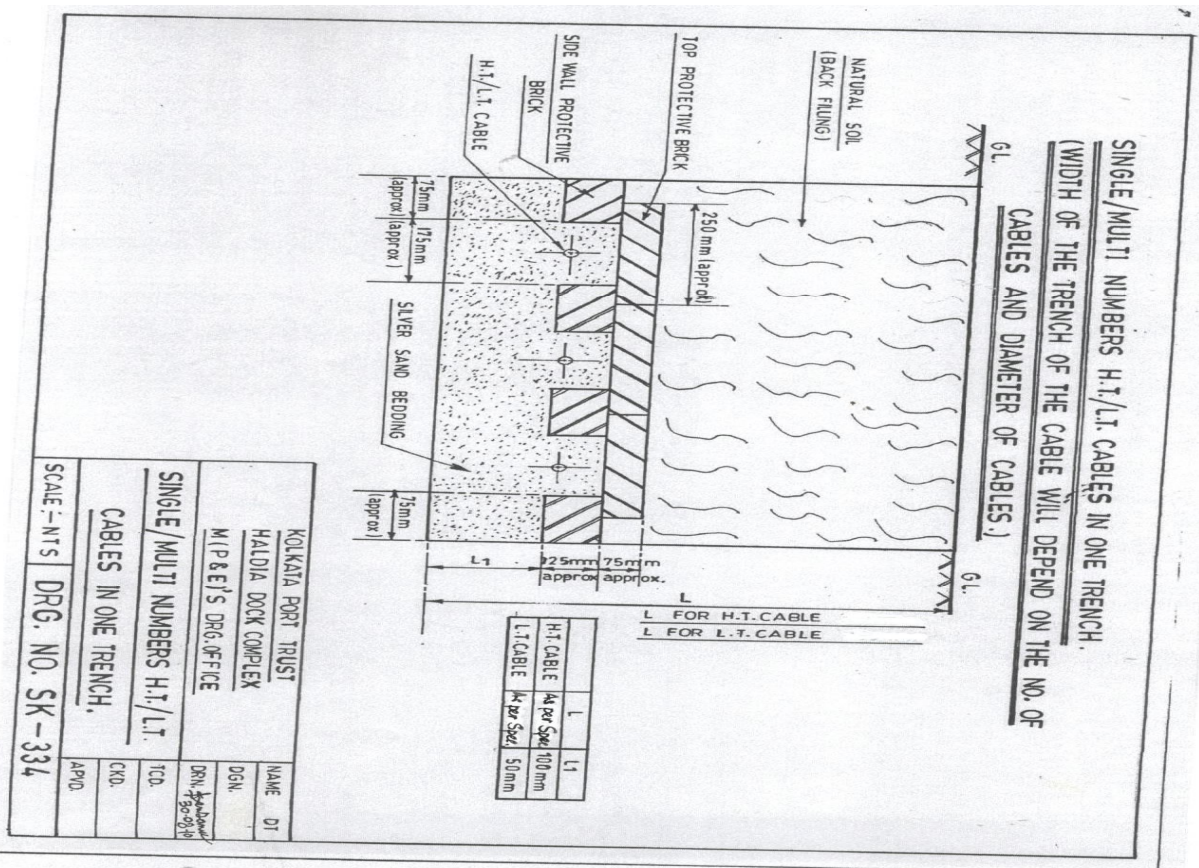
Following tests will be witnessed by **the TPI Agency or** the representative of Engineer at Manufacturer's works before despatch:

- a) **Routine Tests** as per IS.

Manufacturer's Certificate for **Type Test**, for similar type equipments, should be made available to **the TPI Agency or** the representative of Engineer during the above inspection.

14.12 St. through and end termination jointing kits:

The kits will be inspected at site, after delivery, by **the TPI Agency or** the representative of Engineer, based on Manufacturer's Internal routine Test Certificate as per IS: 7098-I.

**EARTH PIT****CABLE LAYING**