

TECHNICAL INFORMATIONS

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1.0 INTRODUCTION:

The NOCCI Balasore Infrastructure Company (NBIC)) is revamping power distribution infrastructure in industrial estates of Balasore, Orissa under Industrial Infrastructure Upgradation Scheme (IIUS) of Government of India .The total work is divided in two packages.

Package 1: Upgradation of Power Distribution Infrastructure at Ganeswarpur

Package 2: Upgradation of Power Distribution Infrastructure at Somnathpur

The total work in each package has been divided into three parts viz.

Part-A: Design, fabrication and supply of electrical equipments along with allied components like cables etc

Part-B: Installation, testing & commissioning of equipments along with allied components including civil works like foundation, control rooms etc.

Part-C: Civil works.

The contractor shall undertake the complete work and there shall not be any exclusion whatsoever of any PART. It is understood that any minor work, which may not be explicitly detailed but is necessary for the proper functioning of the individual equipment or infrastructure as a whole, is included in the scope of work without any additional cost.

The general technical specification of the major components and the ancillary item described in the technical section and the equipment, its capacities and quantity proposed by the Purchaser is furnished in the design data and schedule of quantities are for the guidance of the contractor only. However, contractor had been requested to get themselves familiarized / acquainted about the nature and the quantum of work involved before submitting its offer without deviating the basic requirement of the packages.

The quantity of cables, cable trays, earthing, instruments, supporting structure etc are to be provided based on the actual requirement at site. The contractor has to work out the substation layout, site layout and schematic diagram exact details based on the system offered and submit the same for the approval of the purchaser.

Water for installation shall be provided at one point within the site, free of charge.

Electricity for installation has to be arranged by the supplier. However, if the power is provided by the Purchaser, **the recovery shall be made @ 0.5% of the total purchase order value.**

Completion period : 7 (Seven) months from the date of order.

Foundation and other civil works shall be provided by the contractor.

2.0 PROJECT SITE DETAILS:

Name of the project	Revamping of Power Infrastructure of Industrial Estates in Balasore
Project Authority/Owner	NOCCI Balasore Infrastructure Company
Site Address	Ganeswarpur Industrial Estate Balasore – 756019 District – Balasore (Orissa)
Nearest Railway Station.	Balasore
Nearest airport	Kolkata/Bhubaneswar
Nearest City	Balasore

THE EQUIPMENT TO BE SUPPLIED AND INSTALLED BY THE CONTRACTOR MUST BE SUITABLE FOR CONTINUOUS OPERATION UNDER VARYING CLIMATIC CONDITIONS AT THE PROJECT SITE.

TROPICALISATION :

All equipment supplied against these specifications shall be given tropical treatment in view of the severe climatic conditions prevailing at the site. Tropical protection shall conform to **BS:CP:1014:1963 entitled Protection of Electrical Equipment against Climatic Conditions OR IS: 3202**

3.0 SCOPE OF WORK:

PACKAGE 1:

Ganeswarpur I.E.:

The scope of work at Ganeswarpur is as follows

1. Supply & installation of 4 Run of single core 11KV XLPE 300mm² armoured cable from 33/11 KV substation in prepared trench along the existing 11 KV overhead line inside Ganeswarpur I:E including end termination & take off arrangements at the substation.
2. Supply & Installation of cable joint kit & 95 mm² XLPE armoured cable for power supply to individual distribution transformers from the main underground cable including road crossing cable support structure & out door end termination.
3. Supply & Installation of 1 no. 11 KV outdoor VCB with control & relay panel, isolating device foundation etc. complete for power supply to the underground cable system.

Single line diagram for existing 11 KV power distribution inside Ganeswarpur I:E is furnished for reference.

PACKAGE 2:

Somnathpur I.E.:

The project requirement for Somnathpur I:E is to design, manufacture & supplying of all equipments, materials required for 1x5 MVA new 33/11KV substation including complete

erection testing, commissioning, energization & hand over installation with detailed inventory for operation & maintenance to NESCO. The scope of work is as follows:

1. Develop 2000 sq metre land with approach road and boundary wall with barbedwire fencing on top and main gate for new 33/11 KV substation.
2. Switch yard for 33 KV, 11 KV & all equipment foundation to be erected with Galvanized MS lattice structure for gentry tower, beams& lighting tower.
3. 33 KV switch yard to have 3 bays, one for 33 KV incoming 2nd for Transformer incomer & the 3rd for future extension for 2nd power transformer.
4. Installation of 1 no. 5 MVA 33/11KV power transformer.
5. 11 KV switch yard to have 4 bays, 1 for incomer & 3 for outgoing feeders.
6. One no. 250 KVA, 33/0.4 KV transformer is to be installed for power supply requirement of the substation & for extending power supply to NBIC Facility at Ganeswarpur.
7. One control room of size 12m x 10 m is to be erected to house control panels for 33 KV & 11 KV switch gears, battery with charger DCDB & ACDB Panel.
8. Provision for adequate lighting for control room as well as switch yard.
9. Provision for bore well with submersible motor for water supply in the substation area.
10. Safety equipments & tools & Plants for operation maintenance for the substation.
11. Any other equipment or provision not specifically mentioned but required for smooth operation & maintenance of the substation.

Design, engineering, manufacture, testing, supply including transportation to site, insurance, storage, installation, testing and commissioning of the following equipment/items, complete in all respects.

- (a) 1 No 5MVA, 33/11 kV, 3-phase Transformer shall be installed in the new location at Somnathpur. The foundation for 5 MVA Transformer shall be so designed that it should be capable of withstanding the load for 5 MVA transformer at all severe conditions.
- (b) Complete set of 11 kV VCB outdoor Switchgear with circuit breakers, current transformers, protective relaying, meters, indicating lamps etc. complete as required and as per specifications at Somnathpur. The 11KV structure shall have 3nos 11kV outgoing feeders . One number 250 KVA 33/0.415 KV , transformer for use as structure transformer and power supply to NBIC project area.

The 33 KV switchyard, VCB , power transformer 5 MVA 33/11KV and all 11KV switchyard and VCB's shall be all outdoor type.
- (c) Complete outdoor Substation with 33 KV Vacuum Circuit Breakers, Current Transformers, Voltage Transformers / Potential Transformers, Horizontal Central Break(HCB) Isolator, Surge Arrester etc. along with the steel structures
The Contractor shall prepare new layout for 33KV switchyard and submit for approval to the NBIC.
- (d) Complete control, relay and protection system, energy meters on all 33 kV and 11 kV incoming and outgoing feeders.
- (e) LT switchgear (AC/DC Distribution boards, Lighting DBs etc). These boards shall have adequate number of feeders to cater to required loads.
- (f) One set each of 24 Volt Battery and Battery Charger. The batteries shall be of Plante type Lead Acid with transparent containers. The minimum AH rating of batteries shall be 80 AH for 24 Volt systems. Contractor shall furnish all calculations for ratings /sizing of batteries and battery chargers during detailed engineering.

- (g) 1.1 kV grade XLPE, PVC Power cables and PVC control copper cables along with complete accessories. (Size of cables to be used by the Contractor shall be supported by calculations duly approved by the Employer).
- (i) Bus Post Insulators, insulator strings and hardware, clamps and connectors, conductor and earth wire, Bus bar and earthing materials, Bay marshalling box, spacers, cable supporting angles/channels, Cable trays and covers, Junction box, buried cable trenches etc.
- (j) Complete lighting and illumination of the Switchyard (including approach road and all peripheral roads in switchyard) and Control Room building . Also ceiling fan/ Exhaust fan should be provided in the control room. Lighting calculations to be submitted by the contractor during detailed engineering.
- (k) Terminal connectors of all types.
- (l) Any other equipment/material required to complete the turnkey works

Civil Works - The work shall include but not limited to the following:
Civil Works for:

- (a) Foundation for all Transformers.
- (b) Foundation for equipment, gantries, Lattice structures, lighting poles, CT, PT, VCB, LA etc., panels and control cubicles of equipment wherever required.
- (c) Cable trenches in the switchyard and control room building along with covers and sump pits.
- (d) Roads from main gate to Control Room and compound wall shall be in the scope of Contract. All roads shall be with black topping.
- (e) Stone spreading and anti weed treatment of substation area.
- (f) Drainage system with necessary slope protections in the substation.
- (g) Construction of Control Room Buildings. The construction shall involve phase wise construction as per the direction of NBIC. The design and drawing of control room building will be prepared by the successful bidder and shall provide necessary supporting design calculations for Employer's approval.

The Bidder should survey the route of transportation and site conditions. The supply and transportation of the equipment are to be planned accordingly. The bidders are advised to visit the site.

The Bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the successful erection, testing and commissioning of the equipment in all respects. All materials required for the Civil and construction/installation work shall be supplied by the Contractor. The Contractor shall also supply the cement and steel and all materials required.

Common for all Packages:

The scope of work includes design, fabrication, supply, installation, testing and commissioning of all equipment, cabling and earthing etc. of complete upgradation as per the general technical specifications and the schedule of quantities mentioned in these work packages.

The contractor shall be responsible for designing and developing the conceptual layout, Power and Control Wiring diagram etc., to ensure that the system is installed with minimum investment and least operating cost to meet all the quality standards as well as to fulfill the design data and technical specifications specified in the bidding document. The work shall be carried out with the best quality materials and in a best workmanship manner, strictly in conformity with the specifications mentioned hereunder.

The system shall be designed, supplied and executed in accordance with prevailing and applicable

- Bureau of Indian Standards
- Indian Electricity Rules
- Indian Electricity Act
- Fire Insurance Regulations
- Indian Factory Act
- State Statutory Requirement

and any other applicable Indian Act. Wherever Indian Standards are not available / applicable, the contractor shall follow International Standards. In case of non-availability / applicability of both the standards mentioned above, DIN, British or American Standards shall be used.

The supplier shall be responsible for arranging approval from various Central and State Statutory Authorities viz. Electrical Inspectorate, etc., for the entire electrical execution carried out by them on behalf of the Purchaser / Owner. Submission of filled-in application and pro-forma furnishing all the necessary details, drawings, test reports to the appropriate authorities shall be the responsibility of the Supplier. The actual prescribed statutory fees shall, however, be reimbursed by the Purchaser on production of money-receipt.

The technical specification for supply and installation for upgradation has been specified in few sections and brief content of each of these is given under Design Data.

The scope of work includes DESIGN, SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF EQUIPMENT FOR UPGRADATION OF POWER SUPPLY INFRASTRUCTURE for package A, B and C respectively as mentioned in the schedule of quantities.

The Scope also includes Operation, Maintenance and Training for one year for respective package.

The Contractor shall ensure performance tests be carried out in the presence of and to the satisfaction of purchaser. Necessary test kits required for performance test shall be arranged by the contractor.

Contractor shall ensure satisfactory performance and after sales service of bought-out items.

The Contractor shall impart necessary training to the plant personnel on operation and maintenance of the equipment.

Detailed Preventive maintenance schedule as well as operational manuals of equipment shall be provided by the Supplier at the time commissioning:

The manual shall cover the following aspects:

- Start up, commissioning, normal operation, emergency operation.
- Trouble shooting chart covering operational status, reasons (causes) and actions to be taken (remedy)
- As-built drawings of the equipment, electrical schematic, controls wiring drawings, etc

Manuals and drawings are to be supplied as follows:

- 4 Sets of drawings and manuals in hard copy
- 3 Sets of drawings and manuals in CDs (softcopy)

Note :

Scope of cables laying includes providing necessary terminating lugs and glands including termination with respective PCC, MCC.

CPRI approved panel boards should be supplied. Necessary proof (short circuit test, temperature rise test and ingress protection test reports) to this effect are to be submitted and NBIC's approval is to be obtained prior to taking up the panel fabrication work.

4.0 SCHEMATIC DIAGRAM & DESCRIPTION:

The supplier / contractor has to design and develop the schematic diagram based on major parameters specified in bidding document.

The supplier / contractor has to submit the building plan drawing showing the tentative layout of equipment and schematic single line diagram for feeder details of HT and LT power control centres and the conceptual schematic diagram of the complete electrical installation and how the electrical energy shall be received from Local Electricity Supply Authority / State Electricity Board and distributed. This needs to be submitted along with the bid.

For Package 1:

1. The UG cable trenches shall be routed mainly on the other side of the road of the existing 11KV OH line clearing the existing UG water lines etc.
2. Power supply to the existing consumers will be provided from the new cable line through Feeder Pillar.

For Package 2 :

33 KV HT Power shall be received within the project site through overhead line of NESCO. HT Power shall be taken from DP to the proposed structure through outdoor breaker and metering unit. The step down power transformer will receive supply from the structure and feed to individual feeders through outdoor independent VCB's as specified in the design data. Necessary protection through relays and interlocking shall be provided in HT Panel and PCC.

The Contractor shall submit the execution drawings for approval of NBIC before commencing the work.

EQUIPMENT SPECIFICATION

This section provides general technical specification of all major equipment required. It may be noted that specifications of the equipment mentioned are very brief and the contractor is to design, manufacture, supply and install the complete system to ensure the best performance of the individual equipment as well as the complete system.

IRRESPECTIVE OF WHETHER THE SPECIFICATION OF AN EQUIPMENT OR ACCESSORY IS MENTIONED OR NOT IN THIS SECTION OR SCHEMATIC DIAGRAM, ALL THE EQUIPMENT AND ACCESSORIES REQUIRED TO MEET THE DESIGN DATA WITHIN THE BATTERY LIMITS SHALL BE SUPPLIED INSTALLED AND COMMISSIONED BY THE SUPPLIER.

5.0 DESIGN DATA :

This section gives brief design data of upgradation such as voltages, capacities and special requirements of important equipment.

5.1 General Basic Requirements :

- DESIGN AND LAYOUT SHOULD BE SUITABLE FOR EASY EXPANSION IN FUTURE
- DESIGN, EQUIPMENT AND LAYOUT TO OFFER MAXIMUM EASE OF MAINTENANCE AND OPERATION
- ALL EQUIPMENT PARTS REQUIRING MAINTENANCE SHOULD BE EASILY ACCESSIBLE

5.2 Specific Project Requirement :

Package 1:

Power Supply

INCOMING FROM NESCO	11 KV +/- 10 %, 50 HZ, 3 PHASE, 3 WIRE EARTHED SYSTEM
LAYING OF UNDERGROUND CABLE	11KV
LAYING OF OVERHEAD AB CABLE	11KV

Package2:

Power Supply

INCOMING FROM NESCO	33 KV+5%--15% , 50 HZ, 3 PHASE, 3 WIRE EARTHED SYSTEM
MOTIVE POWER FOR PROJECT	11KV, 50 HZ, 3 PHASE, 3WIRE EARTHED SYSTEM

LIGHTING POWER FOR PROJECT	415V, 50 HZ, 3 PHASE, 4 WIRE EARTHED SYSTEM
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5.3 **Equipment Details :**

5.3.1 **Electric Pole Structure** : Double Pole

5.3.2 **HT Panel Feeder Details** : The VCB shall be complete with protective relays as per technical specification. Type of VCB :33 KV Outdoor and 11KV Outdoor.

5.3.3 **Battery & Battery Charger** : 24V, suitable AH as specified above.

5.3.4 **Distribution Transformer** :

PACKAGE 2

The transformer rating and type shall be as under:	
Capacity	5000 KVA
Frequency	50 C/s
Voltage Primary	33KVolts
Voltage Secondary	11KVolts
Phase	Three
Installation	Outdoor
Type	ONAN cooled
Primary/Secondary power connection details	
Primary side conductor	232 sqmm
Secondary side conductor	XLPE

5.3.5 **LT Power Control Centre :**

P.C.C. Operation	Only from Front
Incoming feeder suitable for receiving power through	Bus Ducts from Transformers & Aluminium armoured cables from DG Sets

5.3.6 **Cables :**

HT Power cable	11 kV grade, XLPE
HT Power cable	33KV grade XLPE
Size	For incoming feeder : 2x3C x 300 mm ² For outgoing feeder : 2x3C x 240 mm ²
LT Power Cable	1.1 kV grade, XLPE, Armoured Aluminium conductor
Size & no. of runs	Shall be as per the drawing approved by NBIC
LT Control Cable	1.1 KV grade Armoured copper conductor
Size & no. of runs	Shall be as per the drawing approved by NBIC

5.3.7 Earthing Pits & Earthing strips :

Plate Earth pits for Body earthing of Sub-station Equipment including DG set	8 Nos. connected in ring main system
Copper Plate Earth pit for Neutral Earthing of Transformers & DG Set	6 Nos.
Copper Earth conducting strip of cross-section	As per statutory and site requirement
G I Earth conducting strip of cross-section	As per statutory and site requirement

5.3.8 **Electrical Grade Neoprene Mats (minimum 12 mm thick) : one lot** as per statutory and site requirement

5.3.9 TECHNICAL SPECIFICATIONS OF SUB-STATION EQUIPMENT

6.0 FOUR POLE STRUCTURE FOR HIGH VOLTAGE :

This is required to receive medium voltage i.e., 33 kV electric supply from NESCO, control and feed it to HT Circuit Breaker panel. The structure would comprise of :

- (i) 4 nos. – ISMB 200 x 100 mm, 10 M long each with necessary cross MS channels 75 x 40 mm and 3 M long each (12 nos. minimum) fitted to these **for four pole structure.**
- (ii) 3 nos. – Lightning arrestor, pole-mounted type suitable for high voltage, 50 Hz. AC supply with necessary copper strip clamps, bolts etc. for earthing.
- (iii) 1 set - HT pin insulators with metal parts complete.
- (iv) 1 set - HT disc insulator with metal parts complete, conforming to IS: 2544-1963 (read with latest revision, if any) and IS: 731-1963 (read with latest revision, if any).
- (v) 2 set - HT double break, triple pole, gang operated air break switch unit with suitable HT drop out fuses, operating rod of suitable length, conforming to IS: 1818-1972 (read with latest revision, if any) and complete with copper chain for earthing and earthing rod **for Four Pole Structure.** Suitable arrangement for providing lock to the switch in both 'ON' & 'OFF' positions.
- (vi) 1 lot – Necessary jumpers, aluminium conductors with PG clamps and connectors etc. complete for interconnections up to SEB structure.
- (vii) 2 nos. – Cable end box **for Four Pole Structure**, epoxy type complete with all consumables, suitable for 11 KV, 50 Hz. 3 X 240 sq mm HT XLPE cable
- (viii) 1 lot - HT danger plates of required size and anti-climbing device as per prevailing statutory regulations **for Four Pole Structure**

6.1 Remarks :

Earthing pits and earthing strips etc. shall be supplied under different items of works mentioned in schedule of quantities and cost of these shall not be included under these items.

Note: Cables shall be laid underground & on suitable cable trays in the masonry trenches.

6.2 HT PANEL:

The indoor type HT panel is required to receive HT grid power from four-pole structure and to supply it to transformer.

6.2.1 Design Requirements and Scope of Supply :

The HT panels shall be connected to each other by common bus bar chamber. One VCB panel out of these shall act as an incoming feeder for receiving HT power from the NECO and remaining as outgoing feeders for feeding HT power to transformers. **The manufacturer of the panel must possess a type test certificate / accreditation from CPRI.**

6.2.2 Vacuum Circuit Breaker (VCB) :

The VCB shall be free standing, floor mounted, metal clad, fully compartmentalized draw-out type suitable for indoor use and for the rating specified in the feeder schedule, efficiently earthed neutral system having a fault level and voltage rating as specified in the data sheet and comprising of housing for breaker, mechanical interlocks to prevent insertion or withdrawal of the circuit breaker in its closed position with automatic safety shutters covering the fixed main contacts when the circuit breaker is withdrawn, with earthing rails for earthing of circuit breaker carriage in service and test position, isolating plugs and VCB trolley with vacuum interrupters and self aligning finger type isolating contacts suitable for horizontal draw out and vertical or horizontal isolation. The vacuum circuit breaker shall be designed with low switching-over voltage levels and with a long switching life. The interrupter shall be leak-free, with a target value of vacuum life of 20 years. The breaker feeder trolley shall remain inside the cubicle even in the “Test” position. The complete breaker assembly should have their inter-changeability with breakers of identical ratings.

Busbars shall be high conductivity aluminium/copper supported on insulators made of non-hygroscopic, non-inflammable materials.

Closing coils shall operate satisfactorily in the control voltage range of 85 – 110% and tripping coil shall operate in the control voltage range of 70 – 110%. Closing coil & tripping coil shall be rated for continuous operating voltage.

Suitable interlocking shall be provided to prevent faulty operation such as :

- “Plugging in” or “drawing out” of a closed breaker
- “Plugging in” a breaker with the earthing isolator closed
- “Closing” of the earthing isolator with the breaker “plugged in”
- Pulling out the auxiliary circuit plug with the breaker in the service position
- Pushing in the breaker to the service position, with the auxiliary circuit plug not in position

The VCB shall be complete with :

- Independent spring closing, spring tripping, vacuum restrike free, trip free, stored energy operated type and **electric operated (motorized)** with breaker “CLOSE / OPEN” & spring “CHARGED / DISCHARGED” indication and with mechanical operation counter.
- Electrical closing coil suitable for 110 V AC supply

- Shunt trip coil suitable for 110 V DC supply.
- Breaker operated auxiliary switch with 4 NO and 4 NC contacts.

For each outgoing VCB, provision of contacts for the below mentioned faults / alarms should be made for remote annunciation purpose :

- Over load alarm and trip contacts
- Short circuit alarm and trip contacts
- Two numbers single phase 230 V space heater with switch.
- Three nos. single phase fixed type PT with voltage ratio 11 KV / 110 Volts AC, burden 100 VA, class of accuracy 0.5 and as per IS 3156. Voltage transformer shall be dry type, cast resin encapsulated construction with current limiting HRC fuses on both primary and secondary sides for protection. It shall be used for metering purpose and would be required for incoming VCB only.
- Single phase, wound type cast epoxy resin insulated current transformer for each phase as per IS: 2705 with following specifications and STR of 18.4 kA for 2 seconds.

For incoming & transformer feeding VCBs

For metering

CT ratio (Amp)	: Suitable as per the rating of VCB
Class of accuracy	: 1.0
Burden	: 15 VA minimum

For protection

CT ratio (Amp)	: Suitable as per the rating of VCB
Class of accuracy	: 5 P 10
Burden	: 15 VA minimum

However, if the supplier / panel manufacturer chooses to supply two core type CTs for protection & metering, they shall be as per the details given below :

For incoming VCB (Two core type)

CT ratio (Amp)	: Suitable as per the rating of VCB
Class of accuracy for core 1	: 1.0 (for panel metering)
Burden	: 10 VA
Class of accuracy for core 2	: 5 P 10 (for protection)
Burden	: 15 VA

For VCB feeding transformer (Two core type)

CT ratio	: Suitable for transformer rating
Class of accuracy for core 1	: 1.0 (for panel metering)
Class of accuracy for core 2	: 5 P 10 (for protection)
Burden	: 15 VA

Instrument panel fitted with :

- **Digital ammeter** of size 96 mm x 96 mm, flush mounted, with 3½ digit LCD or LED display, to be provided to indicate three phase current for incoming as well as outgoing panels
- **Digital voltmeter** of size 96 mm x 96 mm, flush mounted, with 3½ digit LCD or LED display, to be provided to indicate three phase voltage for incoming panel only
- **Load Manager with LCD display** for measurement and monitoring of Multifunctional Electrical Parameters such as voltage, current, active power, frequency, power factor, active energy, active power, reactive power, apparent power and MDI etc. to be provided for incoming panel only.
- All protective relays shall be of Numerical multifunction type with self monitoring features & must meet all the IEC standards.
- **Numerical Relay shall contain all protections as necessary for safe operation of VCB such as over voltage, over current, earth fault, and short circuit etc. shall be provided for Incoming VCB.**
- **Numerical Relay with protections as necessary for safe operation of VCBs & transformers such as over voltage, over current, earth fault, short circuit, unbalance / negative sequence etc. shall be provided for Transformer feeding outgoing VCB.**

Phase over current and earth fault protection shall have an adjustable timer hold to allow restriking faults detection. The relay should have at least two setting groups with password protection. The relay shall include a backlit LCD display and all alarms / fault messages should be in plain English text on the display.

- Built-in anti-pumping arrangement

NOTE :

Contractors shall quote the make & model of numerical relay considered and furnish technical details thereof for specific approval of NBIC.

- Trip circuit healthy indicating lamp with push button suitable for operation on 110 V AC supply.
- Trip push button for emergency trip.
- Single phasing protection. This is required only for incoming VCB.
- Two nos. indicating lamps red and green for ON and OFF suitable for operation on 110 V AC supply.
- Adequate auxiliary contacts and wiring for interlocking circuits, fault annunciations, indications etc.

6.2.3 Housing Fabrication Details

The panel shall be fabricated using 14 SWG thick cold rolled cold annealed sheet steel structure, indoor, floor mounted, self supporting, abide type made up of vertical panels of uniform height.

Each unit of the switchgear shall have necessary internal sheet metal barriers to form separate compartments for buses, instruments and relays, cable connections etc.

Compartments for XLPE armoured cable connections shall allow cable pulling, termination and connection work with the switchgear energized. **Incoming VCB panel shall be provided with two nos. bottom entry type cable boxes suitable for XLPE cables. One of these boxes shall act as stand by.** Terminal strips for outgoing control cable connection should be accessible to facilitate working and testing with breaker in test/service condition and while the switchboard is energized.

The panels shall be totally enclosed, dust, weather and vermin proof. However, openings for natural ventilation shall be provided, if necessary. These shall be louvered and provided with wire mesh. Wire mesh for bus bar compartments shall be such as to protect against objects of 1 mm and above. The enclosure shall have complete protection against approach to live parts or contacts with internal moving parts as per IS: 3427.

The panels shall be extensible at both the ends by addition of vertical sections in future. Ends of the bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel.

6.2.3.1 All hardware shall be zinc plated. All joints and connections shall be made by galvanized zinc passivated or cadmium plated high tensile strength steel bolts & nuts. Spring washers should be provided to secure against loosening.

6.2.3.2 The maximum height of the panel shall be restricted to 2200 mm and maximum length of a shipping section to 2500 mm. Each shipping section shall be provided with suitable lifting hooks. These hooks when removed shall not leave any opening in the board. The maximum and minimum height of operating handles / push buttons of components shall be approximately 1800 and 400 mm respectively.

6.2.3.3 All equipments of a single feeder shall be housed in a separate enclosed compartment. All identical equipment and corresponding parts including chassis of the modules shall be fully interchangeable.

6.2.3.4 Gaskets of durable materials shall be provided all round the perimeter of adjacent panel, panel and base frame, removable covers, doors and cutouts.

6.2.3.5 All components shall be front operated. The panel shall be single front type unless specified otherwise. For draw out modules, only handles of switchgears, knobs, cutouts for lamps and meters shall be arranged on the front doors to permit operation without opening the doors. Relay of circuit breakers shall be mounted on front doors of the compartments.

6.2.3.6 Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dust. Fabricated structures shall be pickled and treated to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc primer. The under surface shall be made free from all imperfections before undertaking the final coat.

After preparation of the under surface, the panel shall be spray painted with final two coats of powder coated paint. The colour shade of the final paint shall be light grey 631 as per IS: 5 unless otherwise specified. The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint etc.

6.2.3.7 Nameplates

Apart from panel nameplate highlighting the operating voltage, the nameplates for all incoming and outgoing feeders shall be provided on front doors as well as on rear side of the panel of each compartment. Nameplates shall be provided for each equipment (lamp, push buttons, switches, relays, auxiliary contactors, etc.) mounted on the switchboard. Special warning plates shall be provided on all removable covers or doors giving access to high voltage bus bars or cables. Nameplates shall be fixed by screws only and not by adhesives. Special danger plates shall be provided as per requirement.

Inside the panels, stickers shall be provided for all components giving identification number as per detailed wiring diagram.

6.2.4 Bus bar Sizing, Connection & Supports:

The bus bars shall be of high conductivity electrolytic aluminium alloy conforming to grade EQIE of IS: 5082. Buses shall have uniform cross section throughout the length of the panel up to the incoming feeder terminal and shall be sized to carry continuously the current specified in the material requisition. Bus bars shall be housed in a separate chamber and shall be accessible for inspection. **Maximum current density permissible for these bus bars shall be of 0.8 Amps/mm². Maximum current density permissible for Copper bus bars shall be 1.5 Amps/mm².** A suitable body earth electrode shall be provided on the panel.

The bus bars shall be provided with heat shrinkable PVC insulating sleeve of high dielectric strength, which should be non-inflammable, & self-extinguishing type and in fast colours to indicate phases. The sleeves shall be rated to withstand the system line-to-line voltage for 1 minute. All bus bar joints and all tap-off connections from the main horizontal bus bars shall be suitably shrouded.

The bus bars shall be adequately supported by epoxy compound cast SMC blocks in adequate numbers and size to avoid sag in bus bars and these shall be capable of with standing stresses due to short circuit currents of the associated switchgear. All bus supports shall be of non-carbonizing material and shall have hygroscopic characteristics.

Minimum clearances should be as per relevant Indian Standard Specifications.

6.2.5 Power connection:

The incoming and outgoing power connections shall be through XLPE cables. Ample space for connection of these cables shall be provided at the rear of the switchboards. The power cable shall enter the switchboard from the bottom. "Cupal" washers or neutral grease shall be used for copper to aluminium joints.

The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables. The head-room available between cable gland plate and terminal lugs shall preferably not be less than 600 mm for switchgear up to 11 kV and 900 mm for 33 kV cables.

In case the standard panel depth cannot accommodate the specified no. of cables, a rear extension panel of uniform height shall be provided. An earth strip shall also be brought to this extension panel.

6.2.6 Auxiliary Wiring:

Wiring for all controls, protection, metering, signaling etc. inside the panel board shall be done using 1100 V grey colour PVC insulated copper conductors. Minimum size of copper conductor shall be 2.5 mm². The wiring shall preferably be enclosed in plastic / PVC channels. Wiring between HV breakers or cable compartments to relay and metering shall be routed through flexible conduits. Shorting links shall be provided for all CT terminals.

All control wiring should be provided with necessary sockets / lugs at both the ends. Each termination shall be identified at both the ends by PVC ferrules having numbers corresponding to control circuit diagram.

Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. 10% spare terminals shall be provided on each terminal block.

Control cables shall enter the switchgear from the bottom. Supporting facilities shall be provided for clamping the control cables. All inter-panel wiring shall be taken through PVC sleeves or suitable grommets by the switchgear vendor. For inter-panel wiring between the shipping sections, wires in rolls of the required length, connected at one point, shall be supplied with the panel for connection at site.

Breaker tripping and closing devices shall be fed with direct current. The rated DC voltage shall be 110 V as specified in the data sheet.

6.2.7 Earthing connections:

All cubicles shall be connected to an earth bus bar running throughout the length of the switchboard. **The earth bus bar size shall be minimum 30 x 6 mm² copper up to short circuit withstand capacity of 31.5 kA and 50 x 6 mm² copper for a short circuit withstand capacity above 31.5 kA.** All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non-current carrying metallic parts of the equipment and components shall be earthed.

The earth bus shall be brought back to the cable compartment and earthing bolts shall be provided to ground cable armour. The mating surfaces of all bolted parts shall be zinc-passivated to ensure continuity between them.

6.2.8 Instrument Transformers:

Current Transformers:

Current transformers shall be cast resin type and shall generally conform to IS: 2705. The short time withstanding rating should be that of the breaker or the switchboard. They shall be mounted on the stationary part of the switchgear. Protective CTs shall have an accuracy class of 5P and an accuracy limit factor of greater than 10. Low reactance CTs shall be used for protection. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. One leg of the CTs shall be earthed. VA rating of CTs. Shall be specified by the contractor.

Potential Transformers:.

The potential or voltage transformers shall be cast resin type and shall generally conform to IS : 3156. The potential transformers shall be draw out type and shall be provided with fuses on primary side and miniature circuit breakers with auxiliary contacts on secondary side.

The draw out mechanism shall disconnect the PT from the main bus bars. The primary connection shall be disconnected before the PT or its primary fuses become accessible. Neutral point of the star connected PTs both on primary and secondary sides shall be earthed. The PTs shall have an over voltage factor of 1.9 for 30 seconds and an accuracy of class 1.0 from 10% to 120% of normal voltage. If not otherwise specified, the secondary voltage of PTs shall be 110 V.

6.2.9 Protective Relays :

The relays shall be mounted on front door of the compartment and accessible for setting and resetting from the front. Hand reset flag indicators visible from the front shall be provided for mechanical type relays. Details regarding requirement of relays and their type, model etc. shall be as given in the data sheet/ feeder details.

6.2.10 Measuring Instruments :

All **digital measuring instruments for HT panel** shall be of size 96 mm x 96 mm, flush mounting type with 3½ digit LCD or LED display.

6.2.11 Indicating Lamps :

Indicating lamps shall be of LED (cluster of high intensity light emitting diodes) type. These should be provided with translucent covers of red, green and amber colours as required. Bulbs and lenses shall be easily replaceable from the front.

6.2.12 Transformer Protective Devices:

Wherever mentioned in the feeder details, necessary arrangement shall be provided by the contractor in the VCB panel to facilitate connection of the following devices on the transformers.

1. Alarm and trip contacts of Buchholz relay.
2. Alarm contacts of temperature indicator.

6.3 BATTERY & BATTERY CHARGER :

A suitable battery charger, of rating as specified in the data sheet, housed in sheet steel enclosure with adequate ventilation for natural air cooling suitable for indoor operation, floor mounted and provided with 1 no. 2 pole ON/OFF switch at input side, pilot lamp to indicate healthiness of AC supply and 1 no. AC voltmeter.

The battery charger should be complete with trickle and boost charger.

The supply should be complete with SMF (sealed maintenance free) batteries of rating as specified in the data sheet and a wooden stand for the same.

6.3.1 Housing :

The silicon rectifier charger shall be housed in floor standing type sheet steel cabinet. Hinged door shall be provided on the back for easy access of the terminals and the components. The unit will be provided with adequate ventilation for natural air-cooling. Four castor wheels shall be provided for easy portability.

6.3.2 Design Requirements & Scope of Supply:

The battery charger shall be designed to have

Input Voltage : 230V AC, 50 Hz, single phase, primary winding of the transformers shall have tapping at 0 – 200 – 230 – 250 volts AC.

Output Voltage : The output voltage of the battery i.e., 110 V

Current Rating : The charger shall be suitable to float / boost charge 110 V SMF stationery batteries bank (of AH rating as mentioned in the data sheet).

1 no. Variac will be provided to adjust the Trickle / Boost charging current.

The battery charger will be fitted with the followings :

- 1) 1 no. Double pole, mains 'ON/OFF' MCB switch
- 2) 2 nos. HRC type fuses; one for AC input and one for DC
- 3) 1 no. pilot lamp to show the main supply is ON
- 4) 1 no. transformer, single phase, double wound, natural air cooled with copper windings. The transformer coil shall be vacuum impregnated.
- 5) 1 no. Series Transformer to be connected in series with secondary winding of the main transformer
- 6) 1 no. single phase dimmerstat. The primary winding of the series transformer shall be connected at output of the dimmerstat. By adjusting the dimmerstat, it shall be possible to adjust the output voltage in the range of :

2.00 – 2.3 V per cell during float mode and
1.85 – 2.75 volt for cell during boost mode

- 7) 1 no. Rotary switch to be provided to select float / boost mode of charging
- 8) 1 no. Rectifier : This shall be of Silicon Diode type full wave bridge. The Silicon Diodes will be individually mounted on heat sinks and protected by R-C surge suppression network.
- 9) **Metering :**
 - 1 no. Moving Coil type DC ammeter 0 – 30 A
 - 1 no. Moving Coil type DC voltmeter 0 – 150 V

The meter shall be of type SIF-96. Accuracy conforming to IS:1248

- 10) 2 nos. Insulated terminals for DC output.
- 11) 1 no. 3 Core service cord 3 M in length at AC input
- 12) 2 nos. Earthing terminals shall be provided in the charger.
- 13) 1 set of control for automatic switching 'ON' the DC supply to Emergency Lights in case of mains failure and switching 'OFF' the DC supply to Emergency Lights when power is restored.
- 14). **Protections**
 - a) 2 nos. HRC fuses, one at AC input and other at DC output.

- b) Silicon Diode shall be of industrial grade & individually protected R-C surge suppression network.

The battery back up system should be complete with inter-connecting cables and other accessories required for proper operation of the system. The battery shall be housed within the panel with proper ventilation.

6.4 HT CABLES :

Three core aluminium conductor, screened, XLPE insulated, armoured shielded and PVC sheathed cables of size and voltage as specified in the data sheet, earthed system, conforming to IS: 7098 (Part II) with latest amendment.

6.5 OIL FILLED DISTRIBUTION TRANSFORMERS with OLTC :

Oil filled type Distribution Transformers with On-load Tap Changing (OLTC) suitable for outdoor installation are required to receive power at high voltage and step down the voltage to cater to the power requirements of the plant at stepped down voltage of 415 V.

6.5.1 Design Requirements and Scope of Supply:

6.5.2 Statutory Requirements

Transformers are to be manufactured as per BS : 171 & BIS : 2026 (amended as on date) specifications, Indian Electricity Rules, including special requirements of the concerned state electrical inspectorate and the detailed specifications mentioned below :

6.5.3 Housing Details

The transformer tanks shall be fabricated of good quality mild steel plates and stiffened with suitable mild steel sections to ensure structural rigidity. CRCA pressed sheet radiators bank provided with the transformer shall be complete with air release plug, drain plug and isolating valves at points of connection with the tank.

Surface preparation and painting :

1. Steel surface shall be prepared by sand /shot blast or chemical clearing including phosphating as per IS: 3618.
2. Heat resistance paint shall be provided.
3. On external surface one coat of Thermo setting powder paint or two coats of zinc chromate followed by two coats of synthetic enamel paint of dark admiral gray shade conforming to No. 632 of IS : 5 of 1961 shall be provided.

6.5.4 Standard Accessories Required

The transformers shall be core type, double wound copper conductor, oil immersed, oil natural cooled, 3 phase, 50 Hz. having DYN 11 connection. The transformer will have **Amorphous Metal / CRGO / any other low loss Core**. The transformer shall be complete with the followings

1. Conservator with oil filling hole and cap, oil level gauge and a drain valve with plug.
2. Double diaphragm explosion vent

3. Air release plug on tank cover.
4. Lifting lugs.
5. OLTC (On-load tap changing) 17 positions, 16 steps, on H.V windings of transformer, to take care of percentage voltage variation of -10% to +10% in step of 1.25%. The OLTC shall be complete with RTCC (remote tap changing control) and AVR.

The On load tap changing equipment shall be complete with:

- On load tap changing gear mounted on the transformer tank
- Indoor type Remote tap changing control cubical (RTCC panel), fitted with EMCO make electronic automatic voltage regulating relay (AVR) with all necessary controls & accessories including inter connections.

It shall be suitable for the following tap change operation:

- Local manual tap change operation with cranking handle
- Local electrical tap change operation with raise / lower switches / push button on OLTC panel.
- Remote electrical, non-automatic independent / group simultaneous tap change operation with raise / lower switches / push buttons on RTCC panel.
- Remote electrical automatic tap change operation with AVR. Suitable PT / PT ratios to be provided on the LV / Secondary to provide a feed back signal to the AVR for comparison to effect automatic changeover.

The details of OLTC controls are as detailed below:

Manual Mechanical Control

- The cranking device for operation of the OLTC gear shall be removable and located at a height not exceeding 1500mm, above ground level for easy operation. The mechanism shall be complete with normal accessories including at least the following:
- A mechanical tap position indicator (rated tap voltages shall be marked on the diagram plate).
- A mechanical operation counter.
- Mechanical stops to prevent over cranking of the mechanism beyond extreme tap positions.

Electrical Control

Control circuit shall incorporate the following:

- a) Local/remote manual electrical operation.
- b) Device to ensure a positive and full completion of tap change once it is initiated even if there is loss of power.
- c) An interlock to cut-off electrical control automatically upon recourse being taken to manual mechanical control in emergency.
- d) Electrical inter lock to cut-off a counter impulse for a reverse tap change, being initiated during a progressive tap change and until the mechanism comes to rest and resets circuits for a fresh operation.

- e) All auxiliaries and devices for electrical control of OLTC gear should be housed in a weather proof cabinet mounted on the transformer and shall include:
- ✓ Local tap position indicator
 - ✓ 5 digit operation counter
 - ✓ Cubicle lighting
 - ✓ Thermostatically controlled spare heater
 - ✓ Miniature circuit breaker with magnetic and thermal overloads devices for controlling the incoming supply to the OLTC motor.
 - ✓ Pad locking arrangement for the hinged cabinet door
 - ✓ Removable plate with cable glands
 - ✓ Inside tap with control scheme indelibly marked

Remote Electrical Control

Remote control panel shall comprise of the following:

- ✓ Individual/parallel control on Master follower sequence selector switch
- ✓ Raise/lower control switch
- ✓ Potentiometer type tap position indicator
- ✓ Out of step relay
- ✓ Time delay relay
- ✓ Indicating lamp for out of step
- ✓ Out of step buzzer
- ✓ Indicating lamp for tap changer supply available
- ✓ Indicating lamp for tap change in progress

RTCC panel shall be dust and vermin proof, floor mounting, and freestanding type. The enclosure shall be of cold rolled sheet of 2.5mm. All doors and opening shall be provided with neoprene gaskets.

Automatic tap changing control shall be provided complete with voltage sensing relay.

OLTC wherever called for shall be suitable for bi-directional power flow.

OLTC shall also be rated for basic insulation level value as specified for the transformer in the data sheet.

6. Two nos. base channels with jacking lugs and bi-directional flat rollers.
7. Two nos. earthing terminals (without lugs).
8. Thermometer pockets with 150 mm dial thermometer with 2 meter capillary, alarm & trip contacts with maximum reading pointer for measuring transformer winding as well as oil temperature.

9. Double float Buchholz relay with alarm & trip contacts including testing & sampling cocks and 2 nos. oil shut off valves.
10. Marshalling box to house dial thermometers & terminals with wiring complete from Buchholz Relay & dial thermometers up to marshalling box.
11. Top oil filter valve with plug.
12. Bottom oil filter cum drain valve with plug and locking arrangement
13. Silica gel breather with a shut off valve for breather servicing
14. Pressure release valve
15. Rating and diagram plate.
16. 3 nos. HT bushings with cable box for HT XLPE cable terminations.
17. 4 nos. LT bushings with bus links and adaptor box for LT bus duct connections.
18. Neutral terminal 1 no. brought outside for solid earthing
19. Magnetic Oil level indicator with minimum & oil filling level markings
20. First charge of oil. Oil can be supplied separately filled in sealed drums. Oil dielectric strength should be better than 40 kV.
21. Jacking pads

6.5.5 Remarks :

Heat-shrinkable terminal kits of Raychem / M-seal sleeves shall be used during HV cable termination and the cable box clearances shall be provided in line with the same.

6.5.6 Transformer's Tests:

The transformer shall be tested as per IS: 2026 – 1977 & IS: 1180 (Part II) with latest revision. The following routine tests as per IS shall have to be carried out for each transformer, at manufacturer's works, before its despatch to the destination and test reports shall be furnished.

- No load loss measurement test
- Full load loss measurement test
- Winding resistance measurement test
- Impedance voltage of transformer
- Insulation resistance test
- Dielectric strength test of transformer oil
- Turns ratio test
- Separate source voltage test
- Induced over voltage test
- Polarity Phase relationship test

Transformer Losses :

Contractors to note that -

No Load loss at rated Voltage and Frequency and at normal tapping shall not be more than 2.25 kW

Full Load loss at rated Current at 75°C at normal tapping shall not be more than 15 kW.

6.6 LT BUS DUCT :

LT bus ducts are required to connect :

LT of the transformer with transformer incoming feeder module of LT power control centre and DG set control panel power output to DG set incoming feeder module of LT power control centre.

6.6.1 Design Requirements and Scope of Supply :

The design, construction, manufacture, installation of the bus ducts shall be as per the detailed specification hereunder. Bus ducts shall be made as per IS: 8623 (Part II) – 1993.

6.6.2 Rating :

The bus duct rating shall be of specified continuous current rating as mentioned in the data sheet of the project with fault level of 50 kA. The bus duct shall be suitable to 3 phase, 4 wires (neutral being solidly grounded) system, 415 V \pm 10%, 50 Hz. \pm 3%, AC supply system.

6.6.3 Bus bar Enclosure :

Outdoor type enclosure shall be fabricated from minimum 14 gauge CRCA sheet steel, stiffened and reinforced by sturdy angle iron frame to form a rigid structure. The section of bus duct shall be in rectangular box frame. All necessary G.I. hardware shall be supplied along with the bus duct. The terminal enclosures shall be provided with flanged ends to suit flanges of transformer / PCC. The bus duct shall be totally enclosed, dust, weather and vermin proof and shall have the construction to conform to protection class IP 55 minimum as per IS 2147. The covers shall be of convenient length for easy removal. All joints and covers shall be provided with neoprene gaskets. The bus duct shall be adequately supported. Top cover for outside installation shall have slope on both edges for draining of rainwater.

The bus duct MS fabrication shall be pre-treated as per standard practice and then be finished with stove enamel paint. Inside surface of MS fabrication shall be painted with black mat finish, while external surface shall be finished with epoxy paint of shade no. 631 of IS : 5.

6.6.4 Bus bars & Supports :

Bus bars shall be of electric grade high conductivity electrolytic aluminium conforming to grade E91E of IS: 5082 (read with latest revisions, if any) and their sizes are to be selected on the basis of current density 0.8 A per mm². Section of buses shall be uniform and rectangular. The main buses of the bus ducts shall be designed to carry continuously the current specified in the design data, while the neutral shall be of at least half the section of phase bus. The temperature rise of buses shall be limited to 40° C above an ambient of 45° C.

The bus bars shall be able to withstand short circuit current of 50 kA RMS for 1 second. The bus bars shall also be shrouded with red, yellow and blue colour heat shrinkable sleeves for three phases and black colour for neutral. Suitable size 2 numbers rectangular section Aluminium

conductor earth bus shall also be provided to entire length of the bus duct as per the statutory regulation. The minimum cross section of aluminium earth bus shall be 250 mm². The minimum clearance of 25 mm shall be maintained between phase to phase and phase to earth or neutral.

For electrical connections between the bus duct and LT side of the transformer as well as on power control centre's incoming switchgear, flexible copper bus bars (i.e., braided flexible strips of copper) of the current rating same as that of the aluminium bus bars of the bus duct, shall be provided.

The bus bar supports shall be of epoxy cast resin material (SMC or DMC blocks) and should withstand 110 kA peak short circuit current and the mechanical stress between the bus bars.

Galvanized zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers / spring washers shall be provided for all joints in bus bars and links connections.

6.6.5 Testing :

All routine tests as specified in the applicable Standards and Codes shall be conducted and test results of the same shall be submitted along with supply.

6.7 LT POWER CONTROL CENTRE :

The indoor type power control centre in sheet steel enclosure is required to receive LT power supply from transformers & DG sets and supply the same to various motor control centres and distribution boards at 415 volts, 3 phase, 50 Hz. System.

6.7.1 Statutory Requirements

The design construction, manufacture and performance of the PCC shall conform to the latest applicable Indian Standards, Indian Electricity Rules, Indian Electricity Act, Fire Insurance Regulations and comply with all currently applicable statutory requirements of concerned State Electricity Inspectorate and safety codes in the locality where the equipment will be installed and as per the detailed specifications mentioned below. **The manufacturer of the panel must possess a type test certificate / accreditation from CPRI.**

6.7.2 Housing Details

6.7.2.1 The PCC shall be fabricated using pressed and shaped cold rolled sheet steel sections structure of adequate thickness. The cold rolled sheet steel used for panel shall be minimum 14 SWG thick except that the partition plates and inter-panel barriers may be made of 16 SWG. The PCC shall be indoor, floor mounted, self-supporting, front openable, cubicle type made up of vertical panels arranged to form a continuous line-up of uniform height. Front doors and rear covers shall be hinged type.

Switch Board shall be extensible at both the ends by addition of vertical sections. Ends of the bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel. The switchboard shall be provided with integral base frame. The panel base plate/cable gland plate shall be 2.5 mm thick.

The PCC shall be totally enclosed, dust, weather and vermin proof and shall conform to degree of protection not less than IP 44. Gaskets of durable materials shall be provided all round the perimeter of adjacent panel, panel and base frame, removable covers, doors and cutouts.

6.7.2.2 All hardware shall be zinc plated. All joints and connections shall be made by\

alvanized zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers secured against loosening.

6.7.2.3 The maximum height of the panel shall generally be restricted to 2300 mm and maximum length of a shipping section shall be 2500 mm. Each shipping section shall be provided with suitable lifting hooks. These hooks when removed, shall not leave any opening in the board. The maximum and minimum height of operating handles / push buttons of components shall be approximately 1900 mm & 300 mm respectively with reference to panel base.

6.7.2.4 All equipments of a single feeder shall be housed in a separate enclosed compartment. **Only ACB modules shall be of draw out type and all identical ACBs and the corresponding parts including chassis of the ACB modules shall be fully interchangeable. All other switchgears like MCCB & Switch Disconnecter Fuse unit etc. shall be of non-draw out design**

6.7.2.5 Suitable cable and bus alleys shall be provided. Cable alleys shall be provided with hinged doors. Adequate number of slotted cable supports shall be provided in cable alleys for dressing of cables. All doors shall be provided with concealed type hinges and captive screws. Rear doors also shall be openable.

6.7.2.6 All components shall be front operated. The PCC shall be **single front type**. For draw out modules, only handles of switchgears, knobs, cutouts for lamps and meters shall be arranged on the front doors to permit operation without opening the doors. Relays, other than built-in in circuit breakers, shall be mounted on front doors of the ACB compartments. Other accessories of ACB shall be mounted on withdrawable chassis.

6.7.3 Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dust. Fabricated structures shall be pickled and treated to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc primer. The under surface shall be made free from all imperfections before undertaking the final coat.

After preparation of the under surfaces, the panel shall be spray painted with final two coats of approved shade of **powder coating** paint. Thickness of powder coating shall not be less than 60 microns.

The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion, etc.

6.7.4 Nameplates :

Apart from panel nameplate highlighting the operating voltage, the nameplates for all incoming and outgoing feeders shall be provided on doors of each compartment. Nameplates shall be fixed by screws only and not by adhesives. Engraved nameplates shall preferably be of 3-ply (Black-White-Black) acrylic sheets or anodized aluminium. Special danger plates shall be provided as per requirement.

Inside the panels, stickers should be provided for all components giving identification no. as per detailed wiring diagram.

6.7.5 Busbar Sizing Connection and Supports :

The bus bars shall be made of high conductivity electrolytic aluminium alloy conforming to grade E91E IS-5082. Buses shall have uniform cross section throughout the length of the panel and up to the incoming feeder terminals. **Maximum current density permissible for these bus bars shall be 0.8 A/mm² for bus bar area above 500 mm² & 1.0 A / mm² for bus bar area below 500 mm² per phase.** A suitable section earthing bus bar (minimum 300 mm²) of aluminium shall be provided outside the PCC at back bottom through out the length of the PCC. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. **All doors shall be earthed using flexible copper connections to the fixed frame of the switchboard.**

Maximum current density permissible for Copper bus bars shall be 1.5 Amps./mm²

The bus bars shall be provided with heat shrinkable high dielectric PVC insulating sleeves of 1100 V grade. Red, yellow and blue colour shall be used for phase bus bars and black colour shall be used for neutral bus bars. The sleeves should be non-inflammable and self-extinguishing type. **All joints in main horizontal bus bars and all tap-off connections from the main horizontal bus bars shall be provided with suitably shrouded.** Supports for bus bars shall be made of suitable size non-hygroscopic and non-inflammable epoxy compound SMC / DMC blocks and these should be adequate in number so as to avoid any sag in the bus bars and these shall be capable of withstanding stresses due to short circuit currents of the associated switchgear. Main bus bars shall have rupturing capacity of 50 kA.

Minimum clearance between main bus bars phase-to-phase 25 mm and that between phase to neutral / earth shall be 20 mm.

6.7.6 Power Connection

Interconnections between the main bus bars and individual units shall be made by using copper or aluminium bus bar strips of adequate rating. These **interconnections and terminals shall also be shrouded suitably.** For current rating 63 A and below copper conductor PVC insulated wires of adequate section with sockets at both ends can be used but their minimum size shall not be less than 4 mm². Cable lugs / sockets of suitable size and type shall be used for all cable terminations.

For all aluminium to copper connections, the copper surface will be silver plated and the aluminium surface will be properly cleaned and supplied with oxide inhibiting grease.

The outgoing power connections from PCC will be through PVC insulated aluminium conductor armoured cables. The cable entry shall be either from top or bottom as specified in feeder details. Removable gland plates of minimum 12 gauge thickness shall be provided on top / bottom of panel (as required), for cable entries. The cable alleys shall also be totally isolated from switchgears by suitable partition plates.

For outgoing feeders, cable termination directly at switchgear terminals shall not be allowed and hence panel builder should make provision by suitable bus link from switchgear terminals so that required no. of cables could be connected to these links.

To prevent accidental contacts, all junctions of interconnecting cables and bus bars also shall be shrouded suitably using coloured PVC insulation tape. Standard colour code of red, yellow and blue for phases and black for Neutral to be followed for all bus bars/conductors.

6.7.6.1 Auxiliary Wiring

Wiring for all controls, protection, metering, signaling etc. inside the switchboard shall be done with 1100 V grey colour PVC insulated FRLS copper conductors. Minimum size of control wire shall be 1.5 mm². However, CT circuit wiring shall be done with 2.5 mm². Control wiring to components fixed on doors shall be flexible type.

All control wiring should be provided with necessary sockets / lugs at both the ends. Each termination shall be identified at both the ends by PVC ferrules having numbers corresponding to control circuit diagram.

6.7.7 Electrical Switchgears :

6.7.7.1 Air Circuit Breakers (ACBs) :

ACBs for transformers and DG sets Incoming feeders and Bus coupler :

The air circuit breakers (ACBs) shall be suitable for 415 V, 50 Hz. Supply, **4 pole, electrically operated fully draw out type with programmable intelligent release suitable for power monitoring and controlling.** These ACBs shall have microprocessor based true RMS sensing and programmable protection & control unit shall be self powered and shall have protection & settings for overload, short circuit, instantaneous and earth fault currents with time delay settings, under/over voltage etc. and on screen LCD display to show various conditions such as Power ON, Overload, Short-circuit, Instantaneous Earth fault, Percentage load, Self Diagnostic Test etc. **The breaking capacity of these ACBs shall be minimum 65 kA. Also, these ACBs should also have protection against single phasing.**

The release unit shall also have onscreen display of following measurements :

Current : Phase, line, average, max, % loading
 Voltage : Phase, line, average
 Power & energy : Active, reactive, total
 Frequency & power factor
 Maximum Demand

ACB release of all incomer & bus-coupler shall be with feature of both way communication, % harmonic distortion and should display IDMT graph.

LED indication for different fault & Power ON should be provided on release chassis. Release should be able to perform self test to check healthiness of micro-processor. Release should be provided with test port for testing with test kit. Communication feature should be inbuilt and with RS485 port. Release should be able to communicate thru. Modbus Protocol and should be compatible with SCADA system.

The **make & model of ACBs for incoming feeders and bus coupler** shall be as under :

L&T U-power series with UN-RS 3 / Siemens 3WL series with 76 B / Schneider Masterpact NW series with 6.0P

ACBs for outgoing feeders :

The air circuit breakers (ACBs) shall be suitable for 415 V, 50 Hz. Supply, **4 pole, manually operated fully draw out type with programmable intelligent release suitable for power**

monitoring and controlling. These ACBs shall have microprocessor based true RMS sensing and programmable protection & control unit shall be self powered and shall have protection & settings for overload, short circuit, instantaneous and earth fault currents with time delay settings and on screen LCD display to show various conditions such as Power ON, Overload, Short-circuit, Instantaneous Earth fault, Percentage load, Self Diagnostic Test etc. **The breaking capacity of these ACBs shall be minimum 50 kA.**

The release unit shall also have onscreen display of following measurements :

Current : Phase, line, average, max, % loading

Voltage : Phase, line, average

The **make & model of ACBs for outgoing feeders** shall be as under :

L&T U-power series with UN-RS 2.5GC / Siemens 3WL series with 45 B / Schneider Masterpact NW series with 6.0A

Through a suitable converter / gateway, all data from the ACBs shall be made available to suitable communication bus / Ethernet (to be finalized during detailed engineering) for SCADA based control & monitoring of ACBs.

All ACBs shall be provided with removable arc chutes and the mechanical spring charging mechanism, stored energy type, with indicators to show 'Open', 'Closed', 'Service' & 'Test' positions. The circuit breaker shall be provided with emergency tripping device. This device shall be available on the front of the panel.

The control supply shall be 240 V AC. 6 NO + 6 NC auxiliary contacts shall be provided.

The interlocks shall be as under :

It shall not be possible to plug in a closed circuit breaker or to draw out a circuit breaker in closed position. It shall not be possible to operate a circuit breaker unless it is in fully plugged-in, test or fully isolated position. In test position, the breaker shall be tested without energizing the power circuit. The ACB feeder cubical door cannot be opened when ACB is "ON". However, it shall be possible to defeat this interlock for inspection purpose. Whenever specified, interlock to prevent paralleling shall be provided. Closing and trip coils shall work under the following voltage variation conditions :

Closing coils - 85 % to 110 % of rated voltage
Trip coils - 50 % to 110 % of rated voltage

While incoming feeders ACBs shall be provided with under voltage coil, the outgoing feeders ACBs shall be provided with shunt trip.

Current rating, short circuit current, protection relays etc. shall be as specified in feeder details.

The circuit breaker position shall be indicated electrically. The following indicating colours shall be used :

BREAKER 'CLOSE'	-	RED
BREAKER 'OPEN'	-	GREEN
BREAKER 'AUTO TRIP'	-	AMBER

Remarks

- a) The ACBs should be compatible to communicate with central automation system for online viewing, monitoring, controlling and automatic data transfer with the communication network of Banas 3. However, the scope of this package will be limited to providing a suitable converter / gateway only in the PCC panel to enable control and monitoring of incoming feeders and bus coupler ACBs and only monitoring of all outgoing feeders ACBs. All ACBs shall be hooked up through SCADA with customer's PC. However, all the required hardware & software shall be in the scope of supply of the panel builder.
- b) SCADA software shall be provided to parameterize, operate & monitor circuit breakers. This will permit remotely controlled closing, opening and reset of breaker etc. All protection parameters, metering settings and communication parameters etc. can be set and modified
- c) Following information of each breaker shall be available on the SCADA screen
- d)
 1. Switching status ; Main contacts ON / OFF
 2. Stored energy status
 3. Ready-to-close status
 4. Tripped-signal
 5. Temperature inside the circuit breaker
 6. Status of 1st and 2nd auxiliary release
- e) Metering function
 1. current
 2. voltage
 3. power
 4. cos phi
 5. energy
 6. frequency
 7. Total Harmonic Distortion (THD), Formfactor, Crestfactor
 8. Frequency analysis up to the 29th harmonics
 9. Recording of currents & voltages in waveform buffers (two ring buffers permit graphical evaluation of current and voltage profiles)
- f) Mechanical as well as electrical interlocking shall be provided between incoming feeders from transformers and DG sets in such a way that when DG sets ACBs are 'ON', it should not be possible to put on the ACBs of the main supply from transformers or vice-versa either mechanically or electrically.
- g) All incoming feeders from transformers and DG set shall be provided with 240 V Under Voltage coil & all outgoing feeders shall be provided with 240 V, AC shunt trip coil only.

The panels shall be designed for proper protection system & 50 kA fault level.

6.7.7.2 Moulded Case Circuit Breakers (MCCBs) :

MCCBs shall always be provided with separate rotary operating handle mechanism with door interlocking. **The MCCBs shall be of four-pole construction** arranged for simultaneous manual closing or opening of all the poles of the MCCB and automatic instantaneous tripping on short circuits. All MCCBs shall be microprocessor type with in-built earth fault feature.

Closing mechanism shall be quick make, quick break and trip-free type. Operating handle shall give a clear 'ON', 'OFF' and 'Trip' indications. The MCCBs should preferably have an anti-reclosing feature.

MCCBs shall be provided with microprocessor based tripping device with earth fault protection as integral feature of the MCCB.

The MCCBs shall be rated for continuous maximum duty as specified. The rating of the MCCBs shall be as per the feeder details.

Minimum rated **breaking capacities** shall be as under :

The MCCBs should have a Service short circuit breaking capacity (Ics) as well as Ultimate breaking capacities (Icu) as 50 KA at 415 Volts 50 Hz AC.

The control voltage of MCCB shall be 240 V AC.

6.7.7.3.1 Protection Releases of MCCB :

- Adjustable Overload protection adjustable from 40% to 100% of I_n .
- Adjustable short circuit protection 6 to 9 times I_r upto 400 A MCCB & 3 to 6 times I_r for above 400 A MCCB.
- Adjustable Ground Fault protection with pick up settings from 20% to 50% of I_n and delay settings from 100 m. secs or 200 m. secs.
- In-built thermal memory.
- True RMS sensing.

Accessories :

- Internal Accessories - The MCCB should have user friendly clip-fit type site fittable. Internal accessories like Shunt / Trip alarm contacts / auxiliary contacts etc. shall be provided wherever required.
- Internal accessories should have double insulation & No side bias.

Make & model of MCCB shall be : L&T D'Sine / Siemens 3 VL / Merlin Gerin Simpact Series.

6.7.7.3 Switch Disconnecter Fuse Units :

The load break switches shall be suitable for continuous maximum rating, air break type and shall have manual quick make / break mechanism. These shall have positive isolation with positive indication of contact separation. They shall have high short circuit making and withstanding capacities. Breaking capacity shall correspond to AC 23A utilization category. Switch handle shall be provided with door interlocking arrangement. Also, 'defeat' arrangement shall be provided to open the door in switch 'Close' position for testing purpose. Live terminals of the

switch shall be shrouded. Fuses shall be HRC cartridge link type. **One set of fuse pullers to cover entire range of fuses used in the panel also shall be provided.**

6.7.7.4 Current Transformers (CTs) :

Current transformers shall be cast resin type. Primary and secondary terminals shall be marked indelibly. CTs shall preferably be mounted on stationery parts. The short time withstand rating of CTs shall be equal to that of the associated switchgear for one second.

The protection CTs shall be of minimum rating 15 VA, accuracy class 5P and an accuracy limit factor of greater than "10.0". The instrument CTs shall be of minimum 10 VA, accuracy class "1.0" and an accuracy limit factor less than "5.0".

Separate CTs to be provided for protection and metering purposes.

6.7.7.5 Protective Relays :

In case of any protective relays being specified in addition to the built-in relays provided with ACBs & MCCBs, the same shall be mounted on front door of the compartment and accessible for setting and resetting from the front. Hand-reset flag indicators visible from the front shall be provided.

All such protective relays, wherever used, shall be back connected, draw out type suitable for flush mounting and fitted with dust tight covers. Alternatively, plug-in type relays shall also be acceptable. The relay cases shall have provision for installation of test plug at the front for "testing and calibration" using an external power supply without disconnecting permanent wiring. It should be possible to short the CTs through the test plugs.

Auxiliary relays / contactors shall generally be used for interlocking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum estimated current. In any case their rating must not be less than 5 A for 240 V, AC at a power factor between 0.3 to 0.1 and 1.5 A for 100 V, DC (inductive load).

Lower voltage contactors with a series resistance will not be acceptable for 220 V DC control supply.

6.7.7.6 Measuring Instruments :

These shall be of square pattern having approx dimensions 144 mm x 144 mm for analogue type and 96 mm x 96 mm for digital type, flush mounting type with range as per corresponding feeder. All AC meters shall generally be of Digital type for displaying three phases reading. Suitable selector switch shall be provided if the digital meter does not have provision for simultaneous display of three phase readings.

Ammeters shall always be CT operated. Necessary auxiliary instruments like CTs etc. are also included in the scope of supply.

Voltmeter shall be suitable for direct line connection. Voltmeters shall be connected through fuses only.

The voltmeters and ammeters shall have 3½ digit display whereas the power factor meter shall have 4 digit display.

Intelligent Panel Meter (Load Manager) shall be provided with transformers and DG sets incoming feeders of the PCC for the local measurement & digital display of Multifunctional Electrical Parameters such as voltage, current, active power, reactive power, frequency, power factor, active energy, reactive energy, etc.

6.7.7.7 Indicating Lamps :

Indicating lamps shall be of LED (cluster of high intensity light emitting diodes) type, suitable for 240 V AC supply. These shall be provided with translucent covers of red, green and amber colours as required. These lamps shall be of minimum 22.5 mm dia. Indication lamps to be provided for all feeders.

6.7.7.8 Push Buttons :

Push buttons shall be of momentary contact type, rated to carry 10 A, 240 V AC with 2 NO + 2 NC contacts. These should be of size 22.5 mm dia and conform to IP 65 protection to prevent any dust and water ingress.

Colour codes shall be as under :

Start, Close	:	Green
Stop, Open / Emergency	:	Red

6.7.7.9 Contactors :

All contactors shall be suitable for AC3 duty unless specified otherwise. Contactor coil shall be suitable for 240 Volts, 50 Hz. All contactors shall be supplied with minimum 2 NO + 2 NC auxiliary contacts. Minimum contactor rating for power shall be 16 Amp.

6.7.8 ANNUNCIATION PANEL :

The alarm and annunciation system, suitable to operate on 110 V DC supply, shall be incorporated in the HT or Main LT panel to comprehensively indicate the following faults in the system complete with internal wiring and terminals duly identified for various inputs:

For each transformer feeder panel:		
1	For high oil temperature	1 No
2	For Buchholz relay	1 No
3	For high winding temperature	1 No
4	For low oil level	1 No
5	For restricted earth fault relay	1 No
For each 11 KV VCB panel:		
1	Over current trip	1 No
2	Short circuit trip	1 No
3	Earth fault trip	1 No
4	Control circuit healthy	1 No
Other annunciation		
1	Power failure	1 No
2	Annunciation for restoration of power from GEB	1 No

The annunciation panel shall have the following :

Hooter for audible alarm suitable for operation on 110 V, DC

Auxiliary relay for hooter cancellation

Push button for hooter cancellation

Auxiliary relay for audible alarm for restoration of power supply

The scope of work also includes providing and laying required armoured copper control cables (2.5 mm² conductor size) for entire field cabling up to the output terminals of various relays, etc. as required.

6.8 CAPACITORS Panel with AUTOMATIC p.f. CORRECTION RELAY :

6.8.1 POWER FACTOR IMPROVEMENT PANEL WITH APFCR RELAY :

Power Factor Correction Panel with Microprocessor based Automatic Power Factor Controlling Relay and bank of capacitors as given in the data sheet shall be provided for each sections (i.e., transformer incomer) of PCC to continuously measure and monitor the power factor of the electrical system by sensing the total load from the incomer and switch ON / OFF bank of power capacitors to bring the power factor of the system to a preset value. The APFCR shall have a digital power factor meter with 4 digit LCD / LED display.

Panel to be fabricated with 14 SWG thick cold rolled sheet steel structure, indoor type, floor/wall mounted, weather and vermin proof.

Panel should be suitable for 415 volt, 50 Hz., 3 phase supply.

It would consist of –

- An automatic power factor correction relay, **microprocessor based**, with arrangement for sensing the power factor of the inductive load and giving signal to 10 feeders of power capacitors as per the setting of P. F. and electronic circuit to ensure that once a capacitor gets cut off, it is not put on at least for a minute. The relay should automatically manage capacitor banks according to the reactive power required to correct the power factor of the load to the power factor set on the relay. The capacitors must be turned “on” and “off” to correct the power factor of the load to the power factor set on the relay. The relay should have automatic and manual mode of operation with an LED to indicate the operating mode. The auto/manual function makes it possible to turn the capacitor banks “on” and “off” manually regardless of the line value measured.
- For each of capacitor feeder one set of suitable rating MCCB, contactor, pair of ON/OFF push button and indication lamp shall be provided.
- Flush mounted, 96 mm x 96 mm square, digital Power Factor meter having 4 digits LCD or LED display.
- Selector switch and CT operated digital ammeter of size 96 mm x 96 mm.
- Selector switch and digital voltmeter of size 96 mm x 96 mm.
- Auto-manual switch and connected circuit to ensure that in manual mode each capacitor can be put ‘ON / ‘OFF’ manually also.
- Incoming feeder of the panel : 4 pole, 415 V, 50 Hz., Manually operated fully draw out type ACB of suitable rating with **built-in microprocessor based programmable protection**. Microprocessor based programmable protection unit shall have settings for overload, short circuit, instantaneous and earth fault currents with time delay and LED indicators to show various conditions such as Power ON, Overload, Short-circuit, Instantaneous Earth fault, Percentage load, Self Diagnostic Test etc. Mechanical spring charging mechanism stored energy type shall be provided with mechanical indicators to show 'Open', 'Closed', 'Service' & 'Test' positions. The circuit breaker shall be provided

with mechanically operated emergency tripping device. This device shall be available on the front of the panel. The built-in earth fault relay shall be provided for the ACB.

- Suitable 3 phase and neutral bus bars.

Wiring for all above accessories/functions should be complete and ready for use. The details of each capacitor bank rating, no. of capacitor banks for power factor improvement shall be as per details given in the data sheet and schedule of quantities.

All power cabling between PCC and capacitor banks panel and cabling of each capacitor are included in the scope of work of this package. Power improvement capacitors shall be housed in the panel itself and provided with adequate louvers for proper ventilation.

6.8.2 POWER CAPACITORS BANKS :

The power capacitor banks shall be used to improve the power factor of an electrical system and shall be housed in the APFC panel itself and provided with adequate louvers for proper ventilation.

6.8.2.1 Design Requirements :

Each basic unit is to be built up with a number of elements. These elements shall be of two layer dielectric design (non-self healing) using heavy Polypropylene Film, Aluminium Foil and Capacitor Tissue Paper as required; to ensure that total dielectric thickness is more than 14 micron. Capacitor element must be completely sealed with epoxy resins to provide maximum humidity protection and highest insulation. The capacitor elements are to be given adequate outside insulation and should be put in all welded surface treated MS containers. The outer surface shall be provided with a coat of protective primer followed by two coats of synthetic enamel paint of approved shade. These capacitors shall be impregnated with special grade of capacitor oil under high vacuum. The metal case shall be equipped with porcelain bushings to permit connection between power lines and active capacitors. The unit shall have built-in internal individual fuses.

Externally each capacitor unit shall have two separate earthing points, name plate confirming to the requirements of IS-2834 (amended up to date), discharge resistances etc. Each capacitor should be suitable for operation on 440 V, 3 Phase, 50 Hz AC power supply.

6.9 LT POWER & CONTROL CABLES :

6.9.1 LT Power Cables :

Power cables for use on 415 V system shall be of 1100 V grade, aluminium conductor, XLPE insulated, PVC sheathed, armoured and overall PVC sheathed, strictly as per IS : 7098 (Part I)/88 for cables of size 35 mm² and above. Power cables of size less than 35 mm² shall be PVC insulated, PVC sheathed, armoured and overall PVC sheathed as per IS : 1554 (Part I)/88. **Unarmoured cable to be used only if specifically mentioned in schedule of quantities.**

The size of various cables shall be worked out by the contractor and details and indicated in single line diagram to be submitted with their bids.

6.9.2 LT Control Cables :

Control cables for use on 415 V system shall be of 1100 V grade, copper conductor, PVC insulated, PVC sheathed armoured and overall PVC sheathed, strictly as per IS: 1554 (Part I) – 1976. Unarmoured cables to be used only if specifically mentioned in schedule of quantities.

The size of various cables shall be worked out by the contractor and details and indicated in single line diagram to be submitted with their bids. The minimum conductor diameter shall be 2.5 mm².

6.10 EARTHING SYSTEM & LIGHTNING ARRESTOR :

The intent of this specification is to define the requirement for the supply, installation, testing and commissioning of the earthing system and lightning arrestor.

6.10.1 Earthing Network : The scope of earthing includes complete earthing system for the four pole structure, HT VCB Panels, transformers, PCC, APFC panels, cable glands etc complete with suitable earth pits and earth strips as per IS 3043.

6.10.1.1 The entire earthing installation shall be done in accordance with the earthing drawings, specifications and standard drawings of reference. The entire earthing system shall fully comply with the Indian Electricity Act and Rules framed there under. The contractors shall carry out any changes desired by the Electrical Inspector or the Owner in order to make the installation conform to the Indian Electricity Rules at no extra cost. Any changes in the method, routing, size of conductors etc. shall be subject to approval of the owner / engineer in-charge before execution.

6.10.1.2 Excavating and refilling of earth necessary for laying underground earth bus loops shall be the responsibility of the contractor.

6.10.1.3 The resistance between the earthing system and the general mass of earth shall be as per IS code of practice. The earth loop impedance to any point in the electrical system shall not be in excess of 1.0 Ohm in order to ensure satisfactory operation of the protective devices.

6.10.1.4 The main earth loop shall be laid at the depth of 500 mm below ground level. Wherever cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleated to the walls when running in concrete lined trenches. The earthing strip shall be protected against mechanical damage.

6.10.1.5 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below ground shall be welded and suitably protected. Joints above ground shall be made by means of connectors/lugs as far as possible. The connectors shall be used for tapping earth leads from the main earth loop wherever it is installed above ground. Where aluminium risers are to be connected to the underground GI earth bus, the aluminium riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable then GI riser shall be brought above ground and a bolted joint shall be made between this GI riser and the aluminium riser.

6.10.1.6 Conduits in which cables have been installed shall be effectively bonded and earthed. Cables armouring shall be earthed at both ends.

6.10.2 Earth Pits & Electrodes :

6.10.2.1 Earth pits and the **plate electrodes (of 1200 mm x 1200 mm x 12 mm thick CI plate)** of earth pits shall be installed in accordance with the standard drawings of reference and latest amendment of IS: 3043- 1987. However, the earth pits for neutral earthing of transformers and DG sets shall have copper plate electrode of 600 mm x 600 mm x 3 mm. The earth pit shall be complete with GI pipe and funnel for watering, necessary quantity of salt & charcoal and a masonry chamber with hinged CI cover. Their location shall be marked to enable accurate location by permanent markers.

6.10.2.2 All earth electrodes shall preferably be driven to a sufficient depth to reach permanent moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

6.10.2.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months preferably after a protected dry spell. If necessary a number of electrodes shall be connected in parallel to reduce the earth resistance. In such a case, the distance between the electrodes shall preferably be not less than twice the length of the electrode.

6.10.2.4 The electrodes shall have a clean surface not covered by paint, enamel, grease or materials of poor conductivity.

6.10.2.5 The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/engineer-in-charge or his authorized representative, depending upon the soil data and resistivity to meet the ohmic values as per statutory requirement.

6.10.2.6 The distance of Earth Pit centre from the nearest building shall not be less than 2 meter. Also, the earth pit to earth pit distance shall not be less than 3 meter.

6.10.2.7 Test disconnect facility shall be provided for the earth pits to check their earth resistance periodically.

6.10.3 Connection :

6.10.3.1 All electrical equipment under the scope of this tender is to be doubly earthed by connecting two earth conductors from the frame of the equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The cable armouring will be earthed through the strips cable glands.

6.10.3.2 In hazardous areas, all major process equipment shall be connected to the earthing ring by means of anti-loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

6.10.3.3 The following shall be earthed :

Transformers neutral earthing	Shall have two earth pits per transformer with 600 X 600 X 3 mm copper plate electrode. These shall be independent of all other earth pits
Transformers housing/body earthing	Shall have earth pits with 1200 X 1200 X 12 mm CI plate electrode. These shall be independent of all earth

	pits meant for earthing of four pole structure and neutral earthing of DG sets and transformers
All switchgear panels and their earth buses	Shall have earth pits with 1200 X 1200 X 12 mm CI plate electrode. These shall be independent of all earth pits meant for earthing of four pole structure and neutral earthing of DG sets and transformers
All fences/enclosures housing elect. Equip	Shall have earth pits with 1200 X 1200 X 12 mm CI plate electrode. These shall be independent of all earth pits meant for earthing of four pole structure and neutral earthing of DG sets and transformers
DG Set neutral earthing	Shall have two earth pits with 600 X 600 X 3 mm copper plate electrode. These shall be independent of all other earth pits
DG set body earthing	shall have earth pits with 1200 X 1200 X 12 mm CI plate electrode. These shall be independent of all other earth pits

Number of earth pits and conductor size for connection to various equipment shall be as per the requirement / approval of the purchaser / owner and meet the requirement of local electrical inspectorate.

6.10.3.4 System shall be earthed by two distinct conductors directly connected to independent earth electrodes, which in turn shall be connected to the earth loop.

The earth connection shall be properly made. A small flexible aluminium loop to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a lightning surge, high voltage surge or failure of bushings.

6.10.3.5 All paint, scale & enamel shall be removed from the contact surface before the earthing connections are made.

6.10.3.6 Earth connections at the equipment terminals shall be made in a mutually agreed manner. Anchor bolts or fixing bolts shall not be used for earthing.

6.10.3.7 All hardware used for earthing installation shall be hot dipped galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment having parts of vibrations.

6.10.3.8 Testing :

Earthing systems/connections shall be tested as follows :

- i) Resistance of individual electrodes shall be measured after disconnecting it from the grid.
- ii) Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid and generally the test value shall conform to IS Code of practice unless otherwise specified.
- iii) The resistance to earth shall be measured at the following :

- a. At each electrical system (earth or system neutral earth)
- b. At one point on each earthing system used to earth electrical equipment enclosures.
- c. At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.
- d. At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

6.11 RUBBER MATS :

Neoprene rubber mats of thickness suitable for the applicable voltage grade and conforming to the relevant IS specifications shall be supplied for HT panels, LT Power Control Centre, DG set control Panel etc.

6.12 SAFETY ACCESSORIES & MISCELLANEOUS ITEMS :

The supply and installation, wherever applicable, of following sub-station safety accessories and miscellaneous items is included under the scope of work of this contract:

- Fire extinguishers, of type and capacity as approved by the purchaser, for substation building and fire buckets with stand for switch yards & transformer yard – 1 lot
- Hand Gloves suitable for the applicable HT voltage grade – 2 pairs
- VCB breaker operating tools and tackles – 2 sets
- D.O. fuse operating handle suitable for the applicable HT voltage grade – 1 set
- Danger Boards, Shock Treatment Chart, Artificial Resuscitation Unit, First-aid box etc., which are required as per statutory regulations – 1 lot

6.13 LIST OF PREFERRED MAKES OF EQUIPMENT & ACCESSORIES :

MAKES OF ELECTRICAL ITEMS	
NAME OF ITEMS	APPROVED MAKES
HT VCB Panel	SIEMENS / ABB / SHNEIDER / AREVA T&D
OLTC Transformer (oil filled type)	SIEMENS / BHARAT BIJLEE / AREVA T&D / VOLTAMP / KIRLOSKAR
Air Circuit Breaker	L&T –U Power/ SIEMENS 3 WL / SCHNEIDER Masterpact NW series
MCCB	L&T D' SINE / MDS-LEGRAND / SIEMENS 3 VL / MERLIN GERIN Simpact series
Protection Relays	L&T / SIEMENS / ABB / SCHNEIDER / AREVA T&D

Contactors	L&T / SIEMENS / ABB / SCHNEIDER
Timers Electronic	L&T / SIEMENS / SCHNEIDER / GE
Switch Dis-connector Fuse Units	L&T / SIEMENS / ABB / SCHNEIDER
MCBs	SIEMENS / HAGER / MERLIN GERIN / MDS-LEGRAND
Indicating Lamps	L&T / SIEMENS / SCHNEIDER / VAISHNO / TEKNIC / ESSEN / BINAY
Push Buttons	ESBEE / SIEMENS / SCHNEIDER / ABB / GE / VAISHNO / TEKNIC
Load Manager	ENERCON / ALLEN BRADLEY (ROCKWELL) / SCHNEIDER / ABB / SIEMENS / L&T
Digital Ammeter & Voltmeter	ENERCON / L&T / HPL SOCOMEC / CADEL / MECO
Analog Ammeter & Voltmeter	RISHABH / IMP / MECO / AE
Digital Energy Meter	ENERCON / L&T / SCHNEIDER / HPL SOCOMEC / AE
PVC Conduit & accessories	PRECISION / POLYCAB / CLIPSAL
Power Factor Meter	RISHABH / IMP / MECO / AE
Current Transformer	KAPPA / MECO / AE / IMP / INDCOIL
HT XLPE Power Cables	CCI / RPG ASIAN / FINOLEX / FORT GLOSTER / POLYCAB
LT XLPE Power Cables	CCI / RPG ASIAN / FINOLEX / FORT GLOSTER / POLYCAB
LT Copper Control Cables	LAPP KABEL / CONCACB / CCI / RPG ASIAN / FINOLEX / RR KABELS (UNILAY) / FORT GLOSTER / POLYCAB
Signal & Instrument cable	LAPP KABEL / CONCACB / POLYCAB
Power Capacitors	SIEMENS EPCOS / MEHER / KHATAU JANKAR /
APFC Relay	BELUKE / EPCOS / L&T / PHASITRON / MECO
Cable Tray	INDIANA / MEK / SUNRISE / SUPER / PILCO
Isolating Switches	SIEMENS / L&T / ABB / SCHNEIDER
HRC fuses	L&T / SIEMENS / EE / GE
Terminal Blocks	WAGO / LAPP INDIA / CONNECT WELL / ELMEX
Potential Transformers	KAPPA / JYOTI / IMP / AE / ASHMORE
Rotary Selector Switch	KAYCEE / SALZER / L&T / SIEMENS / ABB / SCHNEIDER
Cable Glands	COMET / EX-PROTECTA / DOWELS / LAPP KABEL
Cable Lugs	DOWELS / COMET / LAPP KABEL

Mechanical Interlock	L&T / SCHNEIDER / ABB
XLPE cable jointing / terminating kit	RAYCHEM / M-SEAL
Programmable Protection Relay	MINILEC
DG Set	CUMMINS / CATERPILLAR / KIRLOSKAR

NOTE : CONTRACTORS HAVE TO CLEARLY INDICATE THE MAKE OF ITEMS / EQUIPMENT CONSIDERED BY THEM IN THEIR OFFER.

7.0 BATTERY LIMIT :

This specifies in brief the scope of the contractor and Owner / Purchaser by specifying the limits at which contractor's scope Starts and Ends.

<i>CONTRACTORS SCOPE</i>	<i>CONTRACTOR'S SCOPE</i>
<i>Package A, B and C</i>	
Civil Works:	
All civil buildings for the indoor type equipment and RCC foundations / platforms for installation of transformers	Providing all necessary foundation bolts, foundation plates and templates
RCC hume pipes for crossing roads.	Civil works related to laying of underground cables, such as digging of trenches, providing sand and bricks etc., and for fixing cable route markers
Fencing with related civil works for transformer yard.	Civil works related to earth pits such as digging of earth, making watering chambers etc.
	Civil works related to installation of Four pole structure
RCC cable trenches in transformer yard and sub-station building with MS angle nosing for laying HT/LT cables	Supply and grouting of additional MS angles/channels supports/brackets for installation of equipment, cable trays and laying cables in trenches inside the building. Supply and installation of chequered plate covers for cable trenches in substation building.
	Clearing of site, de-watering, if water logging is encountered during digging for cable laying / earth pits / Four pole structure erection etc.
Electrical Works:	
Lighting in sub-station building and transformer area	Starts from outgoing side of the State Electricity Board's HV DP structure and ends at termination of LT bus duct and

	cables in PCC
Supply and laying of cables from DG Sets up to PCC including termination, DG set earthing	Supply and installation of earth continuity strip as per statutory requirement

8.0 INFORMATION TO BE PROVIDED BY THE CONTRACTOR :

The contractor shall have to provide the following technical data and information

- **Suggested Equipment Layout drawing of sub-station**
- **Single Line Drawing of all panels**
- **Cable scheduling and route**
- **Earthing System layout**
- **HT panel critical technical data**
- **Transformers critical technical data**

1. No load losses at rated voltage & frequency : ----- Watts
2. Full load losses at rated current at 75 Deg. C. : ----- Watts
3. Impedance at rated current & frequency at 75 Deg. C. : ----- %
4. Efficiency at full load 0.8 P.F. lagging at 75 Deg. C. : ----- %
5. Approximate quantity of oil required for first filling : ----- Litres
6. Max. rise in winding temperature (above ambient temp.): 55 Deg C
7. Max. rise in oil temperature (above ambient temp.) : ----- Deg C
8. Duration and percentage overloading : As per IS 6600
9. Losses to be indicated by the contractor at 100%, 75%, 50% & 25% load of transformer rated capacity

- **PCC critical technical data**

1. Fault Level :
2. Class of Protection : IP -----

9.0 APPLICABLE BIS CODES & STANDARDS :

The switchgear and the mounted equipment shall conform to the latest revision of the following Indian Standards:

IS:12729 General requirements for switchgear and controlgear for voltages exceeding 1000 V

IS:13118 General requirements for circuit breakers for voltages exceeding 1000 V

IS: 9920 Switches and switch isolators for voltages above 1000 V exceeding 11000V

IS:3427 Metal enclosed switchgear and controlgear for voltages above 1000V but not

- IS:5082 Material data for Aluminium bus bars
- IS:9921 AC disconnectors (isolators) and earthing switches for voltage above 1000
- IS:9046 AC contactors of voltage above 1000 V upto & including 11000
- IS:13703 Low voltage fuses
- IS:2705 Current transformers
- IS:3156 Voltage transformer
- IS:3231 Electrical relays for power system protection
- IS:6875 Control switches and push buttons
- IS:694 PVC insulated cables for working voltages up to and including 1100V
- IS:11353 Guide for uniform system of marking and identification of conductors and apparatus terminal
- 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 for phosphating of iron and steel
- IS:772 Part-I AC Electricity Meters : Part –I general requirements and test
- IS:1248 Direct acting electrical indicating instruments
- IS:3618 LV Switchgear and control gear
- IS:5 Colours for ready mixed (Part-I to Part-5)